DYNAMIC HOMEOSTASIS

A UNIFYING PRINCIPLE IN ORGANIC, SOCIAL, AND ETHICAL EVOLUTION[1]

by Alfred E. Emerson

Much controversy occurs concerning the application of methods and principles from the natural sciences to the humanities and social sciences. Although sciences are divided according to their subject matter, they all use a logical method for the attainment of self-correcting knowledge, and the method may be applied to a great variety of fields of inquiry. The essential principles of the scientific method are: observation by means of sensory perception, classification of related facts, determination of causes and effects, and the formulation of theoretical interpretations in conformity to the facts and their relations, the verification of relevant facts, and finally, the reporting of facts, relationships, and interpretations in order that others may criticize, modify, and correct the data and the conclusions.

Grounds for a Scientific Study of Values

There would seem to be no valid reason why symbols, culture, and ethics cannot be studied by the scientific method.[2] It is true that science is based upon objective data, whereas ethics may arise in part from subjective feelings, but subjective data may be objectivized and analyzed. Psychologists constantly treat subjective emotions scientifically. The origins and the effects of subjective attitudes may be studied by the objective methods of psychological and social science, in large part the same methods that are used in natural science. Subjective concepts and emotions give rise to behavior in both animals and man. Both observation and experiment indicate that areas in the brain (hypothalamus) control emotional expressions such as anger and fear, while maternal care is controlled by other areas (cerebrum). It also has been demonstrated that hormones may affect behavior and in turn may be affected by emotions. There is no longer any question that emotions influence thinking and that they respond in turn to the intellectual activity of the cerebral cortex. Psychosomatic medicine and hypnosis have demonstrated the relation between learned behavior and the physiology of the body. Scientific thinking cannot divorce itself

Alfred E. Emerson's "Dynamic Homeostasis: A Unifying Principle in Organic, Social, and Ethical Evolution" is a classic analysis made in 1953 at a time when our culture's faith that human values could be discovered or enhanced through the sciences was at a very low point. Emerson wrote so wisely that a decade and a half later (a long time with reference to rapid developments of the sciences) the validity of its scientific concepts, some of which were then and even still are rather daring hypotheses of a perspicacious scientific frontiersman, seem to me to be more validated rather than outmoded by further developments of this period. I can reprint it with but few changes[48] and feel that it is scientifically sound.

From the religious point of view, I find it also a classic, a veritable mine of resources for a contemporary natural theology. Furthermore, it is a conceptual scheme that permits a genuine bridge for unifying the natural sciences with the social sciences and humanities—all of which, as he makes plausible, can be brought under the reign of a single broad principle, the natural selection of living or evolving dynamic homeostatic systems. It presents a text of such rich potentialities for further elaboration that scientists, humanists, and theologians will likely find it a blueprint for efforts for many years.

The condensation in "Dynamic Homeostasis" of such a vast amount of scientific information and human wisdom may make it difficult reading for those not already familiar with theories of organic and cultural evolution. Even for the scientifically literate, some passages will require some careful meditation. Before it can be understood by a general public, its elements would perhaps need to be expanded into a volume or several volumes. But I suggest that *Zygon* readers will find it a master key for the development of their own thinking on how the sciences may provide a common theology for elucidating and evaluating man's convictions about right and wrong, about his destiny and proper hopes and fears therein. I don't, of course, pretend to imply that this paper is without fault—only that it is unusually sound and pregnant for theological life.

But we republish this document not only because of its capacity as it stands to provide a basic unifying principle for religion and science, and because it is referred to in footnotes in *Zygon* and elsewhere and is not now easily available for reference, but also because we expect to publish, in the not too distant future, further papers, carrying forward on the basis of the understanding presented herein.—EDITOR.

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from human emotions and human nature, but it can gradually discover the relations and interdependence of objective and subjective manifestations.

There are some who feel that so-called cold-blooded scientific analysis takes away the response to beauty and the aesthetic delight inherent in art and religion. The philosophy of aesthetics is still in a crude form. However, there is some reason to think that the recognition of order and harmony in thought and ideas as well as in nature and the works of man may give rise to emotional pleasure and inspiration akin to that derived from other forms of beauty. The motivation from aesthetic emotions stimulates the scientist and the humanist alike.

Many scientists would not agree with some of the above statements and would take the position that ethics, value, and beauty are not subject to scientific investigation. The contention of this essay is that a partial understanding of value systems is possible through scientific method. Numerous modern scientists advocate a scientific approach to ethics, a position that may be referred to as Naturalistic Ethics.[3]

Man tends to rationalize his subjective attitudes. Ethical statements often are used to cover up more basic motivations and feelings. This conscious or unconscious hypocrisy is not dealt with in detail here. It is thought best to confine this discussion to ethics as it initiates and controls human behavior and social co-ordination. The psychological aspects of ethics are important but are left for further analysis to the psychologists. Knowledge of personality development is highly pertinent to the ensuing discussion, but time, space, and the competence of the author do not justify its inclusion.

Because of the complexity of society, we may expect to find the scientific methods used in biology rather than those used in the physical sciences applicable to the social sciences. Biology handles intricate data and concepts. Neither biology nor ethics can ever become an exact science with rigid mathematical formulation or prediction. If a few factors influence a repeated event and these can be quantified, mathematical formulation and prediction are possible. In biology and the social sciences, however, a great many factors usually affect any given event, and these are seldom completely known or measured. In spite of the complexity of the subject matter, biology has made great advances in understanding and in controlling life processes. Progress in agriculture and in medicine demonstrate the applicability of basic biological science to complex activities and events. There would seem to be no intrinsic reason why social science, including the humanities and ethics, may not be expected to advance and to find applications in

some measure commensurate with the rapid development of the biological sciences.

We should not expect to find absolute truth by means of the scientific method. Unproved and possibly unprovable assumptions are fundamental to scientific method, for example, the validity of sensory perception in bringing us into contact with reality. Relations of sensory experience are basic to the logic of science, and all scientific truth is therefore relative. So, likewise, our scientific knowledge of social science and ethics will remain relative and will never become absolute.[4]

Philosophical considerations, possibly beyond the scope of science, produce much argument and controversy. For example, the relation of "is" to "ought," if any, underlies any science of ethics.[5] Without attempting to settle this ancient problem, it seems that value systems and attitudes evolve and are directed by dynamics similar to those found in biological systems and that our philosophical difficulties are more semantic than scientifically real.[6]

Certain biological principles are found to be transferable to social science. Biology and anthropology have clearly demonstrated that man has evolved directly from certain higher animals. Not only do his body and mental faculties show relationship to his primate relatives, but his society is based upon mammalian group behavior, particularly family group behavior. These comparisons may assist us in understanding fundamental principles of societal co-ordination. For example, a social hierarchy founded upon dominance and subordination learned through individual contacts is characteristic of many vertebrates, particularly in flocks of birds and in herds of mammals. A similar social hierarchy seems to be characteristic of man in his various social organizations.[7] The background of vertebrate group behavior should not be relied upon exclusively for a science of society. Insects also have evolved complex societies that illustrate certain social activities, for example, shelter building and agriculture.[8] Division of labor among adult individuals of the same sex is characteristic of insects and humans but is only vaguely discernible in the subhuman mammals.

We may conclude, therefore, that intricate social behavior evolves and is an expansion of biological antecedents, and biology should be able to supply us with basic principles underlying social co-ordination. There are many unique characteristics of the societies of man, particularly those associated with language. Biology does not deal directly with social phenomena that are dependent upon symbolization. But these unique qualities do not prove the lack of fundamental connecting principles between the social and natural sciences. Probably the study

of the great bulk of human activities will properly remain within the field of the social sciences, and biologists will only assist in laying foundations upon which the social scientist can build. Several intermediate sciences, particularly human geography, psychology, anthropology, and mathematics, investigate and relate both natural and cultural phenomena. On occasion the biologist may use principles discovered by the social scientist. The concept of division of labor between parts of a whole now found universally applicable to all living things was first enunciated by students of human society.

Science and Analogy

If we agree that scientific method and concepts as used in the complex biological sciences may be applicable to the study of ethics, we must validate the use of analogy. No biological group with the exception of social man possesses an ethics based upon communication by symbols; therefore, the comparison of ethical man to any other living system is through analogy. We may briefly state that comparative resemblances are classified into three types: fortuitous, homologous, and analogous.

In the case of fortuitous resemblance the correlations of observed facts indicate no incidence beyond that expected by chance, and no cause and effect relations can be established. Sympathetic magic (e.g., the attempt to injure a person by injuring his image, or the modern custom of hanging in effigy), and astrology may be cited as widely held beliefs of causation with little or no indication of any significant correlations beyond those that may be attributed to chance.

Comparisons of homologues are used frequently in biology and are fundamental to much of our knowledge. Homologues are similar because they possess the same intrinsic cause and effect relations. For example, the eyes of a gorilla, a chimpanzee, and a man are considered homologous because the data on the structure, physiology, and development of the eyes of these animals are interpreted as indicating that identical genes or gene parts (self-replicating organic molecules) initiate identical developmental processes that result in an identity of growth and physiological function. These genes, in all probability, were present in the common ancestor of the gorilla, chimpanzee, and man, and have been passed from generation to generation through millions of years.

Illustrative homologues usually have only a proportion of identity that seldom reaches 100 per cent. In consequence, differences occur associated with homologous similarities, and complete identity of compared organs or systems is rare.

In the study of ethics, we may apply the concept of homology to similarities of ethical practice with the same origin under the same guiding forces and passed from one individual to another by means of the same symbols with the same meanings. For example, similarities of ethics and symbols in different Christian sects may be considered socially homologous if they can be traced to the same historical source.

Biological analogy refers to functional resemblances arising independently of each other through the action of natural selection on different genetic systems. Analogous similarities are neither fortuitous nor homologous, but they appear through the action of similar extrinsic or environmental guiding forces. For example, the eye of an insect and the eye of a man have similarity in their image-perceiving function, but there is no evidence that any genes initiating eye development are the same in these two forms. The ancestral animals common to both types (primitive bilateral unsegmented worms) certainly did not possess an image-perceiving eye, and the development and physiology are very different in spite of the functional resemblance that is recognized by the use of the word "eye." Analogues in biological systems are the result of convergent adaptive evolution—a principle that will be briefly mentioned later.

A complex structure or process may have both homologous and analogous traits at the same time, and these may be difficult to separate. On the other hand, homology and analogy may be easily separated in certain instances. In the classical case of the wing of a bird and the wing of a bat, all the structure, physiology, development, and genetics that pertain to the function of flight are clearly analogous, while all the basic structure, physiology, development, and genetics of the forelimb that are continuous in evolution and that occurred in the common ancestral reptile are clearly homologous.

Much of biological science is founded upon comparisons of analogues. It need only be stated that many genes are analogues; different hormones in the vertebrate body are analogues; sex determination mechanisms in trees, insects, and man are analogues; the multicellular individual sponge, vertebrate, and plant are analogues; and the societies of termites, ants, and men are analogues. In none of these compared categories are the similarities the result of identical protoplasmic self-duplicating mechanisms derived from identical ancestors possessing the compared characteristic. It is obvious that comparisons of analogues are basic to important sciences, including genetics, endocrinology, sex biology, the study of organismic systems, and comparative sociology.

Only general resemblances between analogues should be expected.

Significant analogues often lack close similarity of detail. Because of the expected limitations in the degree of identity between analogues, extrapolation from one to another has definite restrictions.[9] One cannot presume that two analogues necessarily possess common traits or principles of organization without comparative facts and significant correlations. But the possession of similarities in independently derived systems substantiates the concept of analogy and stimulates inquiry into the causes of the resemblances. The more distantly related the compared phenomena are, the more difficult it is to recognize shared causation, but at the same time the more fundamental and important is the discovered principle.

Critics of analogical reasoning are concerned over its use for certain false conclusions.[10] It is true that there are many examples of naïve associations and even dangerous thinking resulting from false analogical comparisons. For example, from the fact that the joint efforts of worker bees produce a hive for the colony, the assumption that the hive is common property is not wholly justified and should not be used as an argument favoring socialism, communism, or the totalitarian state. Political systems are in a large measure the result of learned language communication and cultural evolution. Ascribing a similarity of detail (the human concept of private or public property) to a political system and to a genetic system is hardly valid. We may find that the function of political systems in human society has a general analogy to the genetic integration of social insects, but we must be careful not to carry the analogy into details that may be based upon verbalisms. Arguments by false analogy have been used to justify social bias. Rationalization of subjective prejudice is not scientific. Science is objective. Scientists, with the foibles of other humans, are often subjective in their opinions. The danger is real that scientists will rationalize their prejudices by the use of false analogical reasoning under the guise of purported scientific method. It is hoped that this "ethnocentric" danger has been avoided here.

A common example of the use of false analogy is found in the anthropomorphic explanations of animal behavior. Hardly any anecdote told by the owner of a pet is free from the tendency to humanize the beloved animal. And there is also a trend among students of social insects to "termitomorphize" or "myrmecomorphize" human society and to make humans falsely resemble termites or ants. Part of the difficulty is to be found in the limitations of our language. A term that originally has had human connotations is applied to animal behavior and utilized as if it had significant meaning for both humans and animals. A term

with double meaning may be used with a shift of the meaning in different contexts, thus confusing the analysis. Semantic ambiguities often produce what seem to be divergent opinions and conclusions that could be resolved with a clarification of terms. Verbalisms and euphonious metaphors may often prove to be false analogies. Analogy is valuable in scientific comparisons, but only when relative functional resemblance can be demonstrated.

All analogues with similarities of function also have differences of exact mechanism, and these should be clarified. Because of convergent evolution, analogues are expected to have fundamental differences and an understanding of these assists in the analysis of the nature and causation of the similarities. An understanding of any system demands comparative information on both the similarities and differences between it and other systems.[11]

Even though no non-human group of organisms possesses an ethics, if ethics in any way has a functional resemblance to biological activities, analogous comparisons may be made and interpretations proposed. A comparative study of cultural patterns and systems may be expected to reveal fortuitous, homologous, and analogous similarities, and these may be objectively studied and measured. Significant resemblance between ethics and any subhuman biological processes is largely if not wholly analogous.

Analogy between Cultural and Genetic Systems of Inheritance

The reason why culture is confined to humans seems obvious. Man constitutes the only species that has attained communication through learned symbols that can be transmitted from one individual to another and from one generation to another. Consequently, it is possible to acquire socially the experience and thoughts of another individual through the transmission or communication of meaningful symbols from one brain to another by means of language and other behavior, or the artifacts of behavior in written words or other objects. Ethics is composed of the concepts and customs dealing with right and wrong, good and bad, and is socially inherited by means of symbolic expressions.

Biological inheritance is made possible through the transmission of genes. Genes are considered to be replicating nucleic acid (RNA or DNA) molecules, each different one distinctive in its influence on enzymic action. Human social or cultural inheritance is made possible through the transmission of symbols—usually spoken or written lan-

guage. Social contact and contiguity are necessary for social inheritance. Germinal contact and continuity is necessary for biological inheritance. Symbols have meanings that are learned. They are duplicated by each new individual as they are learned from others, and each symbol may initiate associated behavior. Biological and social inheritance are analogues with fundamental differences in mechanisms and fundamental similarities in their hereditary function.*

Genes not only function in the repetition of inherited characters but they also are capable of changing or mutating, and these changes are

* *Editorial note.*—Symbols may be talked about in two different languages: (1) that of the usual humanistic abstract concepts or words with their associated meanings in conscious or remembered life experiences and feelings; and (2) that of the neurophysiological correlates of such activities. In the latter language, symbols may be thought of as patterns of associated memory records in the nervous system that have been established by the way the life experience has modified or elaborated new states in the brain. Many such states of the brain are tied to the elements of the language system encoded in the brain.

The language system is itself a unifying abstraction and ordered codification of experience that is communicated to each growing child's brain by the linguistic structures in his particular environment or culture. Some of the word groups become closely tied to behavioral motivation mechanisms of the brain, such as the words "No, no, that is bad," or "This is good," reinforced by social as well as natural sanctions. Even before human cultures possessed written languages and other artifactual symbol systems, verbal symbol systems became encoded in the neural tissue provided by man's genetic heritage. This linguistic heritage, encoded in neural structures, with all its motivational and moral "do's" and "don'ts," is passed on to a child not only by mother and father but by all other persons in his social group. These culturally elaborated symbols are only partially determined by, and not at all transmitted in their specific forms through, the genetic heritage. Each of the languages and the specific symbol systems formulated out of its verbal units are transmitted from one brain to another in the sounds and sights or other communication mechanisms (transmitting, receiving, and associating) of the organism for which the genotype provides only the rough framework for the individual potentialities of learning.

The coupling between linguistic sounds and particular neural patterns associated with linguistic symbols and between these elements of the nervous system and external behavior or internal behavior (feelings, etc.) is probably not nearly so tight as the coupling between the genetic information and behavior. But even so, it is remarkable how closely correlated with behavior the linguistic transmissions may be, and how they may persist with only minor changes over the centuries even in unwritten linguistic traditions. Such symbol systems may structure the basic wisdom or myths of a culture in ways that produce continuity in behavioral patterns: in the various technologies and social, moral, and religious ways of life. Such symbolic structures transmitted from one brain to another also evolve, just as do the genetic structures. Certain patterns are statistically selected more frequently from among the large number of variant forms that occur in any society, so that through the centuries the languages and other symbolic systems undergo guided evolution and so do the behavioral patterns dependent upon them. The symbols may thus be said to be analogues of genes. They are potentially describable in the biological system, and the intricate nets and webs of cause-and-effect, and feedbacks from effects to causes. Their dynamics and evolution by selection of variant forms can be at least roughly indicated.

also inherited. Mutability, or modifiability, is characteristic of genes. This genetic variability is a necessity for much subsequent evolution. Symbols repeat their function in individuals to whom they have been transmitted and who have learned their meanings. Duplication and the repeated initiation of homologous activity are not the only functional analogies between genes and symbols. Symbols also are able to become modified and to pass on as modified to other individuals. Modification of symbolic meanings seems to be a necessity for progressive social evolution in man. A rigid invariant system of symbols passed from one generation to another would be social inheritance, but it would prevent progress. Any attempt to establish a fixed and unchanging pattern of symbols and ideas is consequently unprogressive. Here we may begin to discern an important difference in emphasis between democratic and authoritarian political philosophies, between freedom of expression and inquiry as contrasted to a stereotyped ideology established by uncritical adherence to repeated slogans. Freedom of the individual is the basis of criticism and new adjustments, and no political regime has lasted that has so restricted individual freedom that it has negated the possibility of reform, and hence better adaptation.

Gene mutations are nearly always haphazard in the adaptive direction of their effect. In contrast, modification of symbols by means of human intelligence and reason often produces a directed adaptive response. Humans not only intelligently direct the change in symbols but they create new symbols to express new meanings and initiate new directional responses. There would seem to be little question that a part of the uniqueness of human social evolution rests upon this important difference from biological evolution. The difference in the rate of the two types of evolution is largely to be explained by this principle. With new discoveries, behavior may change conspicuously as the symbols are communicated by personal contact or by publication or radio. Non-human animals may learn individually and also may reason, but their evolution depends upon genetic change, fixation, and dispersion, and these events take a long time. Therefore we find organic evolution takes many thousands or millions of years before important new adjustments are produced, whereas drastic social evolution is possible over a few years or decades.

The two functions of genes, the replication or duplication leading to fixed or stable inheritance and the capacity to mutate (leading to varied inheritance patterns necessary for progress), result in a compromise between the two. Too much change would destroy inheritance and would result in the loss of accumulated adaptation. Too little change would

prevent evolutionary advancement. Genes have evolved toward a balance between these somewhat opposed functions. This balance is termed "mutation pressure" by biologists. Symbols also probably have evolved toward a balanced regulation of these analogous functions. This trend, if it exists, needs exacting study.

Genes have a unitary attribute that includes a degree of individual independence. Each gene may be naturally selected and sorted somewhat independently according to the efficiency of its function. Complex organic adaptations are always the result of a gene pattern composed of many genes, each functioning under different physiological and developmental conditions to produce a synthetic beneficial result. There seems to be no doubt that symbols also are always grouped and function in organized systems. At the same time, they possess a degree of independence.

One gene may have numerous effects in different physiological settings. It seems obvious that symbols also vary in their effect in different combinations with other symbols and in different social settings. The differences in the meaning of the same word in different contexts is a simple example of this principle as it operates in a cultural system.

Characters of organisms are dependent on many genes. Functional symbolic systems also are dependent upon multiple symbols, each of which can also function in other directions.

Recombination of new and varied assortments of genes is the original function of sex in plants and animals. Recombination of genes into new patterns is a basic cause of genetic variability. Organized recombination of symbols may also profoundly influence the evolution of symbolic systems including ethics. The science of ethics will probably find some significant analogy to sexual fusion. Our common use of the term "cross-fertilization" in speaking of interdisciplinary cultural or social interchanges is indicative of such an analogue.

We may predict that changes in patterns in both gene and symbol systems may produce novelties in structure and behavior. The concept of emergent evolution emphasizes new properties emerging from new associations. As a matter of fact, it is hoped that this essay will produce some emergent concepts from the cross-fertilization of natural and social science, and of science and the humanities.

Ethics an Integrative Mechanism

Individual organisms are integrated by a variety of biological mechanisms, biochemical and biophysical, that are predominantly dependent upon protoplasmic continuity or contiguity. Intraspecies populations

are integrated by genetic continuity, by biochemical agents, and especially by sensory stimulus and response affecting behavior. Population integration is not dependent upon protoplasmic contact except for the reproduction of individuals.

Behavior may result from neurological patterns learned in individual experience or by genetic patterns selected phylogenetically and recorded in the genotype. Learned behavior is predominant in humans, and learned symbols are practically unique. Ethics is an important aspect of learned symbolic communication integrating human populations and groups. It is analogous to population and organismic integrative mechanisms in non-human animals. Learned ethical behavior is both one of the causes and one of the effects of human social unity.

Biological organisms and populations show development in time (ontogeny or life history) and evolution in time (phylogeny). Genes and gene patterns may have sequential effects in the life history of the individual. Distinctive adaptive traits associated with age may evolve in animals or plants, for example, in the different stages of the mosquito development, or the special adaptations of a seed in contrast to those of the mature plants. Populations often exhibit life cycles of the group as a whole (malarial protozoans, tapeworms, aphids), with physiological and psychological functions distinctive in the different generations within the population.

Both individual and population characters have evolved through time with genetic modification during phylogeny. Ethics, as a primary integrative mechanism of human populations, may be expected to have these time dimensions. One may expect a development of ethical concepts from childhood to maturity, and a different ethics for children than for adults. Not only is there an individual development of ethical attitudes, a cultural analogue of ontogeny, but there is an evolution of ethics through racial experience also, a cultural analogue of phylogeny, with cultural transmission from one generation to another.

Cultural accumulation of symbolic units and systems is confined to humans so that social evolution builds upon the past experience of the species. Organic evolution, in contrast, builds upon the past accumulation of genetic units and systems.

Homeostatic Mechanisms and Functional Relations of Organic and Social Systems

Efficiency demands a degree of specialization, and all life now existing exhibits specialization of function among the parts. Division of labor is found among individuals in population systems, particularly in truly

social animals. Nature selects more efficient mechanisms for survival, and the less efficient may be eliminated. The result is a general increase in division of labor during both development and evolution. The psychological division of labor within human society that results from the learning of special skills shows a relation to the time factor of both individual and group development and evolution. Spencer and others emphasized evolutionary increase in complexity and integration. Recent evolutionary study indicates the validity of these trends in most sequences, but if either complexity or integration is considered an end in itself, false conclusions may result.

Division of labor and integration are complementary principles and are always associated. Specialized function has no utility if the parts are not brought into co-ordinate relationship and incorporated into a larger unit. And this unit is the result of the interaction of the parts.

Various levels of integration with division of labor among the parts are found. Some of these living systems may be listed as follows:

1. Cells with protoplasmic parts.
2. Multicellular organisms with cellular parts.
3. Intraspecies populations: (*a*) intrabreeding populations with male and female individuals; (*b*) family groups with parental care of the offspring; (*c*) societies with division of labor extending beyond the sexual and family level among the mature individuals.
4. Interspecies groups: (*a*) man together with his domesticated animals and plants (a biocoenose); (*b*) associated organisms incorporated with their definitive habitats (an ecosystem).

In all levels of interaction we find parts functioning toward the co-ordination of the more inclusive unit. Many types and gradations of mechanisms leading toward integration may be found. These mechanisms are often analogous in different organismic systems (see Simpson[12] and Schneirla[13] for critiques of the social supraorganism, and Emerson[14] for an analysis of the concept).

In human society, integration is attained by numerous devices, including aesthetics, ethics, religion, economics, government, and education. The social institutions and customs are used to enhance, develop, and channelize the basic virtues of love, loyalty, mutual sympathy, and constructive competition. Destructive competition, hatred, and social vices may also be increased through social integration but, in the long run, such inefficiencies tend to be eliminated and functional efficiencies tend to be perpetuated. Competition is not always disintegrative, nor is co-operation always integrative.

Division of labor and integration are not ends in themselves. In order to evolve progressively, they must produce greater functional efficiency. The maintenance and control of the necessities of life at optimal values for efficient existence seem to be a universal evolutionary trend. Self-control, regulation, and maintenance of many important conditions of life within each organismic level or system has been termed "homeostasis" by the great Harvard physiologist, Walter Cannon.[15] Homeostasis within the human body includes the regulation of water, sugar, salts, and temperature, to mention only a few examples. Relative equilibrium within narrow ranges of variation, and balanced compromise among multitudinous activities are characteristic of homeostasis. Homeostasis may be a delicate regulation by means of subtle mechanisms, as well as a grosser and more obvious control. It may be psychological as well as physiological. It may involve activation or inhibition. Homeostatic effects are often web effects with many negative feedbacks. There may be homeostasis of homeostatic mechanisms.

Homeostasis is not static but is dynamic. Functional differentials and unbalance may be homeostatic. For example, the nerve impulse is a wave of depolarization of the nerve membrane. Repolarization is rapid, thus maintaining the functional capacity of the nerve. The maintenance of polarization in this case is the homeostatic establishment of disequilibrium. Optimal conditions of life and existence often require differentials, asymmetries, and variation, rather than uniformity, symmetry, and stability. Homeostasis is the regulation, control, and maintenance of conditions for optimal existence (Cannon[16] and Gerard[17] discuss both physiological and social homeostasis; Emerson[18] discusses evolutionary implications).

Homeostasis of population systems is characteristic of animal groups. It may be observed in the activities leading to group protection from predators, regulation of food resources, and shelter construction. What appears to be individual competition and combat may be group homeostasis. Survival of the species may depend upon efficiency in the spacing of feeding and mating activities. We find animals fighting in defense of mates, nesting sites, and feeding territories. The size of the group in relation to the efficiency of biological activities is important and is often controlled and regulated. Homeostasis may involve an optimal population size rather than minimal or maximal numbers.

Homeostasis within human society includes the social regulation of optimal physical and biotic conditions of human existence by means of architecture, industry, transportation, agriculture, public health, and economic exchange, to mention only a few aspects of social balance and

control. Innumerable aspects of social life may have optimal values. These values, at least in part, may be measured and partially determined. Although the more obvious regulations are used to illustrate the principle—for example, the control of temperature in buildings, the control of the food supply through agriculture and distribution, the control of exchange through transportation, and the control of health through medicine—there is no doubt that a very large number of social variables may become homeostatic. Social research will doubtless discover many subtle aspects of balance and dynamic regulation in multiple social interactions. The roles of music, art, literature, religion, and entertainment have not been fully evaluated in terms of advancing civilization, but there is good reason to believe that a balanced life includes a proportion of time devoted to many activities—physical, aesthetic, intellectual, "spiritual," social, and relaxing. Humor seems to assist in personal and social integration and balance, but its function in human co-ordination is only vaguely understood. The gaps in our knowledge of homeostasis, particularly psychological and social homeostasis, demand much further investigation.

Homeostasis of one functional activity may interfere with another both within the individual organism and within the integrated group system. Balanced adjustment evolves. A degree of separation may reduce the interference. This separation may be chronological or spatial, quantitative or qualitative. Such periodicities, replications, and specializations are characteristic of all integrative levels.

We may conclude from the accumulation of great quantities of evidence that the general long-term trend of all social and organic evolution is toward increased homeostasis and that ethics and economics are important portions of the process in human social evolution. Many terms and phrases carry implications of homeostasis and indicate that this concept is old. These include such words and phrases as "beneficial," "well-being," "adaptation," "adjustment," "welfare," "security," "harmony," "equilibrium," "balance," "the good life," "satisfaction," "prosperity," "enrichment," "self-fulfilment," "the full life," "self-sufficiency," "progress," "the greatest good for the greatest number," "self-control," "peace of mind," "contentment," and "happiness." Many of these terms have ethical connotations. Dynamic homeostasis has an important advantage over nearly all these terms. It can be observed and measured in living systems. It enables us with some accuracy to compare different analogous levels of integration. It enables us to recognize the general temporal trend of all surviving life that until recently has been obscure.

Organic, Social, and Ethical Evolution

The three fundamental factoral complexes that combine to produce progressive organic evolution are genetic variation, reproductive isolation, and natural selection.[19] In the evolution of any social system, we must also expect social variability, a degree of social isolation, and selective assortment of the most efficient social characteristics producing homeostasis.

In organic evolution, genetic variation occurs by means of mutation and sexual recombination. In social evolution, it is suggested that new discoveries and new ideas are roughly analogous to mutations and that new arrangements and organizations of ideas and concepts are analogous to genetic recombination. Both produce a variability that is a necessary prelude to any evolutionary change.

In its initial appearance, variation is likely to be unadjusted and is often deleterious in its effect. To arrive at functional adaptation, other factors must operate. However, any social tendency drastically to restrict variation in ideas and actions may result in an unprogressive stabilization of the system.

Organisms and social systems are too complex ever to expect perfection of adjustment, either now or in the future. There is always room for improvement, and new adjustments are always necessary to meet the constantly changing environment. Therefore, any restriction of evolution by means of a gross limitation of variation and creativeness results in retrograde motion relative to other freer competing systems.

We now begin to detect the role of individual freedom in the evolutionary advance of society. Freedom of opportunity, freedom of speech, freedom of inquiry, and religious freedom are essential forms of controlled variability necessary to social progress. Individual enterprise may be a trial and error mechanism with commensurate reward for ingenuity, initiative, and skill in business or in other human activities, for instance, in scientific research and in the creative arts. Individual enterprise resulting in social exploitation, however, is not ethical if it rewards cleverness directed toward antisocial objectives. Social pressures that inhibit or prevent such individual enterprise are ethical if the result of freedom is a decrease in social health and social homeostasis, a waste of human energy, and an economic exploitation of the ignorant and gullible. Initiative and cleverness are not virtues in themselves. They may be deemed virtues only when they are directed toward individual and social progress. And progress means an increase in individual, social, and ecological homeostasis.

In organic evolution, reproductive isolation (lack of gene exchange between groups) is the dividing factor. It results in the branching of the phylogenetic tree. Through its effect upon inbreeding, isolation also establishes and perpetuates complex gene patterns—a process of prime importance inasmuch as functional characters are usually the combined result of multiple genes, rather than the effects of single genes.

It seems probable that cultural isolation analogous to the reproductive isolation within and between species of organisms has an important bearing upon social evolution. Relative social isolation (of groups or whole cultures) has not been explored sufficiently to give us an adequate understanding of its role, although anthropologists and sociologists are gathering much pertinent information leading toward unified concepts.

Complete reproductive isolation in organic evolution separates species, but also there exist numerous types of partial isolation that separate portions of species populations to some degree, and this partial isolation profoundly affects the characteristics, adjustments, and survival of the intraspecies groups.

Humans are one species. There is not only gene flow between all human groups with quantitative variations in its extent and rate, but there is also a horizontal diffusion (spatial) and vertical flow (temporal) of ideas, concepts, and symbols with variations in the degree and rate of flow.

Complete or partial isolation probably has a highly important effect upon diversity and upon fixation of patterns in both organic and cultural evolution. Diversity and fixation allow whole integrated systems to be selected as units. Partial isolation enables parts of the system to have a particular effect upon other parts.

In human society, there is partial isolation between geographical groups, between language groups, between racial groups, between national groups, between religious groups, between professional groups, and between economic groups, to mention a few. There is also partial isolation between repeated unit institutions within these social groups, for example, churches of the same denomination, universities, and business firms in the same business.

Accompanying the numerous partial isolations, there is communication between all groups and subgroups within the species, so that there is a degree of co-ordinated unity for human society as a whole that even transcends the lines of conflict in war areas.

It is obvious that one individual may belong to a number of partial-

ly isolated social organizations. On a much simpler level, there are parallels to this situation in the biological world. For example, a worker honeybee may sequentially take part in various hive activities and field work. A single human individual may have different social relations and serve different functions in each organization in which he is included. Each of the cultural units to which he belongs tends to develop balance and co-ordination in time. Progressive social evolution is in part dependent upon partial isolation. Either extreme isolation or extreme interchange would slow adaptive evolution, if it be granted that the biological analogies are applicable to social evolution. Individuals in their multiple group relations exert a control over both extremes.

The fluctuating degrees of isolation and interchange may themselves become homeostatic. As has been stated, homeostasis is not complete and static equilibrium. If disequilibrium has a function, and it often does, homeostasis may result from the maintenance and control of periodic fluctuations.

The Ultimate Guidance of Life: Selection

The guiding factor in organic evolution is natural selection. The unfit are eliminated, and the fit perpetuate their fitness. Genes established in different pattern combinations are sorted by natural selection with resulting increase in adaptation and homeostasis. Survival of the fittest carries connotations of competition. Although competition has a strong effect upon survival, the unfit may be eliminated, and the fit may survive even in the absence of competition. Of course the "fit" may denote a more inclusive group system than the individual unit part. Co-operation rather than conflict may enhance fitness, and survival may be quantitative rather than qualitative. Selection may choose any partially independent unit for survival. It may determine the future existence of a gene and the elimination of a slightly modified mutation of the same gene within the same chromosome, cell, organ, individual, or population system. Selection may also choose large inclusive population systems for survival as wholes. Much confusion in the discussions of both biological and social evolution stems from a misunderstanding of this fact.

Other biological mechanisms leading to adaptive evolution have been postulated, but it now seems safe to say, in spite of continued controversy, that the only theory that adequately explains the origin of complex adaptation is the theory of natural selection. Experiments as well as multiple observations have validated this principle.[20]

It appears that selection is also the guiding force in social adaptation.

The effects are strictly analogous because selection operates on genetic variation in organic evolution, whereas it operates on cultural variation in social evolution. If, however, the analogy between genes and symbols has some validity, the analogy between forms of selection may have significance. It is admitted that there are intricacies in the analogy between natural and social selection that need investigation and clarification. Kroeber[21] states that cultural change is additive and accumulative, whereas organic evolution is substitutive. Substitution and accumulation occur in both types of evolution, although the processes may differ in degree.

It would seem probable that social evolution has moved toward increased adjustment and homoeostasis by means of a sort of natural selection of more efficient systems and the slow elimination of the less efficient. The economic principle of laissez faire results in a selective sorting through success and failure.

Natural selection has not just favored the strong, the powerful, and the courageous. It has led to adaptations in innumerable directions, including both competitive and co-operative interrelations. Co-operation within the organism and within the intraspecies population often increases efficiency and well-being and is therefore subject to positive selective pressures. This seems to be the real reason for the evolutionary trend toward better physiological and behavioristic integration—mainly physiological within the organism and mainly behavioristic within the population system. By means of co-operation, the group may become more successful in its competition with other groups and species. But individual power may be self-defeating if it is harmful to the group. Power, therefore, does not always lead to survival. If power is used to augment the long-term well-being of the species as a whole, then an evolutionary trend toward an increase in power may be expected. The relation of strength and power to survival is often misunderstood. Whether or not the strong survive depends upon the use made of strength. Nietzsche built an ethics upon his belief in an evolutionary trend toward increased power, a trend that modern biology refutes.[22]

Selection operates on whole units as well as parts, so whole populations may be selected as entities. Social units are doubtless subject to selection in their entirety without precluding a relatively independent selection of the component individuals. The species as a whole is often the integrated unit. Selection will favor mechanisms that increase living efficiency among individuals composing the species and that increase the adaptation of the entire species in its environment. Fitness may be internal or external adaptation or both.

The developmental and physiological functions within the individual organism are selected as well as the adjustments to the physical and living external environment. Mortality may result from a lack of relative fitness, but often a differential reproductive rate results without the early death of the individual. This recognition of death or prevention of reproduction as necessary to much progressive evolution is disturbing to some. Certainly there is no biological evidence to indicate that the prolongation of individual life is a general directional trend in organic evolution. The individual life span may be increased in time if greater species efficiency results. But evolution will lead to a shorter individual life span if the species adaptation is thereby increased. With the increase of the individual life span in recent human history, social science must direct much study to this problem. Because of the time involved in learning and productivity resulting from education, a long individual life is probably highly important to progressive social evolution. However, the relative pliability of young adults compared to the aged suggests that there may be an optimum of age proportions in a progressive society.

Elimination of the unfit does not always involve death. For instance, competition between males for a female may prevent one male from fathering offspring at least temporarily, but usually does not result in his death. There are many other cases that show that competitive elimination is not always lethal to the loser, and it should be emphasized that co-operative units with less extreme competition may survive at the expense of less co-operative systems and interactions.

When we view survival, differential reproduction, and elimination as guiding factors in social evolution, we immediately see that death is relative.[23] Business enterprises often succeed or fail in relation to their relative efficiency in meeting human wants, but the life or death of the individuals composing the business firm is not crucial. Symbols and ideas may survive within a culture without complete dependence upon the life or death of the individual originating or harboring the concepts. Erroneous ideas may be replaced by correct ideas in the maturation of the individual personality. This principle seems to be grossly misunderstood under some forms of government. Witness the political purges in Soviet Russia and Communist China, the murder of millions of Jews by the Nazis, and the numerous executions of "heretics" under the Spanish Inquisition.

The degree of automaticity of progress is a problem. It is true that progress toward increased homeostasis in organic evolution is almost wholly the automatic result of natural selection, but the growth of the

learning capacity in man, his conceptual thought, and his ability to transmit symbols have produced a striking change in the processes of evolutionary progress. The social growth of knowledge of the physical, biological, and social environment enables man to control the processes of change to a marked degree. Conscious selection tends to replace natural selection in the rapid evolution of domestic animals and plants. There would seem to be no doubt that man controls his own biological and social evolution *to some extent,* and many social trends are the result of his intelligent choice of alternatives rather than the result of automatic sorting by means of natural selection.

With the growth of a scientific understanding of the causes and effects of social evolution, man can exercise greater control over his own destiny. The evolutionary trends resulting from unintelligent and unconscious processes may never be eliminated altogether, but there can be little doubt that far more rapid progress toward better adjustment to complex reality will be fostered by conscious understanding and control. The general direction of progress toward homeostasis is the same in the long run, whether the selective sorting be natural or conscious, but the relative speed of evolution is vastly different. Control, of course, does not imply force by a dictator or dictatorial clique, often with false concepts. Control is by broad social understanding and skill made possible by individual freedom of inquiry and speech.

The analytical task of the social scientist is tremendous. It is usually difficult to isolate and evaluate the factors leading to social progress or decay. The biologist and psychologist have shown that multiple factors may be analyzed in part, and a partial understanding is far better than no understanding, although there are accompanying hazards. Many phenomena are now partially understood and controlled that were formerly considered beyond the capacity of human intelligence. Historically, defeatist philosophies were constantly invoked in the attempt to prevent scientific advance, for example, the philosophy of vitalism that sometimes assumed that inorganic principles could not be applied to life. Prevalent at present is a philosophy that states that biological principles cannot be applied to social and humanistic man.

To return to the analysis of selection, we find that it varies in its effects with certain environmental periodicities. There is a tendency for selection temporarily to guide a system toward short-term efficiency, but the long-term efficiency ultimately prevails because the systemic unit possesses long temporal dimensions. A gene that increases adjustment to a warm climate and that decreases adjustment to a cold climate is positively selected during the summer and is negatively selected dur-

ing the winter. There are doubtless many instances of fluctuating selection pressures in social evolution also. An individual German could not get a certain job in the late 1930's unless he were a Nazi. But, in the late 1940's, an individual could not get the same job if he had been a Nazi.

In both biological and social systems these fluctuating pressures balance each other or result in compromise solutions. On occasion, internal fluctuations may match environmental periodicities, for example, seasonal behavior. On other occasions, asymmetries and lack of equilibrium may be functional and a homeostatic maintenance of controlled variables may evolve, for example, the accumulation of emergency food in one place.

Because both the organism and the social supraorganism are temporal entities incorporating the past and exhibiting adaptation to that portion of the future that repeats the past, selection operates on temporal adjustments, and long-term adjustments tend to survive over short-term adjustments, even though the short-term efficiencies may be temporarily greater. Predators and parasites are known under certain circumstances to destroy their potentially permanent food supply by overexploitation. Strikes for higher wages beyond the capacity of the balanced economy of the business sometimes destroy the livelihood of the workers.

There is a prevalent attitude among biologists that competition and co-operation are opposites and that one prevents the other.[24] Actually there is a fair amount of biological evidence that indicates optimal values of competition, too much or too little both being detrimental to the survival of the group. The studies by Allee[25] on the social hierarchies show that competitive interaction results in a co-operative organization under some circumstances. It seems plausible that competition among men may be socially beneficial at optimal pressures and that either too much or too little competition might interfere with the growth of co-operative social organizations. In the biological world, there is evidence that competitive pressures have survival value and that evolution has resulted in optimal competition. In contrast to competition, the function of co-operation in attaining increased homeostasis is much more obvious, although neither biologists nor social scientists have fully explored the role of competition in its relation to co-operation.

Cause and effect are not always linear in time, and much confusion results from the assumption that they are. It can be demonstrated with data from the study of organic evolution that variation, isolation, and

selection are not linear in the time sequence of their actions. Genetic variation has often been assumed necessarily to precede the action of selection. But there is much evidence that the mechanisms of variation have a function and that these are consequently selected and evolve in an adaptive direction. The mechanisms of isolation may also have survival value. These factoral complexes have circular and web relations, and the effects often feed back to influence the continuous or repeated cause. Many problems of teleology are resolved by an understanding of circular causation. Feedback mechanisms are examples of circular causation. We sometimes find that the end becomes a means.

The principle of circular causation is certainly applicable to the factors determining social evolution. The conscious control of the events of social evolution made possible by scientific knowledge is a clear example. It is quite possible for an individual who is the result of a process to influence the future operations of the process and its effects.

Correlative Effects in Organic and Cultural Evolution

If organic and human social evolution are even partially proceeding according to similar forces and principles, one might expect to find certain parallels in the results. It has already been mentioned that the dividing factor in organic evolution is reproductive isolation. The branching of the family (phylogenetic) tree defines systematic or taxonomic groups in biology. We also see that separations of subgroups result from partial rather than complete isolation. We certainly find partial cultural isolation dividing social systems, and there is no doubt that evolutionary "trees" may be drawn for numerous social and cultural patterns, for example, the splitting of languages from a common stem and the evolution and branching of styles of art.

We are also aware of horizontal infiltration or diffusion in addition to vertical origins in time, for example, the French words incorporated into the English language following the Norman conquest. Horizontal diffusion of genetic components (gene flow) occurs among subspecies and racial groups in organic evolution, always with partial isolation separating the groups. Horizontal diffusion of species is also characteristic of the evolution of interspecies community systems discussed later. Horizontal diffusion is more complicated in social evolution than in organic evolution. Social "evolutionary trees" show numerous intertwinings of the branches. Childe[26] has thought that cultural evolution is sharply separated from organic evolution by this phenomenon. It is true that there is a quantitative difference, but there is no qualitative distinction on this basis.

As natural selection operates upon different organisms in a similar habitat, convergent evolution may lead to similar analogous adaptations. These have similar functions but different origins and detailed mechanisms, for example, the wings of birds and insects.

In social evolution, symbols may be similar in function but unrelated directly in origin. Media of exchange and economic value (money in the broad sense) originated independently at numerous times and places. Taboos on incest have originated independently in widely separated cultures. The cultural anthropologist has given us many other cases of convergence of social practices and customs, including many details of ethical patterns.[27]

An adaptation may often become modified so as to perform several successive functions in turn during progressive evolution. In later stages, a more recent function may dominate or replace an earlier function. For example, among the vertebrates the support of the gills became modified into jaws, and portions of the jaws later were incorporated into the middle ear. The function of a basically homologous organ changed from breathing to eating and ultimately to hearing. Changes of function can be traced through numerous social lines. Words often change their meanings in time. Architectural form may change from utilitarian to aesthetic value. Religious ritual may symbolize one concept at an early time and a different concept in modern times. Individual aggressive hostility that has survival value at an early evolutionary stage may be channelized to serve a co-operative social function in a later evolutionary stage.

Former adaptations may be lost, but the genes involved in the growth of an organ may be so woven into the fabric of the system as to be lost with difficulty. We may detect thousands of vestigial and functionless structures in the bodies of organisms. Examples are the vestigial eyes of cave fishes, the pelvic bones of whales, the reduced wings of flightless birds, and the ear muscles of man. It is a simple matter to find such vestiges in our cultural patterns. Examples are functionless details of architecture and sleeve buttons on men's suits. Legal codes are notorious for their inclusion of outmoded laws. The spelling of a word frequently outlives its original phonetic value. Religious ritual often repeats a form, the meaning of which is lost in antiquity.

Although the word "degenerate" is often used for regressed structures, the implication is not fully justified. There is always a compensation for the loss of function, often by incorporation into a more inclusive system where inefficient duplications of function are reduced. Although the reproductive function of a cell has regressed in a nerve

cell, it is hardly correct to refer to a brain neuron as degenerate. All animals have regressed as they lost the power of photosynthesis possessed by their plant ancestors, but are all animals thus degenerate? It would seem better to recognize regressive evolution as a concomitant of adaptive specialization or division of labor in more inclusive systems, and to measure the resultant increase in homoeostasis of the whole system. We must be careful to evaluate the complexities of social regressions before we label them degenerations. We must also realize that an evolution toward simpler organization at one level of integration is usually if not always associated with an evolution toward efficiency and complexity of organization in a more inclusive level.

Applications of Biology to Ethics

If ethics is correctly conceived as a learned integrated cultural system symbolizing human experience of success and failure in striving for a better life, if ethics is a set of customs pertaining to responsibility, duty, and right, and if right is conceived as conduct leading toward increased optimal living and homeostatic control, we may now study its application to special problems. Garvin[28] says that the proof of a connection between evolution and morality will establish no new moral system as such. However, the scientific relationship of biological and cultural operations and trends gives us a more refined comparative basis for evaluation and produces a more universal standard for ethical judgment. A basic classification of ethics is proposed as it relates to the integration of various levels of organization.

Individual Integration. Evolution has been guided by means of natural selection toward individual integration. Most individual integration is physiological in its nature because of protoplasmic contiguity. However, particularly with man, instinct, learning, and conscious thought also integrate the individual personality, and ethics may function at the individual level, particularly from the "internalization" of social experience. Other things being equal, any controlled behavior that leads toward individual disintegration may be considered unethical, and any behavior leading toward personal balance, control, and greater effectiveness may be considered ethical. Overindulgence in narcotics, tobacco, or alcohol, for instance, might be considered unethical at the personal level. In contrast, any behavior aimed at personal integrity would increase individual homeostasis and would be considered ethical. Effectiveness through self-discipline, serenity through appreciation of the arts, health through exercise and diet, individual

expression through creativity, all these are ethical. One may say that each person is morally responsible and dutifully bound to strive toward individual health, emotional balance, and personal integrity and effectiveness. Or, to put it in somewhat different words, an individual with these attitudes has been and will be favored by selection. Flügel[29] and T. H. and J. S. Huxley[30] discuss the ontogeny of the moral personality, particularly from the standpoint of psychoanalysis. Individual psychology is highly important to any general theory of ethics.[31]

In terms of evolutionary science, we may say that adjustments leading toward individual homeostasis were selected because of their influence upon survival. Before the advent of symbolic thought, these mechanisms of homeostasis were essentially genetic. But with the emergence of intelligent man, symbolic systems could lead effectively toward the same goal with a greater degree of plasticity under diverse environmental and social conditions. Society usually enhances individual homeostasis. So concepts of right and wrong enabled man to control his behavior more effectively for optimal living. Individual happiness is often given as the goal of human life, but homeostasis seems to be a more adequate goal for both organic and social evolution, and has the added advantage of being subject to objective analysis, quantification, and comparison. Individual happiness, but also pain and anxiety, are involved in individual homeostasis. Homeostasis is a more inclusive concept than pleasure and may explain the relativity of pleasure and pain as guides to life. Individual homeostasis of plants, animals, and man can be compared, but individual happiness of man is almost impossible to compare with that of, say, an amoeba or an ant. Spencer, T. H. Huxley, Haeckel, and Darwin emphasized individual egoism as an ultimate principle of biological conduct. Simpson[32] emphasized the ethics of personal responsibility and knowledge. At present, we should not either underemphasize or overemphasize the individual as an integrative unit. If the homeostasis of the individual comes in conflict with the homeostasis of the group, adjustment will evolve either toward the more important function or toward a balanced compromise of the conflict. The evolution of adaptation within the individual organism supplies numerous convincing examples of compromised adjustment between conflicting optima. Perfection of adaptation to different optimal conditions of existence is never attained and cannot be considered attainable.

It is not implied in the foregoing statements that an individual can always control his actions. Although alcoholism is unethical if the individual has the power to direct his own behavior, the addict may be

sick rather than morally undisciplined. The same may be said for neurotic and psychotic behavior. In a broad sense, there may be no more blame for a person who has a psychotic disturbance than if he has a bacterial disease. Any individual or social action leading to a cure of such a disease is ethical. Condemnation on so-called moral principles may be unethical if it is based upon a false understanding of the causes, and if it does not lead to amelioration, cure, or prevention.

Sexual Integration. The integration and mutual adaptation of the sex pair was an early biological evolution based upon physiological and behavioral mechanisms. Sex is one of the most obvious examples of population differentiation with division of labor and integration, both leading to increased homeostasis of variation by means of genetic recombination. Many other family and social functions emerged from the sex relationship. In the case of sex, it should be noted that homeostatic control over genetic variation was established through selection, thus illustrating circular causation. In later stages of evolution, the sexual differentiation of individuals itself became genetic.

Much of human psychology and social life is an outgrowth of sex biology, and it is to be expected that ethics and morality will evolve to a marked degree around the sexual relationship. Marriage has become a sacrament of the church, and morals have guided the mores and stability of the marriage relationship.

The sexual pair is a biological entity, and it is likewise a social entity. Any custom that integrates husband and wife and increases their adjustment and homeostasis is ethical. Any self-controlled behavior that disrupts the biological, emotional, aesthetic, and social values of marriage is unethical. An infinity of detail is ordered by this fundamental principle that is surely biological in its foundation. Biological trends are repeated in the social manifestations of human sexual relations.

Family Integration. The family unit, like sex, is a socially integrated group with an obvious biological basis. Adaptation between parents and young has evolved with an increased control over shelter, food, and defense of the offspring. Specialized organs, such as mammary glands, have undergone adaptive evolution. The unit of selection is the family group as a whole including its temporal dimensions. The possession of functional mammary glands does not give survival value to the individual mother, but it does give survival value to the family group. Behavior leading to hazards and sacrifices on the part of parents evolved among animals long before the rise of human ethics.

Again we find a behavior system evolving out of a physiological system that integrates the group. Some of the group behavior is genetic, as can also be demonstrated in sexual behavior; but with the human family much of the behavior is learned, intelligent, and transmitted through symbols. The emerging learned behavior tends to evolve in the same direction as did the inherited behavior, namely, toward maintenance of the family unit and more optimal conditions for the development and survival of the young.

Behavior leading toward human familial homeostasis has usually been considered ethical, and our analysis substantiates this conclusion. Behavior leading to a disruption of family ties, especially during the period with dependent children, is considered unethical. We may also note that parental interference with the establishment of sexual and family relations by mature children is often considered unethical even though the parental control may have been ethical during the formative years. In other words, ethical relations between parents and offspring change as the children mature.

Social Integration. Animal societies are real biological entities established by evolutionary factors. Like other biological units, they exhibit a division of labor, integration, and a directional evolution toward increased social homeostasis.[33] Among insects, the social interrelations are largely the result of genetic initiation of social behavior that may be modified by developmental, physiological, and ecological factors. In the human species, the social interrelations are largely developed from learned behavior and symbolic communication. It is true that human society is an analogue of insect society. The two types of social behavior have had independent origins, have very different mechanisms, and have no common or homologous genetic ancestry.[34] Primitive subsocial behavior among the primates may possibly be genetically homologous with human social behavior, but the subhuman social behavior of primates hardly transcends the levels of aggregational sexual and familial integration. Among the insects, several social systems have arisen independently and are analogous. For instance, the highly organized society of the ants is analogous to the remarkably equivalent society of the termites. The ant society evolved from the family system of the non-social wasps, and the termite society evolved from the family system of the non-social cockroaches.

Most of the attitudes and behavior that we term ethical involve human social relations, and we shall return to this subject shortly.

Interspecies Integration. We often find, in the study of organic evolution, that groups of species, each reproductively isolated from the other and often very distantly related, exhibit mutual adaptation to each other. The integration of interspecies systems without genetic continuity between the species can best be explained through the action of natural selection upon the interspecies system.[35]

Although genetic continuity integrates the individual, the sex pair, the family, and the intraspecies society, only environmental or ecological continuity, particularly by means of natural selection in similar habitats, integrates the interspecies groups. We have seen, however, that the mechanisms of integration include both internal and external continuities in intraspecies systems, so that supraorganismic co-ordination may still appear in interspecies systems as the result of natural selection, even with the loss of genetic continuity among the interadapted species. Obviously the organism, the intraspecies supraorganism, and the interspecies supraorganism are analogues. These systems have significant similarities produced by the action of similar forces, and they all show division of labor, integration, and an evolutionary increase in homeostasis. Although quantitative comparisons of the degree of integration are lacking, it seems safe to conclude that the individual organism is likely to be a more tightly knit system than the population group and that the intraspecies population usually shows a greater degree of integration than the interspecies system. In other words, internal adaptation and homeostasis of the whole unit decreases in the more inclusive systems. There is probably a greater degree of internal control within the cell than within the multicellular organism, and there is a greater degree of social control within a society than within the ecological community, but each unit lives in a more optimal environment as it evolves in association with other units, and this optimal environment is often enhanced or produced by the evolving organism or supraorganism.

Certain physical and biotic environments are more favorable for certain species than others, so that competition for limited necessities is greater in some habitats than in others. The more favorable habitat is the one in which the organism or group system may attain a greater degree of internal homeostasis without adjustment to extreme fluctuations of many physical and biotic factors. Orientation to and movement toward favorable environmental conditions are evolutionary adaptations. Adaptations evolve that maintain ecological position in favorable habitats, either through attachment devices or through movement with moving factors.[36] Organisms also may avoid severe

competition by evolving adaptations to or control over somewhat unfavorable habitats. Adapted organisms already occupying a favorable habitat will prevent poorly adapted competitors from moving in, although vacant habitats may be populated by initially poorly adapted species. Optimal physical conditions often are incompatible with optimal biotic conditions, and varied compromises result. Both exoadaptation to the physical and biotic environment, and endoadaptation within the organismic system show evolutionary trends toward increased homeostasis. What often appears to be a regressive evolution with decrease of homeostasis in an individual may be shown to be an increase of the homeostasis of the ecosystem which incorporates the physical habitat with its associated organisms. Many more exact data are needed before this general trend can be said to be convincingly demonstrated, but the hypothesis is challenging, and some evidence indicates its validity.

Without question, no species of animal or plant has had such a profound effect upon the physical world and its life as has social man. Homeostasis has not only developed within the society of man but man has also learned to some degree to control his external environment, including all other living organisms. His rapid development of power over the world, however, has sometimes resulted in harm to himself or succeeding generations, and, when it does, negative selection occurs. Julian Huxley[37] gives his opinion that important organic evolution has ceased as social evolution has attained dominance. It is the author's opinion that the evolution of interspecies integration and of homeostasis of the ecosystem will involve both important social and organic evolution, undoubtedly partly under intelligent control by man. Clark[38] emphasizes that "the economic life of early man can most fruitfully be considered in relation to the wider economy of nature."

If man, like other organized living systems, is moving toward increased homeostasis, and this control of optimal values involves other forms of life upon which man is dependent, it seems clear that ethical behavior must include his relations to his domesticated animals and plants, and also to the wild animals and plants occupying his global habitat. We must remember also that the interspecies community, like other biological systems, has time dimensions. The human species is part of a larger entity that is temporally integrated.

Let us ask ourselves whether there is any scientific justification for a human individual to make a personal sacrifice to save African elephants or California redwoods from destruction, particularly if these living organisms are separated from his individual use either geograph-

ically or chronologically. The answer seems clear. Man is integrated with his own species the world over. He is also integrated with other species the world over. And he is integrated with both past and future generations. The human individual is part of a temporal supraorganism that serves him and which he serves in mutual co-operation toward more optimal self-regulation for his own benefit and for the benefit of others included within the same system.

We are already aware of the harm that may be done through the short-sighted destruction of water resources, soils, forests, and wild life, with consequent decrease in the optimal conditions of life. And what we do not know far transcends our present knowledge. One of the greatest values man can attain is a true knowledge of the intricacies of himself and his social, biological, and physical environment. The destruction of complex co-ordinated systems before they can be studied and evaluated is a great handicap to the increase of knowledge and ultimate control.

It may thus be stated, on the basis of some objective evidence and known principles, that man has an ethical responsibility toward the animals and plants of the entire earth as well as toward contemporary and future humanity. Intelligent conservation of our wild life and natural resources is ethically sound. Wasteful exploitation and destruction is wrong and bad. Even harmful species may be studied with benefit to mankind so that a far-sighted ethics may suggest the preservation as well as the control of harmful species. It is advisable that we base our advancing interspecies ethics upon sound scientific information of the physical and biological world in which we live and upon which we are dependent. Besides their economic value, fishing and hunting have recreational value, but conservation policies should not be dominated alone by the desires of the sportsman.

Ethics and Social Homeostasis

Let us now return for a somewhat more extended discussion of one of our main themes—the biological basis of social ethics.

Races are partial genetic segregates within the species of man. The majority of species of animals and plants have similar subdivisions resulting from partial reproductive isolation and natural selection operating in different habitats. Sometimes, although not always, races and subspecies diverge until they are reproductively isolated and contemporarily genetically discontinuous. They evolve into full species by this process. In the case of the human species, the development of transportation has reversed the trend toward increasing isolation of the

races, so that we are now witnessing the slow breakdown of ethnic barriers. The human species is already a genetic and cultural unit, and the present indications point to increasing integration and co-ordination of all peoples. Ethical relations may be expected to change with changes in the organization of the system. Ethical relations between species and between races of the same species have different qualities because of obvious differences in the type of group unity.

Under natural conditions, competitive relations between species that overlap in ranges are often great, and drastic elimination may occur with the survival of one of the competing species. In other cases, the competing species may occupy somewhat different ecological niches, and an evolution of balanced exploitation, toleration, or interdependence may occur with both species surviving. On occasion, species may evolve co-operative relations and become mutually interdependent.

Although competition occurs between individuals within a species, it is noteworthy that combat and drastic elimination are more common between species. The reason for this difference is that the individual is in a greater mutually beneficial relation to other individuals of his species group than to other species, and natural selection operates for the benefit of the whole species rather than only for the benefit of the individual. It is therefore usually against the long-term interests of society for an individual to kill or harm another of his own species, although it may be to the interests of both the individual and his species population to kill an individual of another species. Also, individual exploitation of other individuals within the same species is harmful to the group and will be negatively selected, whereas co-operation, integration, division of labor, and balanced compromise usually result in an increase of efficient homeostasis for all concerned and will be positively selected.

Therefore, we find that the concept of the "brotherhood" of all mankind rests upon firm biological principles. Ethics leading to firmer integration and mutual benefit between races of man is in conformity to biological trends. Behavior leading toward racial elimination, racial exploitation, and human slavery (including the antebellum variety, economic slavery during the early stages of the Industrial Revolution, and politico-economic slavery as reported in Russia during the Stalin regime) does not lead toward increased long-term homeostasis. The exploiter is harmed along with the exploited, and natural selection of these cultural characteristics gradually tends to eliminate unethical racial practices. Behavior close to that of many stated principles of Christian ethics would seem likely to survive the onslaught of tempo-

rarily powerful philosophies like that of naziism with its false theory of racism.

We can pick cases of unethical racial relations close to contemporary America. All of us are aware of the tendencies to suppress, subjugate, and humiliate certain Negroes who are striving to take their dignified place in the great advance of civilization. Good ethics would appear to be that which integrates the Negro with advances in education, the arts, the sciences, and general social progress, and allows him opportunity to be creative. Bad ethics is any action depriving the Negro of human rights and opportunities. The Negro also has a moral responsibility to make his proportionate contribution to social progress.

International conflict and war are probably the most conspicuous wastes of human energy and wealth in the contemporary world. When the world was less integrated, before modern transportation and communication existed, relatively isolated cultures arose with their local qualities of homeostasis. These comparatively independent cultures were often fairly well adjusted to their immediate conditions. All of these separated cultures in different stages of social evolution are now thrown together. Interdependence has rapidly advanced, but conflict has also increased. Attempts at aggressive dominance and exploitation of nation by nation breed resentment, hatred, and defense.

Viewing national warfare from the point of view of biological trends over millions of years, one might predict an ultimate social evolution beyond this stage of national conflict toward a world order of mutually co-operative relations among nations. Division of labor and specialization between cultural groups seem entirely compatible with the biological principles already discussed. Each group could contribute its unique values to the common social welfare. There is no trend toward uniformity of function within organized biological systems, and there seems to be no reason to fear that all provincial customs and artistic accomplishments will be lost in the future world order.

It is not possible to predict with certitude that a social evolution away from national conflicts and devastating war will occur within a decade or so. It may take many centuries to achieve. In the meantime, it may be necessary to operate on the cancers in the body politic that seem to rise and flourish temporarily, to the detriment of both the diseased and the healthy parts of the human supraorganism. At present there is too little social science that diagnoses social disease and discovers cures. More often emotionalism leads the minds of men toward inadequate or misdirected action against social ills. Prejudice and bias combined with ignorance often guide social action. A sort of natural

selection gradually suppresses harmful customs and fosters better mores and ethics. It is expected that social science with a broad perspective from humanistic and scientific knowledge will increasingly dominate human social behavior and international relations.[39]

The observer of modern management-labor relations is often struck by the apparent inefficiency of the system. Reacting to the exploitation by the owner class during the early decades of the Industrial Revolution, labor has developed defenses and attained power. Sometimes the use of power by labor is detrimental to labor itself. Labor and management often seem to be unaware that they are together united in an interdependent relationship, that co-operation between them contributes to a larger society upon which they depend and which they serve. If labor and management were to co-operate in order to exploit the society to which they belong, decreased homeostasis would occur. So progress demands an ethics of mutually beneficial relations between labor and management in industry, and it also demands mutuality between industry and the general public. Communism, with its false theory of antagonistic social classes, would seem to be doomed in time.

Any increase in selfish exploitation of society by any individual or any group is ethically bad. And any increase in homeostasis through co-operation among all classes of human society is ethically good. On the basis of the selection of efficient practices leading toward optimal control over the necessities of civilized life, we may confidently predict a gradual increase in co-operation between specialists grouped into social classes.

Balanced relations and optimal conditions for social advancement are practically infinite in number. Great gaps in accurate knowledge are now apparent, and much research is needed in the fields of the humanities and the sciences. Efficient function depends not only upon the accessibility of materials and the organization of operations but also upon the size of the group performing the function, and the spacing of the functional units may also have optimal values. A repetition of functional systems occurs within more inclusive systems, and social institutions exhibit such duplications in an analogous manner to the organ and tissue replications in individual organisms. Both a degree of competition and a degree of co-operation between parts with similar functions exist, and an evolution toward proper spacing and balance may be anticipated. The control of the size of populations and subpopulations would better adjust the individual to his environment and to his social economy. Much needs to be learned about populations in their relation to natural resources and food supply. Surely a mature

and modern ethics will encourage mores that better living conditions, rather than produce the starvation, misery, poverty, and human degradation that accompanies overpopulation. Quantity of life is not necessarily the same as homeostasis of life.

Social institutions, whether they be different churches, different schools, or different business firms, often seem to view their relations as wholly competitive. An evolutionary perspective upon their social functions, their integration, and their relationship to the more inclusive societal system may bring a better understanding of their roles. And with this better understanding, better ethical standards may bring about a healthier relationship. What is often termed good business may be found to be ethically bad, particularly when the selfish profit motive runs counter to the beneficial service to society.

When a benefit is gained through co-operation by means of learned behavior, honesty enhances confidence between the co-operating individuals, whether the social unit be the sex pair, the family, or the social system. Honesty is thus ethical because it tends to establish firmer co-operation between individuals, between business firms, or between nations. Dishonesty tends to be destructive of group homeostasis and is consequently unethical. Lying and cheating in international diplomacy, in business transactions, or in games tend to destroy the mutual trust necessary for the attainment of mutual welfare.

Justice, when contemplated from the viewpoint of social evolution, emphasizes individual responsibility to the social system, establishes criteria for the judgment of human conflict, and enhances attitudes of fairness and compromise in human relations. Law based upon justice arguments social homeostasis. It can be seen also that social progress necessitates functional pliability and change in legal codes.

Several recent authors have come close to recognizing the evolutionary role of homeostasis. Those who emphasize the functional role in existing individual and group systems have not analyzed the concept from the modern standpoint of the dynamics of evolution.[40] Some have a narrow concept of homeostasis.[41] Some have not fully recognized the reciprocal relations between the individual and the group systems.[42] Some have overemphasized the differences between the mechanisms of organic and social evolution and have underemphasized the functional analogues.[43] Some have not fully bridged the gap between biology and human society.[44] Many have not adequately compared human society to biological systems.[45] Some have not adequately related individual human psychology and social behavior. Many fail to relate conflict and competition to tolerance and co-operation.[46] No one has

adequately related human social homeostasis to ecological homeostasis. No one has adequately analyzed the relation of individual and social homeostasis to the aesthetic arts. Because of the large number of facets to the whole problem, together with the limitations of scientific knowledge available to any individual scientist, much further analysis and synthesis of pertinent data remain to be done.

Many statements made in the body of this paper are oversimplifications. The simplification for brevity and clarity may sound dogmatic and categorical. No generalization is more valid than the data substantiating it. Detailed information does not embarrass sound generalization and theory. It is the "life blood" of scientific interpretation. Thousands of investigators working for centuries are needed before some of the hypotheses stated here can be either refuted or adequately verified. At the present time, we can draw only tentative conclusions based upon indicated correlations. We are still a long distance from the attainment of an adequate knowledge and understanding of social man. In the meantime, however, we have an indicated order of social and biological events upon which we can build.

We can now begin to perceive the direction we should follow in our search for ethical truth, ethical wisdom, and methods of increasing human welfare. Not knowing why social evolution has taken place nor whither it is bound, but vaguely sensing its reality and direction, man has often rationalized his intuition by means of mystical explanations. At present, we are only at the threshold of a science of social evolution—a science that can objectively analyze changes in aesthetics, ethics, economics, and politics, and thereby increase our ability to interpret, predict, and evaluate processes and effects more adequately than is now possible.

Progress equated with increased homeostasis of living systems organized in various levels of integration seems to be a general trend of biological and human individual and group evolution. This does not mean that fluctuations of trends, delay, disintegration, and extinction never occur. The cause and effect web relations of intricate life activities and attributes are clarified, and a general directional trend can be detected, measured, and compared in ordered systems that have both unique differences and common similarities. The trend does not lead to a final arrival at perfection. It also fails to solve the ultimate question of what part evolutionary progress plays in cosmic evolution and increased entropy. It would seem that all life on earth would cease with the dissipation of the energy of the sun and what atomic energy is available to complex chemical organisms. The standards for moral

evaluation emerging from scientific knowledge of organic and social processes are relative and never absolute or final, but a refinement of ethical decision is available through increased knowledge of natural and social events and processes. All problems are not completely solved because knowledge is never complete, but many questions that heretofore have seemed unsolvable,[47] now can be partially resolved and can contribute to the welfare of humanity.

The scientific principle of homeostasis assists in the resolution of many controversies and dilemmas. It relates the individual to the group, divergence to convergence, competition to co-operation, isolation to integration, independence to dependence, conflict to harmony, life to death, regression to progress, conservatism to creativity, organic evolution to social evolution, psychology to biology, emotion to intelligence, the conscious to the unconscious, science to ethics and aesthetics, reality to value, and means to ends. It is both a mechanism and a trend of life processes. It indicates the gaps in our knowledge and understanding, and it directs future investigations.

NOTES

1. This paper is an expansion and revision of chapter x in *Goals of Economic Life* (New York: Harper & Bros., 1953), reproduced here with the permission of the publisher. This book resulted from conferences of a study committee of the Federal Council of Churches under the chairmanship of A. D. Ward. I am obligated to this group for critical discussion and to the conference group on the Unified Theory of Human Nature under the chairmanship of Dr. Roy Grinker, Michael Reese Hospital, Chicago. I also owe much of my thinking on this subject to my long personal friendships with W. C. Allee and Ralph W. Gerard.—From *Scientific Monthly* footnote.

2. R. W. Gerard, Scientific Monthly, L (1940), 340, 403, 530; and *Philosophy of Science*, IX (1942), 92.

3. L. Garvin, *A Modern Introduction to Ethics* (Boston: Houghton Mifflin Co., 1953).

4. G. G. Simpson, *The Meaning of Evolution* (New Haven, Conn.: Yale University Press, 1949).

5. F. S. C. Northrop, "Cultural Values," in A. L. Kroeber (ed.), *Anthropology Today* (Chicago: University of Chicago Press, 1953), p. 682.

6. D. Bidney, "The Concept of Value in Modern Anthropology," in Kroeber, *op. cit.*

7. W. C. Allee, *Science*, XCVII (1943), 517; *Cooperation among Animals* (New York: Schuman, 1951).

8. A. E. Emerson, *Ecological Monographs*, VIII (1938), 247.

9. A. E. Emerson, *Colloq. intern. centre nat. recherche sci.* (Paris), No. 34 (1952); R. W. Gerard and A. E. Emerson, *Science*, CI (1945), 582.

10. J. S. Huxley, *Scientific Monthly*, L (1940), 5.

11. J. H. Steward, "Evolution and Process," in Kroeber, *op. cit.*, p. 313.

12. Simpson, *op. cit.*

13. T. C. Schneirla, *Journal of Abnormal and Social Psychology*, XL (1946), 385.

14. Emerson, *Colloq. intern. centre nat. recherche sci.* (see n. 9 above).

15. W. B. Cannon, *The Wisdom of the Body* (New York: W. W. Norton & Co., 1932); *Science*, XCIII (1941), 1.

16. Cannon, *The Wisdom of the Body*.

17. R. W. Gerard, *Common Cause,* III (1950), 630.
18. Emerson, *Colloq. intern. centre nat. recherche sci.; Biological Symposia,* VIII (1942), 163.
19. W. C. Allee *et al., Principles of Animal Ecology* (Philadelphia: W. B. Saunders Co., 1949).
20. *Ibid.*
21. A. L. Kroeber, *Anthropology* (New York: Harcourt, Brace, 1948).
22. Allee, *Cooperation among Animals* (see n. 7 above).
23. S. J. Holmes, *Life and Morals* (New York: Macmillan Co., 1948).
24. Schneirla, *op. cit.*
25. Allee, *Cooperation among Animals.*
26. V. G. Childe, *Social Evolution* (New York: Schuman, 1951).
27. Kroeber, *Anthropology.*
28. Garvin, *op. cit.*
29. J. C. Flügel, *Man, Morals and Society* (London: Gerald A. Duckworth & Co., 1945).
30. T. H. Huxley and J. S. Huxley, *Touchstone for Ethics* (New York: Harper & Bros., 1947).
31. T. Burrow, *Science and Man's Behavior* (New York: Philosophical Library, 1953).
32. Simpson, *op. cit.*
33. Emerson, *Colloq. intern. centre nat. recherche sci.*; Gerard and Emerson, *op. cit.*
34. Emerson, *Biological Symposia.*
35. A. E. Emerson, *Transactions of the Illinois State Academy of Sciences,* XXXIX (1946), 9.
36. Allee *et al., op. cit.*
37. Huxley and Huxley, *op. cit.*
38. J. G. D. Clark, *Prehistoric Europe. The Economic Basis* (London: Methuen & Co., 1952).
39. Burrow, *op. cit.*
40. Allee, *Science;* Cannon, *The Wisdom of the Body;* Cannon, *Science;* Gerard, *Common Cause;* Burrow, *op. cit.*
41. D. Snygg, "The Psychological Basis of Human Values," in A. D. Ward (ed.), *Goals of Economic Life* (New York: Harper & Bros., 1953), p. 335.
42. Simpson, *op. cit.*
43. *Ibid.*; Huxley and Huxley, *op. cit.*; Schneirla, *op. cit.*
44. Emerson, *Colloq. intern. centre nat. recherche sci.*; Allee *et al., op. cit.*
45. Northrop, *op. cit.*; Steward, *op. cit.*; Childe, *op. cit.*
46. Schneirla, *op. cit.*
47. C. H. Waddington *et al., Science and Ethics* (London: Allen & Unwin, 1942).
48. Since 1953 there has been an increasing literature that continues to illuminate biological and cultural evolutionary processes as the source of human values in ways which in general seem to confirm and extend the concepts of this paper, although there are dissidents. The author and editor suggest that the following might be included in a list of this literature:

Asimov, Isaac. *Life and Energy.* New York: Doubleday & Co., 1962 (also in Bantam paperback).
Bakan, David. *Disease, Pain and Suffering.* Chicago: University of Chicago Press, 1968.
Barringer, H. R., Blanksten, G. I., Mack, R. W. (eds.). *Social Changes in Developing Areas, a Reinterpretation of Evolutionary Theory.* Cambridge, Mass.: Schenkman Publishing Co., 1965.
Birch, L. C. *Nature and God.* London: S.C.M. Press, 1965.
Blum, H. F. *Time's Arrow and Evolution.* Princeton, N.J.: Princeton University Press, 1955.

Boulding, Kenneth E. *The Meaning of the 20th Century*. New York: Harper & Row, 1964.
Bronowski, J. *Science and Human Values*. New York: Julian Messner, Inc., 1956 (Harper Torchbook).
Darlington, C. D. *The Facts of Life*. New York: Macmillan Co., 1956.
Dobzhansky, Theodosius. *The Biology of Ultimate Concern*. New York: New American Library, 1967.
Dobzhansky, Theodosius. *Mankind Evolving, the Evolution of the Human Species*. New Haven, Conn.: Yale University Press, 1962.
Dubos, René. *Man Adapting*. New Haven, Conn.: Yale University Press, 1966.
Eiseley, Loren. *The Immense Journey*. New York: Random House, 1946.
Emerson, A. E. "The Impact of Darwin on Biology," *Acta Biotheoretica,* XV (1962), 175–216.
Emerson, A. E. "Regenerative Behavior and Social Homeostasis of Termites," *Ecology,* XXXVII (1956), 248–58.
Etkin, William. *Social Behavior from Fish to Man*. With a chapter by Daniel G. Freedman. Chicago: University of Chicago Press, 1968 (Phoenix paperback).
Glass, Bentley. *Science and Ethical Values*. Durham: University of North Carolina Press, 1965.
Glass, H. Bentley. "The Ethical Basis of Science," *Science,* CL (1965), 1254–61.
Grinker, Roy R., and Hughes, Helen MacGill (eds.). *Toward a Unified Theory of Human Behavior*. New York: Basic Books, 1956.
Hardin, Garrett. *Nature and Man's Fate*. New York: Holt, Rinehart & Winston, 1959.
Herrick, C. J. *The Evolution of Human Nature*. Austin: University of Texas Press, 1956.
Hoagland, Hudson, and Burhoe, Ralph W. (eds.). *Evolution and Man's Progress*. New York: Columbia University Press, 1961.
Huxley, Julian. "Psychometabolism: General and Lorenzian," *Perspectives in Biology and Medicine,* VII (1964), 399–432.
Langer, Suzanne K. *Mind: An Essay on Human Feeling*. Baltimore: Johns Hopkins University Press, 1967.
Mayr, Ernst. *Animal Species and Evolution*. Cambridge, Mass.: Harvard University Press, 1963.
Medawar, P. B. *The Future of Man*. New York: Basic Books, 1960.
Montagu, M. F. Ashley (ed.). *Culture and the Evolution of Man*. New York: Oxford University Press, 1962 (Galaxy Book).
Platt, John R. (ed.). *New Views of the Nature of Man*. Chicago: University of Chicago Press, 1965.
Rensch, B. *Evolution above the Species Level*. New York: Columbia University Press, 1960.
Roe, Anne, and Simpson, George Gaylord (eds.). *Behavior and Evolution*. New Haven, Conn.: Yale University Press, 1958.
Scott, John Paul. *Animal Behavior*. Garden City, N.J.: Doubleday & Co., 1963 (Anchor Books).
Shapley, Harlow. *Science Ponders Religion*. New York: Appleton-Century-Crofts, Inc., 1960.
Simpson, G. G. "Naturalistic Ethics and the Social Sciences," *American Psychologist,* XXI (1966), 27–36.
Simpson, George Gaylord. *This View of Life, the World of an Evolutionist*. New York: Harcourt, Brace & World, 1963.
Spuhler, J. H. (ed.). *The Evolution of Man's Capacity for Culture*. Detroit: Wayne State University Press, 1959.
Tax, Sol (ed.). *Evolution after Darwin*. 3 vols. Chicago: University of Chicago Press, 1960.

Teilhard de Chardin, Pierre. *The Phenomenon of Man.* New York: Harper & Bros., 1955.
Thompson, Laura. "Steps toward a Unified Anthropology," *Current Anthropology,* VIII (1967), 67–91.
Thorpe, W. H. *Science, Man and Morals.* Ithaca, N.Y.: Cornell University Press, 1966.
Tinbergen, N. *Social Behavior in Animals.* London: Methuen & Co., 1953.
Waddington, C. H. *The Ethical Animal.* New York: Atheneum Press, 1961.
Waddington, C. H. *The Nature of Life.* New York: Atheneum Press, 1962.
Waddington, C. H. *New Patterns of Genetics and Development.* New York: Columbia University Press, 1962.
Wald, George. "The Origins of Life," *Proceedings of the National Academy of Sciences,* LII (August 1964), 595–611.
Washburn, S. L. *Social Life of Early Man.* Chicago: Aldine Publishing Co., 1961.
Wolstenholme, G. (ed.). *Man and His Future.* Boston: Little, Brown & Co., 1963.
Wooldridge, Dean E. *Mechanical Man, the Physical Basis of Intelligent Life.* New York: McGraw-Hill Book Co., 1968.
Young, J. Z. *A Model of the Brain.* London: Oxford University Press, 1964.