WHAT DOES DETERMINE HUMAN DESTINY?—SCIENCE APPLIED TO INTERPRET RELIGION

by Ralph Wendell Burhoe

What does determine human destiny? The operations of an omnipotent, sovereign God proclaimed by traditional religions as the Lord of History that predestines all, or the operations of science's nature, which, with its invariant laws and arbitrarily given circumstances, may be a mechanism within which the successive stages of its patterns (including those of man) are determined?

In my paper entitled "The Human Prospect and the 'Lord of History' " (to which I shall hereafter refer as my "Lord of History") I sought to bring together considerable evidence that the two answers are equivalent at the intellectual level.[1] But from my scientific analysis of religion I understand religion to be more fundamental for human life than science, just as a scientific perspective tells me that my food is more fundamental than my science. I also understand that religion has become increasingly impotent to appeal to a scientifically informed mind and civilization. Therefore I suggested how an awareness of the intellectual equivalence might make possible a scientific theology that could revitalize religion's capacity to motivate man's morale and morals so as to enable him to be viable in a culture dominated by science and its technologies. But my claims for a scientific theology have been challenged as to both its scientific authenticity and its capacity to revitalize religion. I believe the challenges stem largely from a lack of understanding of the scientific grounds on the basis of which I seek to interpret religion and a failure to appreciate how beautifully this confirms the basic wisdom of traditional religion. The challenges therefore stem from my failure to communicate, and this paper will be an essay to remedy this communication.

Since there was exceptional interest in and some controversy about

Ralph Wendell Burhoe is *Zygon* editor and director of the Center for Advanced Study in Religion and Science, affiliated with the Chicago Cluster of Theological Schools. This paper is his response to the five critiques, published in the March 1977 *Zygon*, of his scientific approach to theology.

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the *Zygon* issue on the Symposium on the Human Prospect, a Chicago-based, faculty-level seminar in the spring of 1976 met to review it.[2] Five seminar papers critically examined my claim, particularly in my "Lord of History," that I was doing scientific theology and also my claim that this could save religion and thus save civilization from the decline and fall predicted by Robert L. Heilbroner's *An Inquiry into the Human Prospect,* which was the focus of the symposium.[3]

While these five papers were prepared by my friends, all of whom are strongly concerned with the need to respond to the threats to civilization such as those recounted by Heilbroner and all of whom felt that somehow religion needed to be involved, the paper writers obviously did not find my "Lord of History" paper convincing either from the religious or the scientific point of view. Because I know their criticisms represent a wide spectrum of critics of my position and hence of *Zygon*'s position, I published these five papers in the March 1977 or first issue of this volume of *Zygon.* The readers of this paper responding to those five may wish to have them in hand as they read, at least if they wish themselves to become critically involved in this important debate as to whether there can be a scientifically based interpretation of religion that can be significant for human salvation.

Communication Barriers: Cultures, Paradigms

The difficulty that many critics have with the notion of a scientific theology and my "Lord of History" is in large measure one of communication between two cultures of the kind made notorious by Sir Charles P. Snow in his *The Two Cultures and the Scientific Revolution.*[4] This communication is more difficult than that between persons who speak different natural languages because the sounds and shapes of the words in the two cultures may be identical yet have different meanings hidden from the hearer from the other "culture." Everyone knows that the English language is full of words that have different meanings in different contexts. Cleverly used, such words make funny puns as the hearer's mind suddenly becomes aware of a startling incongruity when a second context dawns. But the hearer's mind is confused only when he does not happen to be aware of the different context and connotation. Because of the fact that the sciences are full of terms that look like ordinary English words but to which the different disciplines of the sciences have given very special meanings for necessary reasons in the development of their science, we find ourselves living in a tower-of-Babel culture where the people in one special discipline often do not understand those in another. This barrier to communication is particularly confusing between the two

major groups of contemporary academic disciplines called the humanities and the sciences. The humanities (including religion and other disciplines that communicate cultural values) tend to use a fairly well-understood traditional language, while the sciences (including scientific engineering and technology) tend to use newly defined meanings of words which the nonscientists often do not understand, even when they think they do.[5]

A very nice exposition of the problem is presented on pages 28–31 of Arnold W. Ravin's paper criticizing my "Lord of History."[6] (After my first mention of any of these five critical papers published in the first or March issue of this volume, I shall not provide bibliographic notes but simply give page numbers in parentheses after the quotation.) Ravin points out the different meanings of "natural selection" which became a technical term in evolutionary theory with a very special meaning often not understood by the layman. Curiously he had presumed that I was unfamiliar with the technical meanings of the term, perhaps because of my use of theological talk on the one hand and some newer scientific meanings of natural selection with which he is not familiar on the other hand. This presumption led him to provide a thoughtful and excellent account of the problem of the communications barriers between the two cultures because my language had caused him to presume I needed it.

A more general example of the same difficulty that operates to prevent understanding by persons oriented in one culture, of what is being said by persons in another culture, is presented on the first page of John A. Miles, Jr.'s, critical paper—a quote from William Blanpied's pessimistic assessment of a 1975 "Interdisciplinary Workshop on the Interrelationships between Science and Technology, and Ethics and Values": "The modes of thinking and acting that characterize the different academic disciplines are not really understood or appreciated by scholars outside those disciplines."[7]

Although Snow was referring primarily to the barriers of communication between the scientific and the humanities divisions or two cultures in Western universities, the same difficulty is often found, as Blanpied noted, between many disciplines even within the same general family, such as between different sciences, or even within a single, sharply defined discipline, such as physics. This difficulty was poignantly noted by the Nobel Laureate Max Planck and sometimes has been called "Planck's Law": "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."[8]

Thomas S. Kuhn, writing about this phenomenon of barriers to

understanding in his *The Structure of Scientific Revolutions,* commented that the "transfer of allegiance from paradigm to paradigm is a conversion experience that cannot be forced."[9] Kuhn uses the term "paradigm" to denote roughly what Snow meant by "culture." More specifically Kuhn's "paradigm" refers to the total tradition on the basis of which a community of scientific researchers are carrying on their research in elaborating the "normal science" of that particular tradition.[10]

But in the course of time, as the concepts and methods of a science may become unable to deal adequately with some newly discovered "facts," one man or a few will discover or invent a new paradigm that can describe or explain adequately both the old and the new "facts." Sooner or later the new paradigm replaces the old. A well-known example is the Copernican revolution, the development of a new paradigm or perspective that viewed the sun rather than the earth as the center of the universe. But human nature is such that the notion that the sun stands still and it is the earth that moves affronts the "comon sense" inherent in the earlier paradigm, and it may take a hundred years before the new one is accepted.

The same kinds of change and development happen to cultural tradition in other fields than the sciences, but by somewhat different mechanisms.[11] The totality of a culture or various subdivisions of it—such as languages, religions, politics, etc.—from time to time undergo radical reformations in relatively short periods, after which the newly established paradigm or cultural pattern operates effectively or stably in its "normal state" until another crisis of inadequacy confronts it and forces change.[12]

I am suggesting that the new views held by a number of us associated with the development of *Zygon* represent a new paradigm, a new perspective for looking upon both religious and scientific "truth," that brings both sets of "truth" into a common system. This is as startling both to the theological-philosophical and to the scientific communities of today as was the Copernican system at the time it was emerging. For this reason my papers, and in general the program that has been exemplified by *Zygon,* frequently are not at first sight meaningful or acceptable to some persons, probably most persons in the academic disciplines of either religion or science.

I should point out that the general program of *Zygon* began with a group of distinguished scientists who were concerned with the problem of human values, the relation of the sciences to the humanities, the obvious threats to civilization already clear by the time of World War II posed by the immoral use of scientific technology and the failure of religion to provide effective guidance or motivation for

human values. This group was beginning to shape a new paradigm for the understanding of human values and religion in the context of the sciences, a perspective within which one may see the wisdom and necessity of religious tradition. I have provided earlier accounts of this history and will not detail it again here except to point out that, even though many representatives of our group have been outstanding, the very incomprehensibility and hence appeal of the new paradigm causes the new view or paradigm to be rejected by the central authorities in the various intellectual disciplines involved.[13] I take pleasure in reprinting in this issue of *Zygon* as our lead article F. S. C. Northrop's "The Methods and Grounds of Religious Knowledge," representing the view of one of our associates since the late forties, as still one of the best statements of the problem and programs for its solution, to which I shall refer more later. But the point here is that the problem of our two cultures or of a new paradigm has caused such new views to be left unapplied and seemingly irrelevant or erroneous to the leaders of religious thinking and education as well as to those in the sciences or even the sciences that are being applied to understanding human values.

I should also point out a second lesson from our present understanding of cultural changes or scientific revolutions, and that is that even within the relatively small populations of pioneers, who to some degree associate in providing the new paradigms or ways of understanding, there is inevitably a good deal of disagreement or difference as to how to specify what is essential and significant in the scientific revolution or the religious reformation. It should come as no surprise, then, that in this issue of *Zygon* I should seek to show that I think my five colleagues are wrong in judging my theology not to be scientific and in judging science's nature not to be the Lord of History.

My Response to a Scientist's Critique

I begin with some efforts to correct what I feel are misinterpretations by colleagues in the scientific community and in particular the views expressed by Ravin in his "On Natural and Human Selection, or Saving Religion" in the March 1977 issue of *Zygon*.[14] His views represent some that are widespread but by no means universal among my scientific colleagues. I start with the scientists and Ravin because he and many other scientists do not understand or accept the picture of the evolution of man's mind and culture as fully continuous with that of his genes. Acceptance of this evolutionary picture is essential for seeing that not only preliving material systems and unconscious living systems but even all consciousness itself, including private prefer-

ences, emotions, religion, theology, and even the sciences, are all products of selection by the nature inherent in the evolving system of the universe. This view is a recent one among scientists, some of whom have been published in *Zygon*.[15] I publish in this issue another excellent example, by H. J. Hamilton, of this new theory of evolution, which will constitute part of my response to Ravin. But also I must respond specifically to Ravin.

I should note that Ravin's views represent what has been a relatively small class of scientists who are very sensitive, sympathetic, and concerned with regard to the ethical and religious problems, even though they are skeptical or agnostic about traditional religion. As a rule they do not allow in their thinking for a scientific approach to human values or religion. This tends to disallow for them my scientific approach.[16]

There is another relatively small class or population in the scientific community who are deeply committed to traditional religion and who are even more insistent in not allowing a scientific theology because it threatens what is to them the sacredness of their fully and deeply believed religious faith. Such persons may be found in a society called the American Scientific Affiliation, where there are many "fundamentalist" religious believers who laudably are concerned to defend their faith against corruption by the sciences.[17]

By far the largest part of scientists and scientifically oriented technologists—and especially so in those areas of science that are scientific about human nature—have had little or no use at all for traditional religion and in general have tended to deride it as the superstitions of primitive ancestors.[18]

Thus, for very different reasons, to few scientists does a scientific theology make any sense.

Thus from the scientific community (as well as from the religious and theological community) there have not been many who have much serious interest in the value of our, or even any, movement to integrate religion and science.

I have classified Ravin in the relatively small class of scientists who have a strong sensitivity and concern for values and ethics. But, as can be seen from reading his paper, he, like the fundamentalists, cannot integrate his science with his notions of values and religion.

Most of the people in this class of scientists are what I would call naive realists in the sense of distinguishing their position from that of the critical realism that Miles properly ascribes to Ian Barbour and which characterizes some theoretical scientists and philosophers of science.[19] The naive realists tend to take the immediate and apparent,

conscious logic and common sense of an uncritical epistemology and ontology as self-evident and adequate for describing how they know and what they know.

My own "epistemology and ontology" do not come from naive common sense or traditional or even sophisticated philosophy, and hence are not at the same level as those of either Ravin or Barbour, but are more like those of Northrop as represented in his paper in this issue of *Zygon*. Like Northrop, I do not claim to be an epistemologist or ontologist or metaphysician in the sense of traditional philosophy but derive my views of knowing and what is known from an analysis of what the sciences themselves have revealed. I share Northrop's understanding of mathematical physics as a key, as when he says, "Trustworthy unseen factors can be distinguished from erroneously inferred ones only by means of the logical and scientific methods developed by the West for making trustworthy inferences about the unseen. . . . [And] no department of Western knowledge is more effective than natural science, especially mathematical physics."[20] But I have gone perhaps further than Northrop in his 1947 book (although perhaps not further than he has gone since) in seeing some of the studies of the past three decades on the brain, information theory, the evolution of cultural as well as genetic information, and the development of the brain in ontogeny as grounds for epistemology and ontology. I do not think Barbour's "critical realism" involves much of this level. I would judge Ravin not to have gone as far as Barbour's critical realism, and clearly Ravin does not understand his own conscious choices to be operating according to a selective program in which they are just as much caused or determined as anything else in nature.[21]

On Natural Selection. Because he obviously has not carefully noted that I clearly separate genetic and cultural evolution and that my use of "natural selection" in the context not only of the selection of genes but also of the selection of culturetypes is not less but more "physicalistic" than that of hard-line neo-Darwinism,[22] Ravin thinks I am using the term in naive, metaphorical fashion, and he is "concerned . . . with a naive use of the metaphor that results in loss of any distinction between biological and human evolution" (p. 30). My distinction between the genetic mechanisms and the cultural mechanisms that inform the structures and behaviors of organic life is very clear and is described in several papers including the ones Ravin is reviewing. I have pointed out the superimposition of culturetypes on genetic information through their interactions with the phenotypic products of the genotypes in the brains of the organisms. Transmis-

sion and reception of cultural information are at the opposite end of the spinal column from those of genetic information. Ravin and others may misunderstand me because they are not so careful as I in distinguishing between biological and genetic evolution, which I learned from G. G. Simpson, who pointed out that "culture is a biological adaptation, and cultural evolution is a continuation of biological evolution by other means." Moreover, since cultures as well as genes are selected by the viability and capacity of their phenotypes to transmit them, they are jointly selected by the adaptation of the phenotypes which they jointly program.[23]

Furthermore, Ravin finds mine "a strange formulation of the mechanism of natural selection, at least to a biologist" (p. 31). Indeed it is strange. Most biologists and developers of the remarkable breakthrough that is modern genetic and evolutionary theory have been too busy with their own immediate research to have had time to do what perhaps only a few among them and some of their colleagues in other disciplines have taken up actively—the placing of that genetic theory of evolution within the larger context of the general processes of our universe ranging from cosmic and chemical levels of phenomena that undergird and lead up through the biological levels, to the cultural and psychological levels that have emerged on these as their base.[24] Moreover, Ravin dismisses Donald T. Campbell's theory of "natural selection" mechanisms operating in cultural and psychological processes on grounds that although "Campbell has been making a valiant effort to find the analogs of variation and selection in human social evolution, . . . he has already had to correct some early proposals" (p. 34). This seems to me to be a very unscientific ground for dismissal.

Perhaps Ravin's misinterpretation of me stems from his misreading my use of selection in human evolution to mean the conscious selection that men make, when in reality I am referring to a selection that nature makes, not man. When I use the term "selection" I am not using it in the anthropomorphic sense to describe the activities of some mind like a man's. I am referring only to the outcome of a constellation of forces that operate to produce it. I speak as does a physicist when describing the tendency of wandering marbles in a shallow, shaking bowl to want to return to the bottom of the bowl as a result of their gravitational attraction toward the center of the earth. All these terms—like "tendency," "wandering," "want," "return," and "attraction"—may once have been analogies to human behaviors in our language. But in general physicists do not imagine any homunculus operating, but only Newton's laws and, where necessary, the modern extensions thereof. This model is for me the basic one which

I use for the meaning of "selection": the forces that under the circumstances determine the relatively stable states of systems of any kind whatever, including the ecological niches of species, the patterns of ecosystems, and the correspondingly required information in gene pools or culturetypes to provide the negative feedbacks necessary for such systems. A careful reading of a few of my papers should reveal this quite clearly.

From his assumption that I confuse genetic and cultural evolution and his assumption that I am confusing selection by nature with human conscious selection I would gather that Ravin has not looked at J. Bronowski's *Zygon* paper on natural selection in the context of thermodynamics or my commentary upon it.[25] As a further supplement toward explaining my view of "selection" and "natural selection" as used in such papers as "Natural Selection and God," I would commend Hamilton's "A Thermodynamic Theory of the Origin and Hierarchical Evolution of Living Systems" in this issue; it goes beyond such earlier *Zygon* papers as those of Bronowski and A. Katchalsky to provide a more detailed hypothesis toward an inclusive evolutionary theory.[26] In particular, Hamilton shows how the neo-Darwinian "natural selection" becomes a special case of the more general process of "thermodynamic selection."

On Cultural Evolution. Ravin notes that "if, indeed, human [cultural] selection amounted to the same thing as natural selection, except for a difference in agency—humans selecting where nature otherwise would—there would be every reason for believing that biological and human sociocultural evolution were entirely coincident" (pp. 30–31). But he then goes into analysis that leads him not to accept this coincidence. I would not accept it myself in the form he has put it, for I do not think there is any difference in the agency doing the selection. For me, humans' selecting is simply part of the total natural operation; even conscious choice making by humans is a part of nature as I use the term. Hence I would say that there is not any difference in agency of the selector, since I view men as creatures in nature or God, depending on your language.

I should detail this point a bit further. While Ravin mentions the second of my two stages of the selective process in cultural evolution (the higher court of judgment by the total system of nature) (p. 34), he does not seem to understand it or, as I shall show, to recognize it as exactly the same as what he himself states. Perhaps this is because he overlooked my first stage or lower court of selection in cultural evolution, which is human choices and which for him is "the heart of the matter" of "human selection [and cultural] evolution" (pp. 32–33). My

papers, which he is criticizing, clearly state what he states: that man's unique brain and its capacity for using cultural symbols as well as other kinds of learned information do "make possible modes of evolution that were not possible . . . prior to his appearance" (p. 32).[27] But, as I have pointed out above, I have never said what he implies I said: that "the laws or processes that explain biological [genetic] evolution are adequate to explain human [cultural] evolution" (p. 32).

Moreover, like Ravin, I say human evolution involves "the coupled use of knowledge and values" (p. 32).[28] But I note these constitute only the "lower court" in cultural selection. I do not suppose, as Ravin apparently does, that human evolution is finally selected by the particular values or knowledge that happened to be possessed by a particular individual or a particular culture. I presume that the choices on the basis of such values all have consequences for the phenotype, consequences which cause that particular phenotypic expression of a conscious value-knowledge element of a culturetype to increase or decrease in a particular environmental setting; and these inevitable consequences are exactly my "higher court of selection." The supreme court of selection is the long-term viability of any subsystem (any phenotype together with whatever genetic, cultural, or other information that shapes its structures and behaviors) within the total pertinent ecosystem—my nature or God.

Because the socially transmitted values enculturated in any brain or populations of brains are modifiable, then any unhappy, unfortunate, or lethal expressions of such value-knowledge patterns are weeded out either by the "learning" in individual brains or by the debilitating consequences in populations of them. Such selection by a "higher court" (the consequences in some environment) of one or another value-knowledge pattern may often reverse their value coding in the "lower courts."

Selection of culturetypes is essentially akin to the selection of genotypes alone in that their expressions in phenotypes are selected or rejected by the fate of the phenotype in an environmental setting. The only difference is the mechanism of coding the information and of using it to shape the phenotype.

Thus human conscious choice—based on values interpreted according to human conscious knowledge of a situation—is only a first step in cultural evolution, and in the end the same supreme court, which humans do not and cannot control (the ultimate nature of things), does the selecting as it does for genotypes. It is in this sense that I said in my "Lord of History" that "human choices may be considered for all practical purposes to be random mutations," a statement with which Ravin says he must disagree (p. 32).

But Ravin's statement of disagreement here must have been a confusion in reading what I said or else in what he really thinks, for on the very next page Ravin writes a very nice exposition of just what I mean by human choices being for all practical purposes random mutations. He writes: "Were our knowledge of the system in which we find ourselves a perfect one . . . our choices eventually should end in . . . *the* preferred one; . . . But, alas, while man intervenes in his evolution . . . he ultimately cannot control that evolution, for, lacking certainty about his explanatory model of the cosmic system, he cannot be sure that the course of action he does pursue will not generate new, distressful problems . . ." (p. 33).

Ravin goes even further to support the notion that I and a number of scientists and philosophers hold: that even science develops under a kind of "selection by nature": "Indeed, . . . modern science . . . changes . . . from our ability to correct and replace hypotheses when their predictions fail to conform with experience [the arbitrary "givens" of nature]. We are unable to give other than a limited and contingent credence [even] to [those] hypotheses whose predictions remain empirically successful" (p. 33).[29] It is exactly in this sense that I say that most human choices, even the best informed ones in the sciences, are for all practical purposes random (contingent) mutations, where the corrections and final outcome are selected by the higher court of nature. It must be kept in mind that I am not confusing cultural evolution here with genetic evolution. Cultural selection operates not on the genes transmitted in the human gene pool (except secondarily) but on socially transmitted information stored in brains—at the opposite end of the spinal column from the storage of genes.[30] Admittedly the details of what constitutes a "culturetype," "idene," "idea," or "meme" that may be the unit of selection is now about as foggy as were the details of what is a gene some thirty or more years ago. But the hypothesis is quite as plausible, and some mechanisms have been suggested.[31]

Thus my interpretation of the selection processes in cultural evolution is that they are not human conscious selections in the end but are human choices only in the lower court. I submit that the preceding paragraphs and the documents to which they point provide the opposite of what Ravin calls "a naive use of the metaphor [of natural selection] that results in loss of any distinction between biological and human evolution" (p. 30). I submit also that contrary to failing to make clear they make extremely "clear . . . that the configurations that [are selected] are beyond the control of the selecting mechanism" and "arise in a random way" (p. 31). Curiously it is I who have to show Ravin the inconsistency of his own exposition that denies my correct-

ness in stating that human choices for long-range purposes are essentially random mutations, while he himself goes beyond this to assert the contingency or randomness of even scientific "hypotheses whose predictions remain empirically successful" (p. 33).

On What Agencies Cause Selection. Ravin states that "[natural] selection consists uniquely in a change in proportion of [the variant] configurations or genotypes on the basis of their fitness, which is nothing more than their relative rates of reproduction. What determines the outcome is the relative capacity to survive and multiply. No other criterion exists, and there is no need to postulate an agency that is doing any selection" (p. 31). This is a kind of dogma that has been popular among some of the neo-Darwinists but has been severely criticized by many competent evolutionists and has lost some of its earlier appeal. It is partly self-contradictory, in that the "relative capacity to survive and multiply" of variant genotypes in variant environments implies that the environment is the agent that does the selecting, and this is often clearly stated by various writers on evolutionary theory. I have joined others to criticize the emptiness of this dogma when stated as "Fitness is nothing more than relative rates of reproduction." That is not science but simply tautology.

Even though Ravin uses this tautological view of some forms of neo-Darwinsim to refute my argument for an agency doing the selection, he concludes his paragraph by saying: ". . . there is no intermediary between the genotypes, or [rather] their bearers, and the environment imposing conditions for survival and reproduction . . ." (p. 31). An *environment* that imposes the conditions seems to me to be just what I have written to describe the agency of natural selection and seems to me contradictory to his earlier statement that "there is no need to postulate an agency that is doing any selection."

Be that as it may, clarifying this point is important for my argument, that is, that selection is not merely a logical or mathematical tautology but a "real" process, system of forces, or "agency" in nature that causes or brings to pass certain results: in other words, that selection theory can be a branch of deductive, empirically tested science like Newtonian or quantum mechanics, not just a circular tautology like "the fit are those who survive," or "those that survive are the fit," or "the reproducers are those that reproduce."

On Science, Determinism, Nature, and God. Here I should digress to say a little more about what I mean by scientific explanation and causality. Scientific statements in themselves as mere statements are, of course, nothing but a system of symbols and may have only the logical properties of any tautological symbolic game. Logic, mathe-

matics, or rules of the game allow one to say proper things relative to the rules of the game. But this says nothing about the "real world" of experience beyond the games of verbal or other symbols.

It has been the genius of modern science to rise above the emptiness or circularity of statements that are true or correct only relative to the internal rules of the symbolic games. It has done this by insisting on the systematic practice of empirical testing. The empirical contact with the "real world" in any naive sense has in this century come to be recognized as what Karl R. Popper has called the problem of erecting the structures of science on piles driven down into a bottomless swamp.[32] But as a first approximation of some empirical reality the scientific community requires some "operational definition" or "epistemic correlation" (many other terms have been used by different scientists and philosophers of science) between the system of symbols in the statements and some tangible, sensory, or other correlated nonverbal experience that practically all men may have if they go to the trouble.

This epistemic correlation of the system of logically interrelated symbols with the sense data or the directly perceived experiences that people commonly have transforms logical tautologies into scientific descriptions of what people usually call causal behavior in the "real world." It is "real" because these descriptions thus tie or relate people's verbal or other symbols directly to what they presume is "the real world," since it is the "natural" unmediated product that the brains of *Homo sapiens* commonly produce in their interactions with what is presumed to be a common general environment. Hence the scientific symbol systems that are thus tied to common experience become the formulations of what we believe to be true ontologically as well as logically.[33]

It should be noted that insofar as you presume that logical relations have been or could be established to relate one thing to another you have implicitly and inescapably committed yourself to a kind of "deterministic" philosophy. By its nature the scientific world view attempts to provide logical relations and hence attempts to be deterministic. Hence the world or the nature described by the sciences is a deterministic scheme insofar as any logical sense has been made of it. If you do not like determinism, do not try to make any logical statements that provide necessary consequences for events in the real world or nature.

The term "nature" as I use it is the mathematically or logically articulated scientific conceptual system that has been firmly anchored to what people experience. Hence it is the closest our verbal or symbol systems get to ties with what people actually experience, the "real

world," the "truth." But, as Northrop and many others point out, the logical hierarchies thus tied or related to actual experiences provide the most powerful abstraction and reduction of the chaos or unrelatedness of the elements of unsystematized experience. Like similar processes in the brain at prior levels—that abstract and simplify and "make sense" of the barrage of inputs to the sensory systems so that some order can be seen in it—the evolution of language, logic, and science has provided hierarchical abstractions of "raw data" from lower levels and made simple enough symbolic or conceptual systems (models) so that the human brain can practically handle or manage in its task of informing the organism (unconsciously as well as consciously) as to how it should respond to the complexity of phenomena around and within it.[34]

"Nature," as the term is now commonly used, however, means more than the logically coherent conceptual or symbolic systems which are simple enough for a finite brain and a still more finite consciousness to entertain. It also means the potential, but not yet actually completed, logical relation of the several realms or disciplines that have been elaborated by the sciences as well as by common sense. Nature means all the symbolic or conceptual components described by physics, chemistry, genetics, physiology, sociology, religious myths, etc. For most specialists who are completely occupied within the central ranges of their particular discipline, this larger use of nature to imply the potential unity or coherence of all human conceptual systems that may have pertinent information for describing complex entities is not so common. But there always have been philosophers—and today there are scientific minds—who pursue such unity and who commonly use the term "nature" to represent the projected even if not yet attained unity of our descriptions of an entity, such as a pond, a tree, a man, or a civilization.

Still further, "nature" as used by a number of scientists means more than all that is yet included in either the data of experience or in the postulated conceptual entities that make it coherent or usable in the symbol systems of human communication. Nature has come to be used as are its correlative terms "world," "universe," or "cosmos" not only to denote what is already seen or known but also to denote all the as yet to be discovered or potentially discoverable experiences and concepts ad infinitum. Evidence for this usage is found all over the place in the talk and writings of the scientific community.

It is because of the conviction or faith, common to many scientists, that there is no limit to the potential capacity of the sciences to integrate puzzling new phenomena more coherently within the potentially unifiable scientific conceptual system or paradigm that the term

"nature" becomes equivalent to the prior philosophical and theological and mythical terms used to represent the ultimate power and order behind all things and events of human experience.

Thus "nature" as commonly used in the sciences to denote the potentially logically representable and empirically confirmable relations and dynamics of the interactions of any entity and its environment is my name for the agency or selector that determines the future, as it has the past, history of that entity and thus is the ultimate arbiter of human destiny as well as that of all other things, too. When I claim that "God" is an earlier term for what scientists now call "nature" (or alternatively "world," "universe," "cosmos," etc.), I am simply pointing to the fact that these are equivalent names for the reality which is the producer and determiner of whatever exists or happens and which is the reality to whose requirements for life all viable entities (and the "information" which shapes their behavior) must adapt or conform. This rule applies not only to the information stored in genotypes but equally to other levels of information, whether stored in cultural rituals and mores, or bibles, or engineering handbooks, or intuitively synthesized at unconscious levels of the brain to emerge in conscious choices as ethics, theology, or science. This rule applies to whatever level of information may be involved in the determining of the behavior of any dynamic or living system as Hamilton and others have pointed out.[35]

On Nature and Human Nature

Ravin has a problem with my use of this term "nature," as do also many of my theological colleagues. Ravin quotes from my "Lord of History": " 'If a culture's evolved system of information patterns does not produce viable organisms or phenotypes, then, as a "higher court of judgment," nature (the total reality involved in the system) obliterates those phenotypes and hence that culturetype, just as she obliterates inadequate DNA information in biological evolution' " (p. 34).

Ravin then goes on to comment: "I call your attention to the curious use of the term 'nature' in this sentence. In what sense is nature the arbiter or agent of cultural change? If Burhoe means no more by 'the total reality' than a system in which evolving patterns occur, the statement is circular. If he means a system in which man intervenes deliberately to affect the viability of particular cultural patterns, what then do we make of the notion of a 'higher court of judgment'? Who 'second guesses' man, who is the ultimate arbiter?" (p. 34).

I shall respond to Ravin's comment and the questions he asks, in the same order. Apparently he finds it "curious" to define "nature" as "the total reality involved in the system." In the preceding paragraphs

I have amplified a bit on some of my previously published definitions of how I understand the term "nature" and find it used by many colleagues in the sciences.

Apparently it is "curious" to Ravin because it does not seem conceivable to him that such a nature could be the "arbiter or agent of cultural change" in the way he asserts it is for genetic evolution when nature is the "environment imposing conditions for survival and reproduction—at least in the 'natural' or nonhuman situation" (p. 31). In response I shall add to the general view that I have given in several preceding paragraphs concerning how I think nature is the "arbiter and agent" of all events of culture and everything else. I shall add some specific examples of how I view it operating in human or cultural change or evolution in particular.

First, with regard to cultural adaptations to man's external environment. It is the *nature,* for instance, of wheat, climate, and soil as well as the *nature* of the human need for food that leads to human agricultural patterns of coadaptive symbiosis with wheat. It is the nature of the air fluid, the gravitational forces, and of certain other factors in external nature that led to the cultural adaptations of man's air transport technology, just as the same factors of external nature millions of years earlier had led to the corresponding air transport adaptations of information in the gene pools of bees, birds, and bats.

Every other technology developed in human cultures for man's adaptive relating himself to his external world is equally defined, shaped, or selected by the requirements the total natural system lays upon man's interacting with that part which environs him. Also, it should be remembered that everything inside human nature is an import from the outside. Not only are the atoms that constitute the body and brain imports from a steady flow that passes through the body, which is like a standing wave in a stream, but even the specific dynamic patterning of the wave by genotypes, culturetypes, and other information is all imported from external nature during the period beginning with zygote formation.

Now, turning from man's adapting to external patterns of nature to man's internal nature adapting to other internal patterns of his nature, I shall give three examples of the universal control that the objectively existing patterns of nature have in selecting any further developments in the nature of human culture. Again, we should keep in mind that every internal pattern of mental or cultural nature was at one time not internal but was selected as an adaptative remembrance of a circumstance in the environment of the life pattern whose "phylogenetic line" we are tracing:

1. For instance, it is the inherent requirement of human *nature* as

sexual that in all probability is a primary factor in the nearly universal cultural adoption of taboos against incest.[36]

2. By *nature* genetic structures inherently are forced by selection to prohibit self-denying behavior. Hence genetic structuring of brains that could advance to the level of reality recognition which would produce self-awareness of the demise of the body could take place only if at the same time a symbiotic culturetype were selected to provide adequate rituals and myths that could assure self-awareness of the transcending of death by some significant aspect of the self. Hence, from their beginnings, religious culturetypes which accomplished this were selected.[37]

3. Since it is the *nature* of complex human societies to require a population of animals in which genetic selection forbids "genetic altruism," and yet since these societies nevertheless require phenotypic altruism of individuals in such genetically competing nonkin populations, I have developed a hypothesis that can account for this in the evolution of culturetypes symbiotically coadapted in their religious value cores with natural selection's requirements for genetic selfishness. In other papers I have shown how this symbiosis was accomplished and how it produced an ecosystem which we call civilization. I shall indicate here only that this symbiotic community makes possible, for the first time in the evolution of life on earth, a complex, cooperative society involving nonkin conspecifics who can bestow the genetically programmed self-sacrificial altruism of parents for offspring upon the cultural organism and hence potentially upon any individuals within it. Thus the selection pressures inherent in the basic *nature* of the human situation have produced the coadapted genetic and cultural information patterns that generate the religious rituals and myths that in turn generate the trans-kin-group altruism necessary for human civilization.[38]

Thus, in my view, it is quite clear that nature is in fact both "the arbiter [and] agent of cultural change" or its evolution. Nature operates over millions of years to select the cultural patterns. I share with R. W. Sperry the view that no feature of the human brain is in any sense separable from nature—not even the slightest difference in the molecular chemistry and local electromagnetic fields that may be presumed to be correlated with the brain's production of our fields of awareness and our choices, individually and collectively.[39] And none of these choices remains as a pattern of being for long unless it also fits the requirements posed by the *nature* of the larger external as well as internalized environment for such stability or continuity. I think much evidence has made it abundantly clear that the brains of a population are the locus of the culturetype and of its symbiotic inter-

action with the products of the gene pool to produce the dynamic phenotype of a civilization.[40]

In response to Ravin's assertion that "if Burhoe means no more by 'the total reality' than a system in which evolving patterns occur, the statement is circular," I believe that, on the contrary, I have freed the concept of nature from circularity. In the tautological sense in which Ravin sometimes puts the nature of natural selection, as something disconnected from any agency or cause, as I pointed out above, it would be indeed circular or tautological to say that survival is defined by that which survives or reproduces. But I have pointed out that to be scientific the mathematics of genetic theory require the epistemic correlates that tie it in both with the larger system of the directly experienced facts and with the network of conceptual entities and relations of the natural world that experience and science have established. It is the involvement of the unavoidable facts of experience within any logical conceptual system that frees it from the circularity of a purely mathematical or logical system. I have defined nature in the above paragraphs and in other papers to be this noncircular, nontautological reality system of the scientific world. Nature, as I have portrayed it, is a system filled with the obstinate givens of experience tied to the logical deductions from scientific concepts that make it anything but circular. And yet it is clearly this nature or this world in which and because of which, as Bronowski noted in *Zygon,* all the processes of evolution from that of atoms to that of human civilizations take place, without any circularity.[41]

Bronowski, an outstanding applied mathematician, in his essay put it beautifully for the second law of thermodynamics, and it applies equally to the mathematics of any other phenomena, including genetics:

> In itself, the Second Law merely enumerates all the configurations which a system could take up, and it remarks that the largest number in this count are average or featureless. Therefore, if there are no preferred configurations (that is, no hidden stabilities in the system on the way to equilibrium), we must expect that any special feature that we find is exceptional and temporary, and will revert to the average in the long run. This is *a true theorem in combinatorial arithmetic,* and (like other statistical laws) *a fair guess at the behavior of long runs.* But it tells us little about the natural world which, in the years since the Second Law seemed exciting, has turned out to be full of preferred configurations and hidden stabilities, even at the most basic and inanimate level of atomic structure.[42]

Thus my use of "nature" as "the total reality," which, by the way, is what Bronowski calls "the natural world" in the above quotation, is

what prevents it from being merely a tautological or circular statement in logic or mathematics. This nature does have its "preferred configurations and hidden stabilities" all the way up the hierarchical ladder of being from atoms to civilizations, and it is these that operate to determine what elements in a random distribution will persist, survive, be selected.

In response to Ravin's statement that "if [Burhoe] means [by nature, as the total reality involved] a system in which man intervenes deliberately to affect the viability of particular cultural patterns, what then do we make of the notion of a 'higher court of judgment'?" Obviously I do not for a moment mean that nature or the total reality system is one in which man can arbitrarily intervene to affect the viability of particular cultural patterns. My papers repeatedly insist that human values and desires can accomplish nothing that will endure unless and until they are adapted to the requirements inherent within the ecosystem within which human life patterns may find niches. I agree that by and large existing human wishes or values are pretty well preselected to accord with such reality requirements, and I agree that there are multiple niches for individuals and societal systems as there are for species or gene pools; but such niches are not infinite; in fact, they are very rare and hard to find. Again, it must be kept in mind that the environment or niche is in fact internal as well as external to the living systems involved.

Therefore I in no way avoid the "higher court of judgment." That higher or ultimate court of selection I assert is connoted equally by "nature," as used by scientists in ways I have set forth, or by "God," the traditional religious symbol for the ultimate creator, sustainer, judge that supervises all events in creation. I have not in this section provided for the term "God" the same kinds of detailed references as to why I consider it to be relevant for what I am talking about and why it can be said to denote essentially what the scientific term "nature" denotes—that detail comes elsewhere in this paper and my other writings. But, to conclude my comments on Ravin's comments and questions on what he calls my "curious use of the term 'nature,' " I hope it is clear that my answer to his final question—"who is the ultimate arbiter?"—is: "nature."

I suspect that the source of most of Ravin's critique of my assertions about nature's determining human destiny stems largely from the threat to his admirable, warm human concern and responsibility, which are implicitly based on a noble religious tradition whose explicit formulation he is unable to fit within the same frame of reference as his science. It is the common condition today of the two-culture prob-

lem, splitting the mind within one head as well as within the thinking of a civilization.

On the End of Evolution and on Ant Societies. Ravin comments on my description of nature's or God's program of weeding out errors by saying that my "prospect then is an end to evolution." And he suggests "there is nothing in the current scientific picture that obligates this point of view" (pp. 36–37). I agree with the last and, of course, deny that I tend to provide any prospect for the end of evolution. I thought I was simply describing what we observe in the perpetual program of selection going on in nature about whose beginnings and ends we have no competence to make any certain statements whatever. In this description of the evolutionary process it seems to me quite valid to state that in due course the nonviable or unstable patterns are forever being weeded out as evolution proceeds from one stage to another. In my "Lord of History" I specifically state that "the scientific community [with which I stand] does not and cannot have *ultimate* explanation."[43] I even referred to man's "nature as a creature elevated by the creator to conscious agency in the creator's *everlasting* program of new creation."[44] I imply nothing about an end of evolution, though I do make judgments about *trends* in it.

Ravin seriously misinterprets me when he says that my "analogy of human society to an ant society is due to a serious error about the extent of both genetic and cultural differences" (p. 37).

In the first place, I never said anything about an "ant society" analogy in the quotation from my "Civilization of the Future" paper on which he was here commenting. That quotation (included in Ravin's paper) was: "I suggest that the brains of a culture, insofar as the information they store derives from a common gene pool and a common culturetype, are essentially replications of the same pattern of information. . . . For each culture we may say there is a single brain type or structure that provides the organic unity of the culture" (p. 37). In this passage (written in 1971) I was developing an early version of my scientific explanation for the puzzling sociobiology of man—the existence of a high level of cooperation and altruism extending far beyond the range of kin selection. I will not go into the details of that explanation here, since in that and several other papers these details are available.[45]

But I must emphasize that my picture of human society (including my published statements about it) is radically different from that of ant society. For instance, in the very same paragraph from which Ravin took this quotation, there are other statements that make crystal clear that I am not guilty of denying the existence of differences or

variance in a culture. I said that "any one brain is, for most practical purposes of the general goals of a society, equivalent to another, granting some statistical distribution of *variance* around a norm. The specialized *differences* in brains are real and important, but it is equally important for understanding the realities that operate to constitute a civilization, culture, or society that the brains in them are essentially copies of one another."[46] This is what was published in between the two sentences Ravin quoted to demonstrate that I erred in not recognizing differences within a culture. Again, on the very next page, I had stated that "when I say 'common brain' of a society, I do not mean that there are no idiosyncratic *differences* but that the brains of a cultural population are so patterned as to yield statistically close approximations to a single pattern of norms or shapes."[47] And I went into detailed illustrations of the *range of variation* around certain of the essential norms of a society.

Equally clearly I did not fail to recognize the genetic differences in human societies. In the passage Ravin quoted I said "common gene pool," not "common genotype," and presumed that would be sufficient. But in my "Lord of History," which Ravin is also criticizing, I emphasized: "We must note that I have said that cooperative human societies are composed of *genetically diverse members of the same species,* not all essentially carbon copies of one another. They are individuals who are genetically much more diverse than cousins," whose genetic bonds help motivate cooperation in small and simple human societies.[48]

What is disconcerting and absurd about this misinterpretation of my scientific theology by Ravin is that it is supposedly documentation of his claim of "another aspect of submission in Burhoe's naturalistic religion. That is the submission of the individual to some corporate society . . ." (p. 37). He apparently did not read that my "Lord of History" is devoted to showing exactly how a scientific theology of the higher religions is perhaps the only way of saving humanity from Heilbroner's predicted decline and fall of our present free society to a totalitarian society in which such things as the "free inquiry on which science is based would have a hard time" and of saving religion from a similar retreat to a form Heilbroner found "to be incompatible with freedom, science, and rational understanding."[49]

Perhaps Ravin's apparent failure to share my understanding that moral, mental, and social phenomena are scientifically analyzable in a hierarchical continuum with genetic and physical phenomena leads him to interpret my writings completely out of context with my attempt to show how, in spite of the genetic and cultural and other differences within a society there are nevertheless scientific grounds

for accounting for the cooperative motivation of the independent individuals that is essential for the highly complex societal organizations we find in humanity, sometimes with little or no totalitarian or political coercion when there is an adequate religious base for altruistic self-giving and public concern.

On Some Areas of Agreement. However, apart from Ravin's rather serious failure to read or understand what I was saying, I find my perspective close to his, especially in the scientific realm. I list what I consider to be fundamental agreements, with slight qualifications to cover what I consider to be his misunderstandings.

1. Mine is a "naturalistic religion" (p. 27), although I seem to have a different view of "nature" and include within it the human brain and conscious feeling, willing, and choosing, as well as all the consequent structures of cultures and societal systems—also any as yet undiscovered or unrevealed elements of the universe or total reality that may in any way affect us at some time. My "nature" coincides with a usage I have found common in the talk and writing of my colleagues in the sciences.

2. I would agree perhaps more than Ravin does with his quotation of Darwin's conclusion that of all the "causes of Change . . . the accumulative action of Selection . . . is by far the predominant Power" (p. 29). With my formulation of "selection" as those conditions and laws of nature that make certain of its states more stable or persistent than others—a sort of general systems dynamics, which in the case of living systems becomes the thermodynamics of quasi-equilibrium (stationary) states of "dissipative structures" in energy flow patterns of which neo-Darwinian evolutionary biology is a special case—then this "Selection" of Darwin is not merely the predominant power; it is the total or only power. At least in the present state of systems analysis the application of basic scientific theories of nature has become so universally applicable and useful that it has become the symbol of what needs to be understood in order to explain anything—the ultimate power. In this sense my account of nature and natural selection coincides with many of the traditional ascriptions of totality, causality, and omnipotence applied to the symbol God and I find God = Nature the key to a highly positive and fruitful relation between science and religion.[50]

3. It is clear that I agree with Ravin that there is no selection "of the sort we associate with [human] choice" until man arrives on the scene (p. 30).

4. I fully concur with Ravin's "I do not . . . suppose that the laws or processes that explain biological evolution are adequate to explain

human [cultural] evolution" (p. 32). I have taken great pains in my papers to introduce the special elements involved in the new level of cultural evolution that in symbiosis with the ape-man makes him human.

5. I fully concur with Ravin's "Man does not have absolute, certain control of his evolution, but he cannot avoid deliberate, rational intervention in that evolution" (p. 35), but the deliberate, rational intervention is only my first stage of cultural evolution which Ravin seemed to overlook, and I place my second stage (a symbol for multiple layers of selective processes not planned for or plannable for by humans) or higher court as the ultimate selector of what is a viable system. But in my view the Lord of History (nature's conditions and laws) resides in all stages, including the first stage (human conscious decision making) if we are to be scientific in our picture of nature and human nature.

6. I concur also with Ravin's view of the "proper mission of religion: It is to help man find meaning and motivation for his participation in an evolution over which he has no certain guidance or final control" (p. 36). It was specifically about this that my "Lord of History" was speaking.

7. I concur essentially with the implication in his question: "If religion does not help us in discerning and acclaiming good, what human purpose is there for it?" (p. 39). I thought my "Lord of History" was providing some outlines of a scientific account of how altruism and a higher and better form of life were generated by religions in spite of selfish genes.

8. I concur with Ravin's statement that "martyrdom is a shabbily treated subject in our cynical and materialistic age, but [it is] the key to human evolution" (p. 39). It was exactly the function of "Lord of History" to provide the outlines of how human altruism, even self-sacrificial altruism, has been evolved in spite of the "selfish genes."

But the Two-Culture Gap Remains. There are innumerable other responses I could make concerning Ravin's misinterpretation of my "Lord of History" effort to save religion by equating God and nature. There are thousands of points where I could show how my scientific views actually coincide with his, within the range of his primary framework, and show how I concur with much of what he believes religion should do. But his mind-set—that God could not be nature and that nature does not select or determine moral values or human consciousness and willing choices—inevitably leads him to conclude that "religion must countervail against the naturalistic mode of selection in human affairs" (p. 40). This leaves me up against the nearly impossible difficulty of talking across the gap between two cultures,

two paradigms about the nature of reality, as I earlier pointed out, that have been noted in "Planck's Law" and by Snow's two cultures and Kuhn's account of the resistance to paradigm conversion that "cannot be justified by proof."[51]

I must immediately point out, too, that the majority of the scientific community, who may largely agree with me about "nature"—those whose mind-set is based upon the conclusion that man's brain, conscious mind, culture, religion, values, and choices are also determined by the nature of scientifically explainable factors—have an equal difficulty in understanding what I am talking about the moment I introduce the term "God" as equal to the nature with which they are involved, for to them the term God has become taboo, a vestige of the primitive mind above which they have risen.

At the same time my colleagues in the humanities and in religion and theology have an equal problem with my "God = nature" theology but for the very different reason that their mind-set or paradigm or culture is largely shaped by none of the perspectives held by modern scientists but by those set by the philosophies that have persisted for nearly twenty-five hundred years—a paradigm that Ravin and a number of other scientists seem to hold when they contemplate man, culture, and conscious choices and which prevents them from being scientific about human affairs, a paradigm that separates man's mind and behavior from the rest of the operations of nature.

As is obvious, the conflict between that dualistic paradigm and the monistic modern scientific paradigm is maintained because there have been no adequate resolutions of the problems that most thinking people have when they contemplate the seeming reality of "free-will" of their "minds" as contrasted with the seeming "determinism" of explainable events of the observed or "material" world. The mind versus matter and the freedom versus determinism paradoxes keep human opinions divided into those who for their own particular reasons have been led to adhere to one side or the other.[52]

I think that some persons, who are informed very well on both sides of this problem by new light from the sciences, have provided some resolutions of the problem in our time, and I have published several of them in *Zygon* and have written about these solutions in some of my papers. I believe the paradoxes of the past many centuries over mind-matter and freedom-determinism are on the way to solution along lines similar to the paradoxes that raged around earth-centered versus sun-centered cosmic schemes.[53]

The confusion of "cultures" or "paradigms" of our times thus makes it easy to explain that even within a group of persons who are cooperating in pursuit of the possibility of a new intellectual co-

herence and a reunion of the theological–humanities–human-value–generating culture with the scientific-technological culture there are, from the point of view of outside observers, variant, competing views, seeming chaos, and no clearly visible bridge that connects the two cultures. Not only does this confusion explain the fact that a good scientist such as Ravin would see little of value in my "Lord of History" approach to a scientific theology, but it also explains why my colleagues in religion do not see me as really using a scientific approach to theology.

My Response to the Theologians' Critiques

Because my task in this paper is to justify the scientific character of my paper first against misunderstandings in the scientific community, and because that has taken so many pages, for reasons which I think now should be clear to any reader, I am constrained to respond to my four colleagues in religion much more briefly, although the problems are just as complex and require as much detailed analysis. One part of my analysis applies equally to both the scientist and the four representing religion, that is, the problem of Snow's two cultures or Kuhn's scientific revolutions. None of the four fully shares my perspective on the potential unity of the two cultures and on the possibility of my being fully integrated with the scientific world view and the religious world view at the same time.

On Myth and Science. This leads me to begin my response by pointing to the concluding page of Miles's "Burhoe, Barbour, Mythology, and Sociobiology," where Miles says: "Finally, though Burhoe perhaps even less than Barbour would wish to see his work read as a contribution to mythology, he has made what must seem the right mythological decision in drawing all of science into his synthesis under the rubic of evolution" (p. 69). What Miles had not become acquainted with when he wrote this was that for more than two decades I have been on record as pointing to the fact that the scientific enterprise is itself a special kind of mythology and that, therefore, I am delighted to be recognized as making a contribution to "mythology."[54] But my science as myth is not the limited notion of myth that Miles has in mind. By his notion of myth he wishes to imply I am not being scientific.

There are many others who have recognized the character of the scientific theoretical or conceptual structures as special kinds of myths or fabrications of man's imagination; and I have referred to several of them already in this paper.[55] The recent developments by scientists on their own scientific philosophy of science, including even many in

the Vienna Circle of Logical Positivists, have pointed clearly to the hypothetical, imaginative, and only provisional character of scientific theories. I already have pointed to Ravin's statement to the same effect.[56]

As against Miles's interpretation of my mythology, I wish to maintain that the mythology I use is fully scientific and not necessarily limited to prescientific myths of the Lévi-Strauss kind that Miles describes. Some of the characteristics of myth that he and Lévi-Strauss describe are, however, quite true of the main body of the theoretical sciences, such as the fact that it is "never complete on its own terms" (p. 65), and if the new "myth of naturalism is to convince as a story . . . then death must stare from its shadows" (p. 65). I have described the inherent incompleteness of a scientific theory and also the requirement of a deeply moving crisis before a new paradigm in the sciences will be considered (as reported by Kuhn among others).[57]

To be brief, I have maintained that scientific myth differs from traditional myth only in the way it is systematically correlated with "empirical facts observable by any competent observer." Traditional myths are tested by a slower form of selection by nature in the history of their success or benefit to a population of people. A cultural myth that benefits a societal system is selected by the facts of the history of that culture, as when it prospers, thrives, and attracts and holds a larger population. A myth that harms a culture declines and dies for corresponding reasons. I have insisted, contrary to Ravin's views of cultural evolution, that it has been for the most part unconsciously designed, not planned or engineered by applied conscious information or science. Hence myths prior to science and even the myths (imaginative models, theories, paradigms, etc.) of the sciences carry "truth value" which is tested by their viability. (Miles, reflecting Campbell, is right about myth's relation to "survival," and he touches but does not embrace Campbell's related view of science [p. 67].) It is on this account that both Campbell and I assert there is wisdom in traditional religion, what I have called a "wisdom of the culture," akin to Walter Cannon's "wisdom of the body" from the selection of genetic information.[58]

But the difference between the systematic and conscious empirical validation or testing of the myths of the sciences and the testing by the unconsciously operating selection processes of prescientific myths is important to note in connection with my proposal for a theology illuminated by science. I am suggesting the use of the validated scientific myths as elements for the reformed theology that I predict will become a necessary mainstay of religion in scientifically informed communities. The earlier myths of creation of the world and of man will have to be translated or shown equivalent to the new scientific

stories of creation, and the old myths concerning the nature of the soul and God and salvation likewise will have to be rendered as credible in the reigning scientific myths of the community of believers if any religion is to be widely and dynamically viable in such a community.

I have suggested in my papers that the scientific form of the myths is necessary not so much to replace the functional validity of the older myths for man's meaning and morals as to show that the general plot of the story they were telling is still essentially true—when translated into symbols credible for today's scientific mind—and sacredly so. I believe there are some corrections in the plot or story to be made here and there on the basis of the new information accumulated by the sciences and also on the basis of new conditions of moral good and evil brought about by scientific technology. But in my view any corrections or revisions of religion are quite secondary to an urgently needed revitalization of the traditionally accumulated wisdom for reasons which follow logically if my model of the nature of existing religions, based on my attempts at a scientific analysis, is valid. Since I have found it difficult to make this point clear, I shall present some details of the reasons.[59]

It must be noted that religions are very complexly structured information carriers, with a hierarchy of levels. Each level of religion is built upon and requires an adequate foundation in each of its "phylogenetically" prior levels. Cognitive beliefs and theologies are only the most recent levels to emerge at the top of the hierarchy. But the real functioning of religion to generate the altruistic behavior and spiritual meaning or morale necessary for humans is "phylogenetically" much older and requires three complex and coadapted earlier levels or stages which are foundations with which any later stages must be coadapted. Each of these levels may be made up of several finer levels, but I am giving only a broad picture.

The first and basic general level of religious information is the genetic coding that programs our fundamental brain structures that (1) generate our deepest feelings and ultimate concerns, (2) shape our responses in terms of such behavior-motivating emotions as fear and joy, hate and love, and despair and hope, (3) provide us with instinctive or automatic "understanding" (proper response patterns) when we perceive the genetically programmed, animal-ritual-communication signs and symbols produced by our fellow creatures, and (4) in general provide us with instinctively felt purposes, goals, courage, hope, meaning, and worthiness as we respond to whatever information we perceive from our environment. These response patterns (including religious experiences of awe and ecstasy) are genet-

ically programmed in the more ancient levels of our brains. Over the millions of years of our creation story they have been so selected as to produce populations of animals adequately adapted to maintain and advance life.

A second general level of information and its transfer which is essential for human religion and which also has been selected over millions of years of human "cultural phylogeny" is the lowest general level of the culturetype and its social transmission. These are the culturally sacralized patterns of animal-ritual communication. These patterns from among those tried out by our ancestors that best enhanced societal viability have been selected (remembered and transmitted) as the viable culturetypes (not genotypes) until our day. They include, for instance, the teaching by parental or peer group through animal-ritual communication of such things as to whom (or what) you shall bow your head or otherwise ritually communicate awe and respect, to whom (or what) you shall cry for help when in need, to whom (or what) you shall growl or snarl to forbid, to whom (or what) you shall clap your hands, press your lips, or embrace to express your joy, gratitude, or love. These ritual langauges for social communication of proper behavior possess the genetically programmed meanings mentioned in the third point of the first level described above. They were given a new level of meaning by the remembrance and social transmission of particular patterns of association manifest in the individuals of a particular tradition.

These combinations of genetically and culturally remembered communications of vital information emerged long before human spoken language. Spoken languages are intimately rooted in and dependent upon them for effective transmission of significant meaning. These culturally organized patterns of our animal-ritual communication are the roots of social institutions or mores. They require input at critical periods of human development from infancy on through life as the basis for the formation of normal human personalities and social systems. The patterns of information (culturetypes) that shape these patterns of behavior, as Campbell and I have pointed out, evolve by variation and selection in ways analogous but not homologous to those of the genotypes. There may be little or no premeditated plan or even consciousness of any kind involved; yet the final wisdom may be as great as that of the genotype and even greater than that of many conscious and rational philosophies. Moreover, these basic levels of culturally transmitted information are much more essential than any rational philosophy, for they are the tie to basic meaning and motivation. Without these ties to the genetically programmed levels of human information, religions become powerless;

theologies, philosophies, and ethics become empty logical exercises in games with meaningless symbols.

A third and more recently evolved general level of information carrier built into human religions emerged as verbal languages developed to the level of telling stories to explain things. This is the level of religious myths. Myths function to explain the ritual traditions and to advance them to new levels of significance. The myths were at first probably little more than parallel verbal models of the symbols of the ritual language, perhaps elaborating and reinforcing the memory and transmission capacity of the ritual system. But as verbal symbols of the world evolved and capacities for conscious calculation with them, they raised logical questions about themselves and the world they symbolized (including the ritual patterns) that required answers that could not be given at the ritual level but only at the level of verbal language. (I accept this Lévi-Strauss picture of the logical problem–solving function of myth as presented in Miles's paper [pp. 55–69], although I do not feel satisfied that their explanation of how myths evolve is wholly adequate.) In the course of time the evoluion of this linguistic modelling of the entities and events of the larger world of experience led to the emergence of new levels of effectiveness in communication and of significant new information and meaning at the self-conscious level about oneself and one's role in the scheme of things that accelerated the rate of evolution of the cultural patterns of life.

All the patterns in the separate levels of sociocultural information transmission were evolved by the selection of their common phenotypes—human sociocultural organisms—so as to be highly coadapted with one another and coadapted with the information in the human gene pool and in the ecosystem within which that gene pool was adapted. The collective information of the several levels of cultural traditions or culturetypes provided successive layers of ever more intricate and powerful modifiers of the expression of lower layers, down through the level of the unique genotypic information in each individual, in such a way that the total hierarchy of information levels, in interacting with the phenomena of the human habitats, produced phenotypes of human individuals internally organized or motivated (not externally constrained) to function as voluntarily cooperating elements of a societal organism. In this the development of human individuals in a society is analogous but not homologous to the development of cells in an organism. They undergo externally induced transformations of the phenotypic controls of the expression of their genotype so that they naturally function as different parts of an organism. In the human case the "organism" is the socioculturally

organized population of human organisms, and there are several new sequential levels of cultural controls of genetic expression. The miracle, found for the first time in humans, is that all this was accomplished by a device for transcending natural selection's prior limits of the extent of a complex society to close family relations. The new flexibilities and powers introduced by language and religious myth led to the greater complexities and powers of religion that made possible human societies as large and as genetically diverse as those of city states.

In these first three foundation layers of religious information, still largely unexplored and undeciphered by modern scholarship and science, lies a tremendous body of combined wisdom of the genes and of the culture, which we cannot bypass and continue as humans living in human societies. But in the past few thousand years a fourth and fifth general level of cultural information have been added to the earlier mythic and ritual levels of culturetypes and the basal information level of the human gene pool.

A fourth general level of religious information on how to live successfully emerged with the discovery that the verbal languages, which had evolved from unconscious or at least unpremeditated evolution of culture, contained the magic of being sufficiently accurate models of the real world that grammatical operations with words could reveal hitherto unknown or unknowable facts about the real world. This development may be associated with the emergence of written records of language, some five thousand years ago; but it reached a peak in the systematic pruning and cultivation of linguistic symbol systems that flowered in the logic, mathematics, science, and philosophy of classical Greece, some twenty-five hundred years ago. A striking instance is that from a few seemingly self-evident postulates Euclid and his successors found that games with well-honed symbols logically could compute correct answers about all sorts of unknowns, such as the width of a river (without crossing it with a measuring line) or the size of the earth (without needing to measure more than a few hundred miles along the Nile River and the shadows of two poles).

This powerful new level of gathering valid information by logical calculus gave to those city states that possessed it a tremendous power to excel or dominate those which did not have it. But it led to problems for the religious myths that had earlier provided the populations of these societies with the necessary morals and meaning to shape individuals sufficiently devoted to the welfare of their societies. Instead the critically sharp, new logical calculus tended to produce skeptics and sophists, and there ensued a decline of religious faith. There were some who felt that the radical sophisticates whose teachings

corrupted the morals and morale of the youth ought to be eliminated, and Socrates was condemned to death. There were others who, like Heilbroner in our day, predicted the impotence of the new knowledge to be able to live with religion; and, since the moral function of religion was found to be essential to social life, some feared the decline of the high civilization and others advocated or brought about more totalitarian controls to provide the necessary order for the state. There were some who tried to express in terms of the new knowledge the significance of some traditional religious systems of ritual and myth that generated morale and morals; and from them stemmed theology as a new level of interpretation of religion, a level that could appeal to those who were immersed in the new philosophy. The purely rational attempts to shape morals and ethics by such as Socrates, Plato, and Aristotle tended to operate successfully only when they were converted into a kind of religious theology as it was among the Stoics. The ethical philosophers did not know all that we now know about the "unconscious" or prerational wisdom of the earlier levels of religious culture and the necessity to coadapt the rational accounts with them and with the wisdom of the gene pool and the ultimate requirements of the total ecosystem.

By the fourth century A.D. some of the church fathers had done a fairly good job in coadapting the neo-Platonic philosophy with a long-evolved traditional religion, although not in time to give Christianity the power to save the Roman Empire, even though in the time of Constantine there was a move to use it for this purpose. By the time of Aquinas even the Aristotelian school of Greek philosophy had been fairly adequately woven into Christian theology, and the ground was laid for a new, Western civilization which could maintain the necessary religious convictions for morals and morale in the face of the revival or Renaissance of the fallen or lost ancient Greco-Roman culture. But the salvatory power of medieval theology, which had been so fully rationalized in terms of Greek philosophical paradigms and so well coadapted with the traditionally evolved wisdom of religious myths and rituals, was short lived. Some of us suppose that—through such minds as those of Copernicus, Kepler, and Newton—medieval theology was itself, along with the Renaissance of Greco-Roman learning in general, a prime generator of the new science, which was eventually to be the undoing of the medieval synthesis.

The fifth general level of information on how to live successfully is this new science. It far transcended Greek science or philosophy by means of its discovery and implementation of a new methodology: the systematic testing and revising of its basic premises and logical formulas against the empirical or observable consequences of events in the "real

world" (actually in the preverbal levels of human experience—the information of genetically adapted sensory data). This new method rapidly expanded the range and reliability of the scientific models or symbol systems that represented the "real world." Together with the religious tradition in which it blossomed, modern science made possible and produced the revolutionary intellectual, technical, and political miracles of Western civilization that we now regard as commonplace. But by the eighteenth century of our era this revolution in ideas (paradigms) produced Western civilization's religious and spiritual crisis, the Enlightenment, analogous to that of the time of Socrates. Since the Enlightenment, the power of the previously completed synthesis of traditional religious faith with the height of Greek science was undermined, for modern science had replaced that very Greek science by radically new paradigms that made the paradigms from Greek physics to metaphysics largely obsolete for discourse in the modern world. With the undermining of its religious faith our civilization, too, is undergoing a rapid decline in meaning and morals. There have not yet appeared among us an adequate number of thinkers who even suppose that new links can be forged between the traditional, well-winnowed religious wisdom and the intellectually powerful and dominant new world view of the sciences.

It should be clear from this story that, while Greek reason or logic and modern scientific world views can undo the power of traditional religious myths and rituals by making them seem incredible and irrelevant, neither reason nor science can survive for long without the wisdom and power of the fundamental religious function in molding human values. Heilbroner is right in discerning civilization's greater need for religion and order than for modern science and freedom; and hence he is right in prophesying the inevitable decline and fall of our civilization amid much suffering—right, that is, if, as he believes, modern science and freedom cannot be integrated with religion and order. Certainly logic and science by themselves, separate from the underlying wisdom and powers to which traditional religions have long been well coadapted, cannot provide meaning and motivation necessary to produce the good in human behavior.

Human nature is such that there is always a need for such meaning and motivation. In the aftermath of World War II and the horrible marvel of the atomic bomb the turning of the public in the United States to look again to the traditional churches for meaning is symptomatic of the need. Because of the seeming inadequacies of the rationale of mainline Western religious traditions, the turning of the youth away from science and toward esoteric religious cults, during the period of the Vietnam war and the novel scientific-technical

achievements of travel in space in the sixties and early seventies, was another symptom of the need. The recent rise of evangelical religion, approaching another Great Awakening, involving Jesus Freaks and fundamentalist mentalities that arbitrarily deny the relevance and authenticity of the modern scientific world view, is another stage of the symptoms that regress further from the scientific world view than did the earlier efforts of the neoorthodox movement. Essential religious, like biological, needs that are denied by reason and science inevitably will destroy such inadequate reason or science.

I differ from Heilbroner only in supposing that modern science can be integrated with traditional religion even more adequately than was Greek philosophy. I believe that in the last part of the twentieth century we stand close to the possibility of a rise in the level of religion and civilization to undreamed heights if this new synthesis is accomplished in time. I interpret our history from pregenetic eons to the present as indicating that it is exactly for discovering new levels of information gathering and integrating them with the previously achieved informational base of living systems that we were created. And I feel certain that this new step of yoking the hierarchy of traditional religious values (information) with the modern sciences will in time be accomplished. I have no faith that psychiatry and sociopolitical reforms can save civilization unless and until they build upon the basic wisdom already selected in the traditional religions. This seems to me to be an obvious conclusion from my extended "natural history" of human life.

My major point in this section is to provide some of my reasons for believing that the major task now for a scientific theology is not so much correcting traditional religions as revitalizing them by showing their essential wisdom and proper representation in the scientific world view.

Ravin asked what the difference is between religion and science. My response to him and others who keep raising this question is in many of my papers and is, simply: Religion is to science as medicine, transport technology, or agriculture is to science. Religion is a technology, an art, a human endeavor to communicate to a population what is good and the desire to do the good, what is evil and the desire to avoid the evil.[60] This desire necessarily has to be effective in terms of the underlying genetic information and hence of what requirements the totality of nature imposes upon genetic information. Thus religion must interpret man's ultimate nature, destiny, and meaning in relation to the ultimate powers. Religion joins or is coadapted with the gene pool in doing this, but religion adds information that the gene

pool cannot add, even if you were to give the gene pool another billion years, as I have pointed out in religion's unprecedented accomplishment in generating altruism among nonkin groups in the same species.[61]

Clearly, to those who know the field, science is not a technology, and hence science is not religion. Theology is the science that interprets religion, but our theology is obsolescent. I have repeatedly suggested that the time has come for religion to be interpreted in the credible myths of the new sciences for it to be effective in today's scientifically informed communities of the world before it is too late. I agree with Miles's view of a crisis, which he notes is being reported from many sources, and I recognize also the role of crisis as a selection pressure for a new paradigm or myth. Scientific information for nonreligious technologies without an equivalently competent and compelling information for religious technology can be lethal, since religion means the transmitter of the central or most important values in a society upon which its life depends, just as agriculture means food-supply technology.

Politics—the art of coercing, by means of socially administered rewards and punishments, societally good behavior in people whose religion has not internalized the desire thus to behave—is not competent to handle more than the small fraction of extremist deviants in a population. To provide the core values essential for the bulk of the population, including the legitimation of their government, a religion is necessary. I have pointed out in my "Lord of History" and other papers that there always is a religion, a myth about sovereign values, even when traditionalists do not recognize its new form or name.

When a religion becomes ineffective and untrue it is weeded out by the Lord of History in the decline and fall of the societal system that carries it or, equally possible, in its dismissal by the population for a hopefully better religion.

A scientific theology therefore is not a prescientific myth but a myth fully informed by the scientifically empirically validated hypothetical schemes. It is different from a "pure" (purely cognitive) science in that, like scientific medicine, scientific theology is scientific information used to interpret the true functions of a traditionally evolved technology or art of life.

Thus I must modify Miles's view that I represent "a scientific mythology" rather than a "scientific theology." Since science is for me a special kind of myth, the contrast becomes meaningless. Moreover, contrary to views that Miles and others share, I do not seek to build a scientific theology that is not related to a traditional religion. It is exactly this relation that I seek to articulate.

I have pointed out that the religious myths of the preliterate populations were in fact the foremost "sciences" (cognitive schemes) of their day and the model on which later sciences were developed.[62] I have stressed the prescientific evolution of the "wisdom of the culture" selected by realities environing their ecological niches of which men were not necessarily consciously aware. This wisdom should be bypassed no more than the "wisdom of the body" should be bypassed by modern medicine. Totally bypassing either is likely lethal.

Of course, I do see the sciences as equally able to enhance religion as they have been able to enhance medical technology. Instead of the cure of body, religion is the cure of the soul—psychiatry, to be literal. However, along with Campbell and others, I have suggested that present psychiatry is not very scientific when it ignores the "natural history" of the cure of souls.[63]

I will mention one other difficulty I have with Miles's interpretation of my "scientific theology," and that is his allegation that I am more concerned with "heat" and practical religious revitalization than I am with "light" or proper scientific understanding of the nature of religion (p. 51). Possibly I am more concerned with the emotional and salvific functions of religion than Barbour. Certainly I am "religiously concerned with personal and social deliverance from evil." But I am possibly more convinced than Barbour that effective religious credence—for me and the expanding fraction of the population that is becoming clear that what sciences say is our best avenue to new truth—necessarily requires a theology that is genuinely in accord with the best scientific "truth." My career and work attest to this. I am one of the organizers of the Society for the Scientific Study of Religion and have gone far beyond most of the members of that organization in examining religion's roots in genetic, organismic, and evolutionary sources. I have not been concerned with the metaphysical or philosophical clarification of the problem, of course, but with the use of the sciences themselves to examine religion. I see the sciences as having replaced most of the traditional philosophical tools for understanding nature or reality, and I prefer the new tools.

"Religion in the *light* of the sciences" is one of my most used phrases, and I have looked at religion in the light of information from a wider range of sciences than perhaps anyone that I know of. My picture of what religions are is a picture that I have derived from a long study of these. I would include as "sciences" the information documented in history, the various criticisms of religious texts, archaeology, comparative religion, etc., as well as the psychosocial scientific studies. But I insist that it is necessary to go further than these superficial scientific examinations and to take the already "naturally

selected" religious rituals, myths, and theologies seriously and use any pertinent science to understand what religions have been all about. This requires one to examine man's origins and destiny in the scheme of things—in evolving ecosystems under selective pressures—which is what religious myths in fact do but at a more primitive level of understanding the scheme than that of modern science. I must examine the human condition in its cosmic context. This requires distinguishing good religious as well as scientific myth.

But of course the whole point of getting a creed illuminated in the light of the sciences is to provide the heat, the emotive power of a faith that delivers one and one's society from evil by a new lease on its credibility.

If you can understand what I mean about science being a myth, and if you interpret me in this form rather than in the more limited form of Lévi-Strauss that Miles uses, and if you understand that I have used the scientific myths to interpret and understand or shed light on the nature of religion and its relation to the sciences, then I think Miles represents a significant interpretation of my efforts in scientific theology. I do not for a moment deny, but assert with pleasure, his recognition of my concern for "heat." As both a scientist and a theologian I am deeply concerned with the destiny of my soul as well as with that of civilization and with that of life on earth, with which my soul is so inextricably intertwined as to be one. I fear that we are in an unprecedented crisis and must repent us of our secular stupidity in supposing we can do as we please and save ourselves in complete disregard of the sovereign Lord of History that determines our destiny, a Lord I find confirmed by the sciences as well as proclaimed by traditional religions, a Lord whose omnipotence has been revitalized in my thinking particularly by my contemplation of the sciences.

On Metaphysics and Science for Interpreting Religion. It seems to me that my three other colleagues in religion—W. Widick Schroeder, Donald W. Musser, and Philip Hefner—all say in another way that I am not scientific in my theology, that I am some kind of metaphysician.[64]

Schroeder would not allow me to interpret religion by science without metaphysics: "One cannot avoid metaphysical questions by appealing to the authority of science" (p. 16); "I do not think it is possible to eliminate metaphysics . . ." (p. 24); and "I would say Burhoe employs an implicit metaphysics" (p. 24).

For Hefner I am more explicitly a metaphysician, even though "Burhoe himself seems to deny this metaphysical dimension" (p. 89). Hefner states that the thrust of his "comments is that if we look upon

Burhoe's work as a metaphysical attempt we can perceive better its significance and subject it to a constructive critique" (p. 88).

Musser says, "I do not believe that scientific theology can properly be called scientific because it is based upon a metaphysical assumption." In the same paragraph Musser says that my "scientific theology is based upon myth and not science" (p. 79).

Musser seems to mix myth and metaphysics in ways that Miles apparently does not. But the main point is that for these four theological colleagues I am either or both a metaphysician and a myth-maker but in no case am I scientific in my claims for "scientific theology."

I do not object to being called a metaphysician any more than I object to being called a myth-maker. But I do object if this is used to support a claim that my approach to theology or my theology itself is somehow not scientific in a sense analogous to scientific engineering or medicine. Some of the descriptions of metaphysics by the three who call me a metaphysician imply to me that their metaphysics is something that comes close to being what the scientists call their theory, in the sense in which Northrop in his paper in this issue and many other philosophers of science and scientists use the term.

I submit that the paradigm, which I hold up in making a definition of nature, is what my theological colleagues call metaphysics or myth and is at the same time what many scientific colleagues would insist is neither myth nor metaphysics but a part of the scientific world view.

I have worked for many years in communities of scientists where generalized statements or propositions are not thereby unscientific and metaphysical, as Schroeder, for instance, implies (p. 16). On the contrary, even "positivists" assert that the goal of scientific statements is generalization and universality. Richard von Mises wrote: "As Mach showed, a characteristic feature in the development of scientific descriptions of observable facts is the increasing 'economy of thought'; [a superior theory is that one] which allows us to survey a wider area by a single idea, a formula, or a law."[65] The second law of thermodynamics has become a powerful tool for understanding a tremendous range of empirical facts, as is illustrated in Hamilton's paper in this issue of *Zygon*. But nearly no one in the sciences calls such generalizations metaphysics.

That such generalizations in conceptual systems by the scientific community can be directly applied to religion has been asserted by a number of us associated with *Zygon* over the years. Northrop's 1947 paper already eloquently said what I am now still trying to say to my colleagues in both the sciences and religion:

The first requirement for the restoration of the integrity of Christianity is the

development upon the part of contemporary man of a confidence in the existence of inferred unseen factors in knowledge. To this end, no department of Western knowledge is more effective than natural science, especially mathematical physics, since the world of man and nature which it reveals to us has characteristics differing radically from what we immediately apprehend. Yet these objects and space-time structures of mathematical physics constitute the most trustworthy knowledge which the Western man possesses at the present moment.[66]

Regardless of the label either of myth or metaphysics, I would insist that my scientific theology is taking understandings about nature (including religion, man, the world, and human destiny) straight from what I find in the sciences and attempting to show how the sciences add up to a confirmation of traditionally evolved religious wisdom, to provide a new ground for the credibility of religious myths and theologies, and perhaps to provide a slight amount of new revelation concerning man's relation to the determiner of his destiny, a beginning that may expand in future decades just as has the application of the sciences to the medical arts.

The misunderstandings by theologians of the nature of science and of my efforts in scientific theology lead them to misinterpret me on multiple points which, by "Planck's Law," I cannot hope to correct short of a radical conversion or a new generation. They live under a very different paradigm or world view and hence have a different perspective from mine. This leads them to a very different interpretation of what I say from what I think I am saying. It is utterly baffling and frustrating to me, for instance, that Musser concludes—from his reading of my efforts in the "Lord of History" to show the scientific validity of the wisdom evolved in religious tradition, including especially "God talk" and theological concepts—that I allow no place for "God talk" and that I propose that "theological concepts be eliminated completely" (p. 79).

When I have said I am scientific about religion and in my theology, I have usually claimed that I am largely an applied scientist, not a pure scientist engaged in the processes of generating new knowledge. To be sure, I have been engaged in the latter processes, although at primarily a theoretical or hypothesis-making level in my developments of new notions about the nature of cultural evolution and the coadaptation of culturetypes and genotypes particularly through the historical operations of religion. However, I have done this because here was a critical gap in modern scientific understanding that needed some filling in if one were to understand human evolution and religion within the general scientific pictures of evolution. But, whether applying science from a multidisciplinary systems-theory

level of analysis or whether making some novel hypotheses that can make sense of cultural evolution and religion and also be validated within the already tested hypotheses about human genetic and cultural evolution, I insist that my approach to religion and theology in my own mind is first of all scientific.

Of the five critics Hefner seems to express a view very close to mine of what I am doing for religion and theology, and at the same time he provides a role for testing credibility against the sciences which almost makes his claim for my being a metaphysician irrelevant from my perspective. His statement on pages 88–89 of this volume is about as clear and accurate a statement of my position as I have seen, except that I would add the italicized words at the end of the following sentence from page 89: "Burhoe's enterprise, then, centers in his effort to valorize scientific understanding in religious terms" *and to validate religious understanding in scientific terms.* This last of course is what Hefner does not grant as a reality in my enterprise but without which I could not valorize scientific understanding.

The difficulty lies in a different assessment of what is involved in the scientific enterprise. As an inhabitant of the scientific community as much or more than of the religious and humanities communities during my career, and even as one who was nursed in part by logical positivists from the Vienna circle in my understanding of what the sciences are, I find that, although the scientific method of inquiry is indeed a very finite one that may confine itself meticulously to simple particulars and is quite different from metaphysics (as Schroeder noted [p. 16]), the net result nevertheless produces a conceptual scheme which is equivalent to Hefner's "vision of the scheme of things entire" (p. 92). It may not be perfectly interlinked logically, which is the case even within physics; but increasingly during the past hundred years the paradigms and models from physics have provided new and useful grounds for understanding the events in chemistry, biology, the psychosocial sciences, and now the humanities. I suggest that while the overall scientific conceptual apparatus may make less claim to absolute truth (e.g., Michael Polanyi), nevertheless its insistent efforts to be grounded in empirical fact or experience make its applications to practical problems of real life more useful or effective than the earlier generalizations from metaphysics.

Many scientists have written about the universality and usefulness of the conceptual generalizations that are the products of scientific enterprise, such as, for instance, the laws of mechanics and thermodynamics. Hamilton's paper in this issue of *Zygon* is extending a typical kind of application of the second law of thermodynamics to

account for the evolution of events at all levels in the hierarchical scheme of things entire. Whether the formulation is fully adequate or absolutely final is not so much the claim as that it is a scientifically based hypothesis that does provide exciting new conceptual handles for comprehending the scheme of things entire, handles that from the experience of applying scientific handles in the past suggests revolutionarily rapid advance in human adequacy in the future.

But Hefner does not understand science quite the way I do, for he says that "what counts for Burhoe's proposal . . . is its credibility, not any sort of 'scientific' verification. We distinguish between these two because by definition a primal vision of things entire cannot be demonstrated or proven empirically beyond doubt" (p. 93). But it is many decades since leaders of even the empirically slanted Vienna Circle of philosophy of science began to prefer the hyphenated "logical-empiricism" to "empiricism" alone as a characterization of the nature of science, and since then many have come to recognize the fact that perhaps nothing in the sciences can "be demonstrated or proven empirically beyond doubt" and that the "paradigms" of the current scientific dogmas are much less than final "truth."

My view of science would insist on the inherent necessity of operational definitions and empirical confirmations; but at the same time I would go along with the great bulk of scientists who find the complex system of interlocking hypotheses, which could never be "proven empirically beyond doubt," constitutes our best validated and most reliable knowledge. It is exactly the degree to which scientific paradigms have been validated by empirical experience—including the validation by their marvelous and useful applications in technology—that provides their credibility. For me as for Northrop there is nothing that anywhere near equals modern science in producing grounds for credibility concerning the invisible aspects of the scheme of things.

Therefore, when I am concerned to translate what earlier-evolved religious myth and wisdom (these also were selected by nature or God) were seeking to convey about the hidden realities that determine human destiny, I bring to my task all the information I can get from the sciences. I would assent to it being called metaphysics only if it is also called what I think it is: an interpretation based on the best pertinent scientific information.

If my insistence on being an applied scientist, using the best I can find in the sciences to interpret the nature of religion, forces Langdon Gilkey to condemn the effort, as Hefner reports, as "inadequate exercises in establishing religous beliefs by means of scientific inquiry, abortive efforts to 'translate scientific theories into analogous religious

notions,' and unfortunate attempts to 'initiate a scientific rescue of theology in a secular age' " (p. 94), then so it has to be. For Gilkey's view as thus expressed would be exactly mine except for the word "unfortunate," for which I would substitute "necessary." The word "establishing" perhaps ought to be qualified so that it is clear that for the most part it connotes "establishing once again" or "reestablishing." I would be a physician of the soul who recognizes the overwhelming and essential power of the already evolved "wisdom of the culture" and would consider a scientific theology's first task to be to establish this tradition's credibility once again.

I would agree with Hefner that I did not generate the religious ideas from the sciences. My task is a two-way street of translation. The religious wisdom I have found in the religious tradition. The problem is that it has been increasingly incredible to the modern mind educated in the sciences, and this kills the power of its faith in its gods, its promises for man's future beyond death, and its capacity to motivate the morals and morale which once it did. I claim that its basic wisdom is still true and quite in accord with the unseen "reality" as it is pictured by the various modern sciences, providing you make the proper translations, providing you discover the right transformation equations to the new frame of reference of the accepted modern ways of thinking.

I certainly have no intention of saying that science replaces religion. I have written papers showing why I think the "scientific" proposals by Auguste Comte, Karl Marx, and Sigmund Freud and others for human salvation are unsound scientifically and unsound exactly because they failed to understand the wisdom implicit in the long-evolved traditional religion. But I understand and sympathize with the intent of such as Comte, Marx, and Freud to try to find something credible for human salvation, since for them and their peers religion had already died because its interpreters had failed to be able to interpret it credibly in the context of a radically changed paradigm of the nature of man and of the world which has grown rapidly upon the intellectuals of the scientifically informed Western civilization since the seventeenth century.

Thus far, at least, my efforts and those who have associated with me to revitalize religious beliefs by means of scientific inquiry have been "inadequate" indeed. Our efforts, to translate scientific theories into analogous religious notions or vice versa to translate traditional religious wisdom into the physics (or, properly qualified, "metaphysics," if you will) that is the credible picture of the hidden or unseen realities of today, certainly have been aborted, and we seem as yet largely un-

able to deliver our translations in forms acceptable to either the religious or the scientific community as a whole.

Unfortunately I find myself in exactly this position and cannot agree with Hefner's escape hatch from my predicament through "metaphysics." His decriptions of my "nature" and "God" not being scientific just do not fit my view of science and what I suppose I am doing. But, fortunately for me, I have had the support and appreciation of Hefner and a handful of others in the religious community, and of such scientists as Philipp Frank, Harlow Shapley, Clyde Kluckhohn, Theodosius Dobzhansky, and Alfred E. Emerson in the other community—even though none of them understood these matters in just the way I do.

My predicament, as is the predicament of all humanity, is that we are inherently ordained by the Lord of History as incomplete. Inherently it is our task to risk, largely fail, and suffer in the creation of anything worthy and acceptable in the continuous building of the kingdom of life as ordained by the Lord of History. Like all humans who seek to be creative, or even to remain viable, our lot is forever to do it by the sweat of our brow, inseparable from a certain amount of pain and sorrow. Fortunately the Lord of History operates to guide and deliver us through a trinity of forms: (1) through the grace that comes to us from the totality of nature external as well as internal to ourselves; (2) through the grace of comforts and wisdom provided in human form; and (3) through the grace that comes to us from the unseen wisdom that operates internally as the product of previously stored wisdom both of the body and of the culture, which, for reasons that we are only beginning to understand, well up from the unconscious levels of our brains to inspirit or inspire us. From the perspective of the nature I understand from the sciences, all three of these sources of grace and life to us are really aspects of one and the same nature; they are the product of an omnipresent, omnipotent selective mechanism or principle that causes the hierarchies of events of the cosmos to evolve as they do.

My vision of God as I learned it from religious tradition and my vision of nature as I learned it from the sciences are in my mind one and the same.

In this scheme neither I nor the collective human community can be conceived to have made itself or to be able to defy in the least any of the requirements ordained for us by the Lord of History, our creator. We are utterly dependent creatures. Ravin sees humans as able to defy their creator and suggests religion should attempt to

"countervail against the naturalistic mode of selection in human affairs" (p. 40) as if human affairs were not subject to the same creator that makes all things and operates everywhere according to its presumed unchanging, invariant, or eternal nature as partially revealed to us anew in such empirically validated visions as the second law of thermodynamics.

As Ravin says, "In the final analysis, then, Burhoe's naturalistic religion . . . returns man to the same submissive posture that many of the older religions did. In some respects the submission is more devastating than before, because Burhoe would have us recognize survival and continuity as the ultimate realities and presumably the ultimate values, since they become the ultimate criteria of the highest court of judgment, the Lord of History" (pp. 38–39).

Ravin expresses fear of this picture of the human predicament and proceeds to the self-contradictory denouncing of it as I earlier pointed out. But I think his fear and his strong desire to denounce this picture comes from his recognition of nature's omnipotence without recognizing what earlier but often no-longer-credible religious pictures had discerned as its justice, justification, or grace.

Let us try to get a clearer picture of the omnipotence and justice of nature as the highest court of judgment or Lord of History. Both from the scientific revelations of nature and from the religious revelations of God I have been persuaded that I have no alternative but to obey the invariant laws of the omnipotent forces that created and sustain me, if I wish to continue to be anything.

Moreover, I do not know many good scientists who suppose that their personal, consciously felt preferences can do anything to alter the basic realities and laws of nature. The scientific tradition is just the other way around: The obstinate facts that nature presents will determine which human hypothesis is correct. Likewise, the scientific engineer will not waste time for a moment to repeal the law of gravity or make a perpetual-motion machine. Instead he submits to the requirements of nature and adapts to them effectively by using his validated myths about such things as different specific gravities of gases, or aerodynamic thrusts, or Newton's third law to enable him to manufacture machines that will transcend the force of gravity and permit him to soar into the heavens.

It would seem that the scientific and engineering communities are inherently of the faith that submissive adaptation to nature's requirements is the way to success or to viable patterns of any kind. The fact that in designing some limited successes there are also some side effects that are lethal is no exception to the rule of submission to the highest court of nature's judgment, but rather it is exactly a demon-

stration of the need so to behave—for the undesirable side effects are indeed a part of the judgment of a higher court before which man must bow if he is to have life and that more abundantly.

But if, in addition to the omnipotence of nature, there are revealed to me certain other, hitherto unknown or hidden facts about nature, namely, that it is gracious to me and to mankind, then God's omnipotence and sovereignty are good news, the very best news. For we have repeatedly learned in history that "man's own judgment about what is worth maintaining, what merits survival and continuity," is, as Ravin himself paradoxically keeps pointing out, not very dependable in the long run. Man "may choose unwisely, on the basis of inadequate knowledge, or act in such a way as to bring about the demise, against his intent, of conditions he preferred or to propagate conditions he sought to eradicate. But such results cannot be prevented entirely and must be risked so long as man lacks omniscience about the nature of that ultimate reality to which Burhoe would have us submit ourselves" p. 39; cf. also version of same on p. 33). I believe that Ravin knows as clearly as do I, and seems to say it right here, that the bad results that arise from human error can be avoided only when man corrects his error, understands more adequately what nature requires, and reforms or submits his behavior to that requirement.

In any case, whether Ravin or anyone else may not happen to like the fact of the omnipotent sovereignty of the Lord of History, I am fully persuaded that this is the human situation and is what determines our destiny. There are considerable numbers of first-rate scientists who do not believe that the laws and initial conditions discovered by the sciences operate to determine human events (especially their own mental events and choices) as they do in other kinds of events in the universe. I find myself in the camp of those scientists who find the totality of man to be an inseparable part of the totality of nature and in principle equally susceptible of being studied scientifically as any other part. I am therefore fully persuaded that the scientific descriptions of nature apply equally to my own history, including to my own conscious choices. Hence my understanding of nature in this respect is equivalent to the religious traditions that ascribe omnipotent Lordship or control over all creation to the operations of an omnipotent God, ultimate reality, or nature upon which humans are utterly dependent.

But, unlike most of the scientists in either of these camps, I also take religion seriously as an entity that can be studied scientifically, that religion has a perennially necessary function in the symbiosis of individual men with nonkin societal systems, and that religion's myths and theologies refer to realities in the world. I take it that its symbols of

gods and souls are hypotheses about real phenomena that can be analyzed and interpreted by the more sophisticated scientific conceptual systems of the late twentieth century. In all this I have used a very different approach to religious studies from most of those in the humanistic, historical, linguistic, and psychosocial studies of religion, although I also include the results of their studies as a part of my tools for analysis.

Concerning the usefulness of the scientific pictures for translating and revalidating the ancient religious wisdom on the justice, justification, or grace of nature, I am not saying much in this paper. As Hefner points out, this is one of my primary hypotheses, which I have in part developed elsewhere. But if and when a "respectable" number of other scientists and theologians recognize that the traditional justice, justification, or grace of God are indeed also revealed by the sciences to be a characteristic operating in the unseen realities of the scientific pictures of nature, then I predict we will be over the hump that separates one paradigm and one age of belief from another, in fact over the hump that has increasingly in recent centuries separated science and religion, values and facts, and left men without credible or meaningful orientation or motivation—fearful of the implications of the sciences for cherished human values.

I give an example of some of the more recent scientific interpretations of nature's grace and meaningfulness for man, even though it is a transcendent power upon which we are completely dependent. I quote from the last paragraph of a recent paper on cosmic evolution by a Harvard astronomer, Eric J. Chaisson, although unlike an earlier one, Harlow Shapley, he does not as yet apparently recognize this nature as equal to the religious and theological term "God":

> The philosophy that we are the product of cosmic evolution is not a new one. It may be as old as that first *Homo sapiens* who contemplated existence. But as we enter into the last quarter of the twentieth century, for the first time we can begin to identify conceptually and test experimentally some of the subtle astrophysical and biochemical processes that enable us to recognize the cosmos as the ground and origin of our existence. It is very much an interdisciplinary approach, interweaving knowledge from virtually every subject a university can offer. It's a warmer and friendlier scenario now, many parts of which have recently become substantiated by experimental science. We are not independent entities, alien to Earth. The earth in turn is not adrift in a vacuum unrelated to the cosmos. The cosmos itself is no longer cold and hostile—because it is *our* universe. It brought us forth and it maintains our being. We are, in the very literal sense of the words, children of the universe.[67]

Conclusion

As a result of the combination of my understanding of science as applying to any events of any realm of human experience and my broadly based scientific study of religion, I have come to increasing confidence in my hypothesis that the scientist's "nature" and the supreme God or ultimate reality of the higher religions translate to essentially the same thing: the creative source and continuing shaper of the events of everything there may be, the determiner of destiny, upon which man is utterly dependent.

Since the term "nature" is used with so many connotations that might be confusing, I shall try to summarize in one brief paragraph what I mean by the term, a meaning that I know I share at least implicitly with many of my colleagues over a lifetime in the sciences even if they would not all of them spell it out just this way on the basis of my particular background in science and its philosophy. Nature is the name for both a system of conceptual symbols and the presumed entities to which the conceptual system refers and of which it is a map or model. The evidence for the presumed entities is derived from the empirical fit of the map at most of the points where it is tested against the data that are sensed or perceived in the private experiences of any number of competent observers who place themselves in the context provided by the operational definitions that specify the meaning of the map symbol in terms of certain characteristics of the general nonverbal experiences that men have, such as the use of a calibrated meter stick to measure the distance between two objects and a clock to measure the time. Because of the success of the scientific model building or map making to provide rather generalized and universal abstract models that in relatively simple formulas can explain beautifully and predict innumerable classes of phenomena each containing seemingly infinite numbers of possible events (such as can Newtonian mechanics, quantum theory, or the laws of thermodynamics), and because the models used in one field or level of analysis are found to be tied to events in other fields or levels of analysis and presumed "ontology" (such as brain chemistry in psychosis and chemical molecules in brain architecture), so that more and more of the possible events experienced by men become modeled and accounted for or explained on the basis of a relatively small number of logically interrelated, postulated concepts (such as the evolutionary history and relationships among the millions of species of life on earth by the mechanism of natural selection of DNA configurations together with certain related theoretical models), the faith of many scientists has grown to suppose that there seems to be no limit to the enlargement

of the coverage of potential human experiences and a correspondingly presumed reality system, even though it is commonly recognized that we could never know ultimate reality, which seems clearly to be an infinite system relative to the finitude of that within it which could seek to know it. Insofar as we may experience presumed events or entities that we cannot account for within some of our logically coherent networks of scientific, empirically validated, and established conceptual systems, we will, of course, admit these also are a part of a prescientific presumption about nature. Such events or entities are properly called "paranormal" unless and until they become explainable within one of the normal scientific symbol systems.

The above-described nature, of course, includes the nature in the field and forest behind the barn, but quite a bit more. It includes the living nature outside of and prior to man on the surface of the earth, but it also includes man. It includes the animal nature of man, but also his culture, mind, and civilization. It includes events far beyond our earth in the heavens and includes the visible events in and characteristics of creation anywhere from which light may travel to us, but much more. Nature includes the system of invisible entities and forces that brought the sun and the planets into being, that populated the earth with its stock of atoms and molecules and the shapes and histories of all that goes on in its waters, lands, and atmosphere. It includes concepts that interpret and explain the source of life and its billion-year history. It includes concepts by which to explain the fundamental aspects of the rise of animal and human life and behavioral patterns. And while this scientific story of nature has only recently begun to provide some account of what is inside the head and the relations between complex hierarchical structures and dynamics of the events in the brain and the complex hierarchical structures and dynamics of events that are input to and output from those brains, it has at least begun to account for the resulting conscious experiences and civilizations and for the religions that transmit the core of the cultural values that are statistically coadapted sufficiently with values transmitted in the gene pool to enable man to be symbiotic with huge nonkin societal systems.

In this picture, the sciences have revealed a lot about the Genesis story of human nature and of its relation to and reflection of the system which has been its generator and its continuing guide and shaper—its creator, sustainer, and destiny's determiner. But not until recently has there been a community which has sought to relate this picture to the accumulated wisdom selected by the same creator and sustainer in these key institutions of civilizations called religion. Not until recently have many been engaged in seeking a realistic transla-

tion between the traditional and the newer conceptual systems about the ultimate source of all, or about man's proper duties and hopes in this situation as selected in the wisdom of the earlier traditions, or how he can find that wisdom credible in the contemporary world view. Not until *Zygon,* joiner of religion and science, has there been a journal for the publication of efforts in this field.

In this paper I could not go into much detail on my interpretations of either Christian or other religious faiths by my translations into the modern scientific terminology of the way things are. I have written some papers that say some things about how nature and its selective processes determine all destiny, including every whit of human consciousness, willing, feeling, art, poetry, and highest civilization. I have written also of how this "deterministic" or "predestinarian" God requires the resurrection of traditional religious wisdom to justify God's omnipotence with God's goodness, with man's free will, responsibility, original sin, and salvation in the kingdom of heaven—all topics that many of my colleagues in liberal theology have been soft-pedalling because these anciently formulated traditions seem incredible to them in the light of the modern sciences whose authority, however misinterpreted, they themselves cannot escape. However, I have found such traditional doctrines not so incredible but in fact renewed in clearer validity and credibility by the modern sciences.

The point of this paper is not to cover this larger theological task and to defend my authenticity as a true theologian or interpreter of religion but primarily to respond to five good colleagues, some of whom have been pretty close, that I do not yield a bit on my claim that my approach to theology is genuinely grounded in the sciences. It is not pseudoscience, myth, or metaphysics, if these terms would suggest that it is not fully grounded in the best of modern science. If I have failed to be within the legitimate bounds of the best science, I shall want to correct my interpretations to make them more adequately so. I reserve, of course, any scientist's right to be myself a member of a small and still not widely accepted group developing a new paradigm, as in the case of my work in the sociobiology of cultural and religious evolution, which I think is crucial and exciting for a scientific theology and for more firmly establishing the relevance of religion as the central agent in the socialization and humanization of this genetic primate.

I do not intend to limit the scientific interpretation of religion to Christianity, and my critics from the Christian tradition who point this out are quite correct. But many of them do not see how the scientific conceptual apparatus allows one to interpret the good that is going on in different religions in ways that are parallel to how scientific inter-

pretation can validate the adequacy of the nourishment of alien diets, not only of populations in alien countries but even of populations as distant as the cellulose-eating termites. I rely upon this capacity of the sciences to transcend the particulars, even better than some have asserted only metaphysics can, and to provide general knowledge against whose background we can appreciate the functional equivalence of otherwise seemingly impossible differences. I have argued that a scientific approach to theology for this reason alone is necessary if humanity is to be welded easily into a viable world village in the atomic age.

The task of creating an acceptable scientific theology has only begun.

NOTES

1. Ralph Wendell Burhoe, "The Human Prospect and the 'Lord of History,' " *Zygon* 10 (1975): 299–375.

2. *Zygon,* vol. 10, no. 3, September 1975. The Symposium on "The Human Prospect: Heilbroner's Challenge to Religion and Science" was held in Washington, D.C., on October 23–24, 1974, by the Institute on Religion in an Age of Science. The Advanced Seminar in Theology and the Sciences, held by the Center for Advanced Study in Religion and Science in conjunction with the Chicago Cluster of Theological Schools, met in the spring of 1976 on ten Thursday evenings, with attendance by some twenty persons mostly on Chicago-area-school faculties in theology and the sciences.

3. Robert L. Heilbroner, *An Inquiry into the Human Prospect* (New York: W. W. Norton & Co., 1974).

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

5. My understanding of the barriers of communication was greatly amplified by my seventeen years as executive officer of the American Academy of Arts and Sciences (1947–64), where I was a common factor in all kinds of interdisciplinary meetings and conferences. The Academy is a very unusual institution with a tradition for interdisciplinary communication that evolved for nearly two centuries as the most outstanding people in their fields tried to communicate with similarly placed people in all academic disciplines and professional fields. My own polyglot education and interests added to my understanding so that I am quite aware from first-hand experience of the seriousness of the communication problem in the top levels of today's culture.

6. Arnold W. Ravin, "On Natural and Human Selection, or Saving Religion," *Zygon* 12 (1977): 27–41.

7. John A. Miles, Jr., "Burhoe, Barbour, Mythology, and Sociobiology," *Zygon* 12 (1977): 42.

8. Max Planck, *Scientific Autobiography and Other Papers,* trans. F. Gaynor (New York: Philosophical Library, 1949), pp. 33–34.

9. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962), p. 150.

10. Ibid., p. 10.

11. Ibid., p. 162.

12. The reformation of religions provides a quite parallel dynamics in terms of crisis produced by newly experienced conditions, the failure of the old ideas, and the appearance of new prophets and visions, with final reconstitution of the system and a less turbulent period of normal orthodoxy. A. F. C. Wallace has written an acute generalization of this, using psychological and thermodynamic concepts among others to account for it: "Religious Revitalization," an occasional paper of the Institute on Relgion in an

Age of Science, 1961, which was republished in different form in his *Religion: An Anthropological View* (New York: Random House, 1966), mostly within pp. 29–38.

13. See my "Appendix on the Publishers [of *Zygon*]: IRAS and CASIRAS," *Zygon* 10 (1975): 116–122 and "The Institute on Religion in an Age of Science: A Twenty-Year View," *Zygon* 8 (1973): 59–80 for some of the history of the movement and the names of various participants. And for some of philosophy and problems of the movement see esp. my editorials in *Zygon* 1 (1966): 1–10, 9 (1974): 2–6, and 10 (1975): 2–11.

14. See n. 6 above.

15. For a classical statement of "The Case for Sociocultural Evolution" see the section of that title in "On the conflicts between Biological and Social Evolution and between Psychology and Moral Tradition" by Donald T. Campbell, *Zygon* 11 (1976): 167–209. See also the other papers in that September 1976 issue, which is devoted to "Religion's Role in the Context of Genetic and Cultural Evolution—Campbell's Hypotheses and Some Evaluative Responses." Various others in the past two decades have been turning their minds again to the puzzle of sociocultural evolution after an eclipse following the failure of the social Darwinists to make a good case beginning early in this century. Some philosophers and historians of science have been suggesting that even the trends in science are a part of a natural evolutionary process, such as Karl R. Popper and Kuhn. Kuhn, e.g., writes: "The analogy that relates the evolution of organisms to the evolution of scientific ideas can easily be pushed too far. But with respect to the issues of this closing section it is very nearly perfect. . . . The resolution of [scientific] revolutions is the selection by conflict within the scientific community of the fittest way to practice future science" (n. 9 above, p. 171). See also H. J. Hamilton's paper ("A Thermodynamic Theory of the Origin and Hierarchical Evolution of Living Systems") in this issue of *Zygon* for a hypothesis that ties sociocultural evolution to a principle that may govern all changes from one level of stable states to another from physical particles to civilizations. George Edgin Pugh's *The Biological Origin of Human Values* (New York: Basic Books, 1977) is an excellent and comprehensive recent development of the field. Richard Dawkins in his *The Selfish Gene* (New York: Oxford University Press, 1976), esp. the last chapter, "Memes: The New Replicators," has joined the growing group who is finding ways to solve the puzzles of sociocultural evolution independently of genetic evolution. An early search that was a pioneer in this recent wave of new work on sociocultural evolution was developed and edited by Hudson Hoagland and me as *Evolution and Man's Progress* (New York: Columbia University Press, 1962) and also at the University of Chicago's Darwin Centennial, published in parts of vols. 2 and 3 of *Evolution after Darwin,* ed. Sol Tax, (Chicago: University of Chicago Press, 1960).

16. I have seen published studies analyzing this type of scientific mind and personality who keep separate their scientific views from certain practical areas of their lives, but I cannot find them just now. I am relying on memory and my personal experience with the population of scientists for saying it is a relatively small class.

17. The *Journal of the American Scientific Affiliation* is a quarterly published since 1949. It states that the "purpose of the Affiliation is to explore any and every area relating Christian faith and science." The "Affiliation is an association of men and women who have made a personal commitment of themselves and their lives to Jesus Christ as Lord and Savior, and who have made a personal commitment of themselves and their lives to a scientific understanding of the world." For a picture of their attitude toward my scientific theology see "Pseudo-Science and Pseudo-Theology: (B) Scientific Theology" by Richard H. Bube (the editor of the *Journal of the American Scientific Affiliation)* in *Journal of the American Scientific Affiliation* (September 1977), pp. 124–29.

18. Again, there is a considerable literature on this topic, written usually by persons engaged in the psychosocial sciences (including such as Anne Roe and Charles Y. Glock), but I am relying on memory and experience in the scientific community for my estimate that this class is large.

19. Miles (n. 7 above), p. 49.

20. F. S. C. Northrop, "The Methods and Grounds of Religious Knowledge," in this issue. I suggest Northrop's writing may be more significant than Whitehead's for doing theology in relation to the sciences.

21. "If man, and no other than man, is responsible for those selections that lead to cultural change, what help is it to tell us that man is part of a larger reality, that of nature? We are simply avoiding the difficulties inherent in our situation by throwing them all upon nature" (Ravin, p. 35).

22. In my papers I have sided with the biologist George C. Williams's harder position on no hope for altruistic behavior from genetic selection in his *Adaptation and Natural Selection* (Princeton, N.J.: Princeton University Press, 1966) over the somewhat softer view taken by E. O. Wilson in his *Sociobiology: The New Synthesis* (Cambridge, Mass.: Belknap Press, 1975). I even take the starker view of Richard Dawkins in his *Selfish Gene* (see n. 15 above).

23. Anne Roe and G. G. Simpson, eds., *Behavior and Evolution* (New Haven, Conn.: Yale University Press, 1958), pp. 519 ff. Also see my "Lord of History," pp. 313–14, for a general statement. The same message appears in many of my papers. See also n. 45 below.

24. Kuhn has noted that in the development of new paradigms "almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change" (n. 9 above, pp. 89–90).

25. J. Bronowski, "'New Concepts in the Evolution of Complexity," *Zygon* 5 (1970): 18–35, and Ralph Wendell Burhoe, "Commentary" thereon, ibid., 36–40.

26. Ralph Wendell Burhoe, "Natural Selection and God," *Zygon* 7 (1972): 30–63; A. Katchalsky, "Thermodynamics of Flow and Biological Organization," *Zygon* 6 (1971): 99–125.

27. My statements about the brain's role in cultural evolution are in many papers but also in the two papers Ravin is criticizing; for instance, in "Lord of History," pp. 305–7, 309–10, and passim throughout the paper; in "Civilization of the Future," *Philosophy Forum* 13 (1973): 149–77, passim.

28. For instance, see my "Civilization of the Future," pp. 161–62, or my "Lord of History," pp. 314–17.

29. See Kuhn (n. 15 above).

30. In my "The Source of Civilization in the Natural Selection of Coadapted Information in Genes and Culture" (*Zygon* 11 [1976]: 263–303) I have given more details on how changes, in any part of the information either solely within the genes or in any other sources that shape any phenotype, must be adjusted to all other elements of the informing or shaping system—a process known in biology as coadaptation.

31. For "idene" we are indebted to Henry Alexander Murray's quip for the cultural analogue of the gene in a conference of the American Academy of Arts and Sciences in 1959 on "The Concept of Progress in Terms of Biological and Cultural Evolution." Hudson Hoagland and Julian Huxley used "idea" (*Nature* 196 [1962]: 203). For "meme" see Dawkins (n. 15 above).

32. Karl R. Popper, *The Logic of Scientific Discovery* (New York: Harper Torchbooks, 1965), p. 111.

33. "Epistemic correlation" is Northrop's term for what P. W. Bridgman calls "operational definition," for what Henry Margenau calls the linkages between the conceptual field and the plane of experience, and for what other scientists and philosophers of science have differing terminology. The concept as I analyze it is primarily to show that scientists in general are never satisfied with merely symbolic games or tautologies, and they insist on an empirical connection, a connection of the verbal or other symbols to some preverbal experiences common to men in general, such as sense data. I believe it is this linkage or correlation between verbal and preverbal brain events that ties the sciences more closely than earlier logical philosophies to selection by the presumed "real world" or nature.

34. My "Five Steps in the Evolution of Man's Knowledge of Good and Evil" (*Zygon* 2 [1967]: 77–96) provides more details of my scientific approach to epistemology, ontology, and axiology.

35. See n. 26 above.

36. We "believe that in Japanese macaques the 'incest taboo,' as a result of which male macaques to not mate with their mothers or sisters, is not genetically determined but has its source in a developmental process." This conclusion, based on investigations reported by G. Gray Eaton on p. 102 of his "The Social Order of Japanese Macaques" (*Scientific American* 253 [October 1976]: 96–106), lends evidence even to prehuman culturetypic evolution of the incest taboo where offspring live together in troops ranging from fifty to one hundred fifty in which only a few would be as closely related as one-half. I cannot find my reference to a recent paper (I think in *Science*) which on the side provided an account for the cultural taboo against incest among humans and its coadaptive virtue for the gene pool. If someone could supply me with that or related references, I would be grateful.

37. See Alfred E. Emerson and Ralph Wendell Burhoe, "Evolutionary Aspects of Freedom, Death, and Dignity," *Zygon* 9 (1974): 156–82, and Robert J. Lifton, *The Life of the Self* (New York: Simon & Schuster, 1976).

38. See reference to necessity for coadaptation of cultural to genetic information in n. 30 above.

39. The intimate correlation of consciousness and brain is another problem that produces logical paradoxes in our language as we shift from the subjective to the objective mode of talking. They are really all the same, namely, human talking about human experiencing. But our language and conceptual system provide confusion when not used carefully. R. W. Sperry's papers (see, for instance, his "Science and the Problem of Values," *Zygon* 9 [1974]: 7–21), the work of Susan K. Langer in *Mind: An Essay on Human Feeling* (Baltimore: Johns Hopkins University Press, 1967, 1972), vols. 1 and 2, and the work of Pugh in his *Biological Origin of Human Values* (n. 15 above) are all examples of new understandings of the identity of mind and matter and of new ways of clarifying our language to avoid the traditional paradox.

40. My papers have provided much evidence from various sources concerning this, but I think a most important recent presentation of it is Pugh's book.

41. Brownoski (n. 25 above).

42. Ibid., p. 33.

43. My "Lord of History," p. 360.

44. Ibid., p. 368 (italics added).

45. In 1957 I wrote in my "Salvation in the Twentieth Century," published as chap. 6 in *Science Ponders Religion*, ed. Harlow Shapley (New York: Appleton-Century-Crofts, 1960), that the "thesis here presented is that religion is that organ or institution of culture which provides the most all-embracing and fundamental integration of ideas and attitudes that move man to behavior that makes life possible. Religion is to human culture what the neuroendocrine motivational centers are to the animal body" (p. 69). "In human life, motivation [including that for self-sacrificial social life] as well as know-how must be provided in part by the culture; and it is this cultural patterning of motivation, of values, especially with regard to the prime necessities, or, as theologian Paul Tillich would say, with regard to the areas of ultimate concern, that we call religion. . . . It seems to be a reasonable interpretation that religions have evolved like the other elements of culture, such as language or agriculture, largely without any man's premeditated design. Moreover, the complexity and effectiveness of religion, like language or agriculture, are such as to defy any ready and facile rational analysis" (p. 71). This thesis of the operation of nonhumanly planned selection of viable designs in cultural evolution—which is quite overlooked by Ravin—has been central in my hypotheses for more than three decades. But only in the past few years have I been struck with the real integration of the genes and the cultural patterns through an extension of the phenomenon that the biological community has called "coadaptation," which is developed in recent and forthcoming papers. The hypothesis hangs upon the empirical facts of the selection process and whether and how the multiple units in the "information" (the remembered and encoded symbol systems of genes, cultures, and other extrachromosomal and extraorganic repositories of information systems which structure the behavior of human systems) are selected by the viability of their common

phenotype—the human societies or civilizations or, one could say, the human societal ecological niches. But it appears to me almost incontestable that a delicately balanced integration of all elements of the information system—coadaptation—is a sine qua non.

46. My "Civilization of the Future" (n. 27 above), p. 151 (italics added).

47. Ibid., p. 152 (italics added).

48. My "Lord of History," p. 310.

49. Ibid., p. 301 and passim throughout the paper.

50. On biological systems analyzed in terms of the thermodynamics of the "dissipative structures" of thermodynamic energy-flow patterns see A. Katchalsky's "Thermodynamics of Flow and Biological Organization," *Zygon* 6 (1971): 99–125, for instance, as well as Hamilton's paper in this issue.

51. Kuhn (n. 9 above), p. 151.

52. For the mind-matter question see, for instance, the section on "Subjective and Objective" in my "The Phenomenon of Religion Seen Scientifically," pp. 24–26 of chap. 1 in *Changing Perspectives in the Scientific Study of Religion,* ed. Allan W. Eister (New York: Wiley-Interscience Series, 1974). There, among others, I cite the Nobel-Prize physicist E. Schrödinger's as one of the best resolutions: "The reason why our sentient, percipient, and thinking ego is met nowhere within our scientific world picture can easily be indicated in seven words: because it is itself that world picture." For the freedom-determinism question, I still think my presentation in my "Lord of History," pp. 336–46, is good.

53. Some are listed in n. 39 above.

54. Among several other places I have described the mythic character of the sciences in my "A Scientific View of the Role of Religion" on p. 156 of my *Science and Human Values in the 21st Century* (Philadelphia: Westminster Press, 1971).

55. See Northrop (n. 20 above), Kuhn (n. 9 above), and Popper (n. 32 above). Also see Henry Alexander Murray's statement of the scientist "who favored the inclusion of the 'truest' scientific models and theories as a special class of myths. He called attention to the fact that for three decades or more scientists have been regarding their most valid concepts of imperceptible entities as well as their best-confirmed theorems . . . as . . . convenient 'myths' . . ." (*Daedalus* issue on myth and mythmaking [Spring 1959], p. 218). See also Philipp Frank's similar statements, ibid. (Fall 1958), p. 159.

56. See especially the accounts in Richard von Mises's *Postivism: A Study in Human Understanding* (Cambridge, Mass.: Harvard University Press, 1951) and in Philipp Frank's *Philosophy of Science: The Link between Science and Philosophy* (Englewood Cliffs, N.J.: Prentice-Hall, 1957) and many other works since, including Kuhn's, which quite clearly have shown the recognition of the relativity of scientific knowledge and the impossibility of man's having any absolute or final truth. Ravin's statement is on p. 33 of his paper. Grounds for understanding the unity of mind and matter were pioneered by such prominent (Nobel Prize–winning) physicists as P. W. Bridgman (see his *The Way Things Are* [Cambridge, Mass.: Harvard University Press, 1959]) and Erwin Schrödinger (see his *Mind and Matter* [Cambridge: Cambridge University Press, 1959]).

57. My acknowledgement of the incompleteness of science is customary, and is included for instance in my "Lord of History," pp. 360–61, 365, and is more completely stated in my "Source of Civilization" (n. 30 above), pp. 267–68. I have had personal experience with what Miles and Kuhn speak of as the requirement of "death staring from the shadows" or of a "crisis" before a new paradigm can come into being. I can remember meetings when Henry Helm Clayton in 1937 tried to tell the meteorological community that they should take into consideration his evidence that the solar variations had an effect upon the earth's weather sufficient to be important for cycles and the forecasting of daily weather—and seeing the sages of the meteorological community laugh at him, only to repent twenty years later when some of them validated such claims. I remember talking with Robert Goddard in 1938 and hearing his unhappiness over the failure of the United States government or his colleagues in physics to take seriously his work in the development of rocket engines that might be important not only for military use but for going to the moon. Such stories can be multiplied ad

infinitum as characteristic of both the history of science and of religion. The first men to recognize the inadequacy of an element of culture and to discover or invent a solution are usually outsiders until a severe crisis or death stares in the face of the larger community of which they are a part.

58. For Campbell's picture see n. 15 above. My published papers developing hypotheses concerning a cultural heritage that provides a wisdom of the culture—analogous to and cooperating with Walter B. Cannon's genetically programmed wisdom of the body—goes back as far as my 1957 "Salvation in the Twentieth Century" (see n. 45 above, esp. p. 69).

59. Various aspects of these reasons have been presented in several of my papers, esp. "Five Steps in the Evolution of Man's Knowledge of Good and Evil," *Zygon* 2 (1967): 77–96, and "Source of Civilization" (n. 30 above).

60. The generally accepted criteria for distinguishing science from technology have been presented in *Zygon* in various papers, but perhaps succinctly in R. B. Lindsay's "The Scientific and Technological Revolutions and Their Implications for Society," *Zygon* 7 (1973): 212–43. Several of my publications have indicated why religion is an art or technology (it serves to fulfill human needs) and theology is a science in accord with the prevailing distinctions, one such publication being *Science and Human Values in the 21st Century* (n. 54 above), chaps. 7–8.

61. See particularly my "Source of Civilization" (n. 30 above).

62. See my "Lord of History," p. 321, and consult C. F. von Weizsäcker's thesis in his *The Relevance of Science* (New York: Harper & Row, 1955).

63. See, for instance, my "Bridging the Gap between Psychiatry and Theology," *Journal of Religion and Health* 8 (1968): 215–26. See also Campbell's "On the Conflicts between Biological and Social Evolution and between Psychology and Moral Tradition" (n. 15 above).

64. W. Widick Schroeder, " 'The Human Prospect and the "Lord of History" ": A Process Critique," *Zygon* 12 (1977): 4–26; Donald W. Musser, "Two Types of Scientific Theology: Burhoe and Nygren," ibid., pp. 72–87; Philip Hefner, "To What Extent Can Science Replace Metaphysics? Reflecting with Ralph Wendell Burhoe on the 'Lord of History,' " ibid., pp. 88–104.

65. von Mises (n. 56 above), p. 140.

66. Northrop (n. 20 above).

67. Eric J. Chaisson, "The Scenario of Cosmic Evolution," *Harvard Magazine* 80 (November–December 1977): 21–33. Harlow Shapley wrote "All Nature is God and all God is Nature" on p. 279 of his "Life, Hope, and Cosmic Evolution," *Zygon* 1 (1966): 275–85.