Natural Selection and the Mental Capacities of Mankind

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THE FUNDAMENTAL MECHANISMS OF the transmission of heredity from parents to offspring are surprisingly uniform in most diverse organisms. Their uniformity is perhaps the most remarkable fact disclosed by genetics. The laws discovered by Mendel apply to human genes just as much as to those of the maize plant, and the processes of cellular division and germ cell maturation in man are not very different from those in a grasshopper. The similarity of the mechanisms of heredity on the individual level is reflected on the population level in a similarity of the basic causative factors of organic evolution throughout the living world. Mutation, selection, and genetic drift are important in the evolution of man as well as in amoebae and in bacteria. Wherever sexuality and cross-fertilization are established as exclusive or predominant methods of reproduction, the field of hereditary variability increases enormously as compared with asexual or self-fertilizing organisms. Isolating mechanisms which prevent interbreeding and fusion of species of mammals are operative also among insects.

Nevertheless, the universality of basic genetic mechanisms and of evolutionary agents permits a variety of evolutionary patterns to exist not only in different lines of descent but even at different times in the same line of descent. It is evident that the evolutionary pattern in the dog species under domestication is not the same as in the wild ancestors of the domestic dogs or in the now living wild relatives. Widespread occurrence of reduplication of chromosome complements (polyploidy) in the evolution of plants introduces complexities which are not found in the animal kingdom, where polyploidy is infrequent. Evolutionary situations among parasites and among cave inhabitants are clearly different from those in free-living forms. Detection and analysis of differences in the evolutionary patterns in different organisms is one of the important tasks of modern evolutionists.

It can scarcely be doubted that man's biological heredity is transmitted by mechanisms similar to those encountered in other animals and in plants. Likewise, there is no reason to believe that the evolutionary development of man has involved causative factors other than those operative in the evolution of other organisms. The evolutionary changes that occurred before the prehuman could become human, as well as those which supervened since the attainment of the human estate, can be described causally only in terms of mutation, selection, genetic drift, and hybridization—familiar processes throughout the living world. This reasoning, indisputable in the purely biological context, becomes a fallacy, however, when used, as it often has been, to justify narrow biologism in dealing with human material.

The specific human features of the evolutionary pattern of man cannot be ignored. Man is a unique product of evolution in that he, far more than any other creature, has escaped from the bondage of the physical and the biological into the multiform social environment. This remarkable development introduces a third dimension in addition to those of the external and internal environments—a dimension which many biologists, in considering the evolution of man, tend to neglect. The most important setting of human evolution is the human social environment. As stated above, this can influence evolutionary changes only through the media of mutation, selection, genetic drift, and hybridization. Nevertheless, there can be no genuine clarity in our understanding of man's biological nature until the role of the social factor in the development of the human species is understood. A biologist approaching the problems of human evolution must never lose sight of the truth stated more than 2,000 years ago by Aristotle: "Man is by nature a political animal."

In the words of Fisher, "For rational systems of evolution, that is, for theories which make at least the most familiar facts intelligible to the reason, we must turn to those that make progressive adaptation the driving force of the process." It is evident that man by means of his reasoning abilities, by becoming a "political animal," has achieved a mastery of the world's varying environments quite unprecedented in the history of organic evolution. The system of genes which has permitted the development of the specifically human mental capacities has thus become the foundation and the paramount influence in all subsequent evolution of the human stock. An animal becomes adapted to its environment by evolving certain genetically determined physical and behavioral traits; the adaptation of man consists chiefly in developing his inventiveness, a quality to which his physical heredity predisposes him and which his social heredity provides him with the means of realizing. To the degree to which this is so, man is unique. As far as his physical responses to the world are concerned, he is almost wholly emancipated from dependence upon inherited biological dispositions, uniquely improving upon the latter by the process of learning that which his social heredity (culture) makes available to him. Man possesses

much more efficient means of achieving immediate or long-term adaptation than any other biological species: namely, through learned responses or novel inventions and improvisations.

In general, two types of biological adaptation in evolution can be distinguished. One is genetic specialization and genetically controlled fixity of traits. The second consists in the ability to respond to a given range of environmental situations by evolving traits favorable in these particular situations; this presupposes genetically controlled plasticity of traits. It is known, for example, that the composition of the blood which is most favorable for life at high altitudes is somewhat different from that which suffices at sea level. A species which ranges from sea level to high altitudes on a mountain range may become differentiated into several altitudinal races, each having a fixed blood composition favored by natural selection at the particular altitude at which it lives; or a genotype may be selected which permits an individual to respond to changes in the atmospheric pressure by definite alterations in the composition of the blood. It is well known that heredity determines in its possessor not the presence or absence of certain traits but, rather, the responses of the organisms to its environments. The responses may be more or less rigidly fixed, so that approximately the same traits develop in all environments in which life is possible. On the other hand, the responses may differ in different environments. Fixity or plasticity of a trait is, therefore, genetically controlled.

Whether the evolutionary adaptation in a given phyletic line will occur chiefly by way of genetic fixity or by way of genetically controlled plasticity of traits will depend on circumstances. In the first place, evolutionary changes are compounded of mutational steps, and consequently the kind of change that takes place is always determined by the composition of the store of mutational variability which happens to be available in the species populations. Secondly, fixity or plasticity of traits is controlled by natural selection. Having a trait fixed by heredity and hence appearing in the development of an individual regardless of environmental variations is, in general, of benefit to organisms whose milieu remains uniform and static except for rare and freakish deviations. Conversely, organisms which inhabit changeable environments are benefited by having their traits plastic and modified by each recurrent configuration of environmental agents in a way most favorable for the survival of the carrier of the trait in question.

Comparative anatomy and embryology show that a fairly general trend in organic evolution seems to be from environmental dependence toward fixation of the basic features of the bodily structure and function. The appearance of these structural features in the embryonic development of higher organisms is, in general, more nearly autonomous and independent of the environment than in lower forms. The development becomes "buffered" against environmental and genetic shocks. If, however, the mode of life of a species happens to be such that it is, of necessity, exposed to a wide range of environments, it becomes desirable to vary some structures and functions in accordance with the circumstances that confront an individual or a strain at a given time and place. Genetic structures which permit adaptive plasticity of traits become, then, obviously advantageous for survival and so are fostered by natural selection.

The social environments that human beings have created everywhere are notable not only for their extreme complexity but also for the rapid changes to which immediate adjustment is demanded. Adjustment occurs chiefly in the psychical realm and has little or nothing to do with physical traits. In view of the fact that from the very beginning of human evolution the changes in the human environment have been not only rapid but diverse and manifold, genetic fixation of behavioral traits in man would have been decidedly unfavorable for survival of individuals as well as of the species as a whole. Success of the individual in most human societies has depended and continues to depend upon his ability rapidly to evolve behavior patterns which fit him to the kaleidoscope of the conditions he encounters. He is best off if he submits to some, compromises with some, rebels against others, and escapes from still other situations. Individuals who display a relatively greater fixity of response than their fellows suffer under most forms of human society and tend to fall by the way. Suppleness, plasticity, and, most important of all, ability to profit by experience and education are required. No other species is comparable to man in its capacity to acquire new behavior patterns and discard old ones in consequence of training. Considered socially as well as biologically, man's outstanding capacity is his educability. The survival value of this capacity is manifest, and therefore the possibility of its development through natural selection is evident.

It should be made clear at this point that the replacement of fixity of behavior by genetically controlled plasticity is not a necessary consequence of all forms of social organization. The quaint attempts to glorify insect societies as examples deserving emulation on the part of man ignore the fact that the behavior of an individual among social insects is remarkable precisely because of the rigidity of its genetic fixation. The perfection of the organized societies of ants, termites, bees, and other insects is indeed wonderful, and the activities of their members may strike an observer very forcibly by their objective purposefulness. This purposefulness is retained, however, only in environments in which the species normally lives. The ability of an ant to adjust its activities to situations not encountered in the normal habitats of its species is very limited. On the other hand, social organizations on the human level are built on the principle that an individual is able to alter his behavior to fit any situation, whether previously experienced or new.

This difference between human and insect societies is, of course, not surprising. Adaptive plasticity of behavior can develop only on the basis of a vastly more complex nervous system than is sufficient for adaptive fixity. The genetic differences between human and insect societies furnish a striking illustration of the two types of evolutionary adaptations—those achieved through genetically controlled plasticity of behavioral traits and those attained through genetic specialization and fixation of behavior.

The genetically controlled plasticity of mental traits is, biologically speaking, the most typical and uniquely human characteristic. It is very probable that the survival value of this characteristic in human evolution has been considerable for a long time, as measured in terms of human historical scales. Just when this characteristic first appeared is, of course, conjectural. Here it is of interest to note that the most marked phylogenetic trend in the evolution of man has been the special development of the brain, and that the characteristic human plasticity of mental traits seems to be associated with the exceptionally large brain size. The brain of, for example, the Lower or Middle Pleistocene fossil forms of man was, grossly at least, scarcely distinguishable from that of modern man. The average Neanderthaloid brain was somewhat larger than that of modern man, though slightly different in shape. More important than the evidence derived from brain size is the testimony of cultural development. The Middle Acheulean handiwork of Swanscombe man of several hundred thousand years ago and the beautiful Mousterian cultural artifacts associated with Neanderthal man indicate the existence of minds of a high order of development.

The cultural evidence thus suggests that the essentially human organization of the mental capacities emerged quite early in the evolution of man. However that may be, the possession of the gene system, which conditions educability rather than behavioral fixity, is a common property of all living mankind. In other words, educability is truly a species character of man, *Homo sapiens*. This does not mean, of course, that the evolutionary process has run its course and that natural selection has introduced no changes in the genetic structure of the human species since the attainment of the human status. Nor do we wish to imply that no genetic variations in mental equipment exist at our time level. On the contrary, it seems likely that with the attainment of human status that part of man's genetic system which is related to mental potentialities did not cease to be labile and subject to change.

This brings us face to face with the old problem of the likelihood that significant genetic differences in the mental capacities of the various ethnic groups of mankind exist. The physical and, even more, the social environments of men who live in different countries are quite diversified. Therefore, it has often been argued, natural selection would be expected to differentiate the human species into local races differing in psychic traits. Populations of different countries may differ in skin color, head shape, and other somatic characters. Why, then, should they be alike in mental traits?

It will be through investigation rather than speculation that the problem of the possible existence of average differences in the mental make-up of human populations of different geographical origins will eventually be settled. Arguments based on analogies are precarious, especially where evolutionary patterns are concerned. If human races differ in structural traits, it does not necessarily follow that they must also differ in mental ones. Race differences arise chiefly because of the differential action of natural selection on geographically separated populations. In the case of man, however, the structural and mental traits are quite likely to be influenced by selection in different ways.

The very complex problem of the origin of racial differentiations in structural traits does not directly concern us here. Suffice it to say that racial differences in traits such as the blood groups may conceivably have been brought about by genetic drift in populations of limited effective size. Other racial traits are genetically too complex and too consistently present in populations of some large territories and absent in other territories to be accounted for by genetic drift alone. Differences in skin color, hair form, nose shape, etc. are almost certainly products of natural selection. The lack of reliable knowledge of the adaptive significance of these traits is perhaps the greatest gap in our understanding of the evolutionary biology of man. Nevertheless, it is at least a plausible working hypothesis that these and similar traits have, or at any rate had in the past, differential survival values in the environments of different parts of the world.

By contrast, the survival value of a higher development of mental capacities in man is obvious. Furthermore, natural selection seemingly favors such a development everywhere. In the ordinary course of events in almost all societies those persons are likely to be favored who show wisdom, maturity of judgment, and ability to get along with people—qualities which may assume different forms in different cultures. Those are the qualities of the plastic personality, not a single trait but a general condition, and this is the condition which appears to have been at a premium in practically all human societies.

In human societies conditions have been neither rigid nor stable enough to permit the selective breeding of genetic types adapted to different statuses or forms of social organization. Such rigidity and stability do not obtain in any society. On the other hand, the outstanding fact about human societies is that they do change and do so more or less rapidly. The rate of change was possibly comparatively slow in earlier societies, as the rate of change in present-day nonliterate societies may be, when compared to the rate characterizing occidental so-

cieties. In any event, rapid changes in behavior are demanded of the person at all levels of social organization even when the society is at its most stable. Life at any level of social development in human societies is a pretty complex business, and it is met and handled most efficiently by those who exhibit the greatest capacity for adaptability, plasticity.

It is this very plasticity of his mental traits which confers upon man the unique position which he occupies in the animal kingdom. Its acquisition freed him from the constraint of a limited range of biologically predetermined responses. He became capable of acting in a more or less regulative manner upon his physical environment instead of being largely regulated by it. The process of natural selection in all climes and at all times have favored genotypes which permit greater and greater educability and plasticity of mental traits under the influence of the uniquely social environments to which man has been continuously exposed.

The effect of natural selection in man has probably been to render genotypic differences in personality traits, as between individuals and particularly as between races, relatively unimportant compared to their phenotypic plasticity. Instead of having his responses genetically fixed as in other animal species, man is a species that invents its own responses, and it is out of this unique ability to invent, to improvise, his responses that his cultures are born.

The Problems of Gerontology

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WITHIN RECENT DECADES THE specialty of pediatrics has developed out of the general field of medicine, and with this specialization progress in promotion of the welfare of children has been largely accelerated. It is rather remarkable that until lately the opposite stretch of the life span has remained a largely neglected field of interest. There is abundant reason to believe that comparably focalized interest in the problems of aging will yield much of profit not only to the elderly themselves but also to society at large. All the various approaches to this problem are incorporated in the science of gerontology.

Generally speaking, the methodology of gerontological research amounts simply to contrasting the youthful and the aging organisms with respect to their various biological characteristics. By the introduction of this comparative feature, almost any research in any field of biology, from that of biochemistry to that of sociology, can be made, in effect, a research in gerontology. This is equally true whether the given research is addressed to description or to experimentation. An important aspect of investigative gerontology is therapeutic research. Thanks to the fact that large aggregations of elderly persons are available in different sorts of eleemosynary institutions, it is possible to set up this type of study with more adequate controls than are possible in many other sorts of therapeutic research.

At the *molecular level* of integration[1] many studies are needed. A few sorts of these may be particularized. One functionally important class of molecules is the amino acids. In view of the special influences of various of these on the processes of cell differentiation and maturation, significant correlations might be found between amino-acid metabolism and acceleration or retardation of the aging processes as well as the biological efficiency of the organism at any given age. Various other metabolically important molecules, such as cholesterol and folic acid, also demand consideration.

Much remains to be elucidated about the different internal secretions. The two major problems in this part of the field involve determination, at various ages, of the levels of production of the several hormones and the reactivity of the body to each. What is partly known regarding the influences of the gonadal, the thyroid, the adrenal, and the anterior pituitary hormones on maturation processes renders further studies along this line imperative. A chief methodological need is to bring to bear the latest advances in the field of physical chemistry in the hope of deriving technics for the quantitative appraisal of the titers of each of the hormones in the circulating blood. Until this is accomplished we shall have to continue to limp along, deriving such information as is possible from studies of urinary excretion of the hormones or their end metabolites. Generally speaking, the entire endocrinology of the senescent and senile periods is in need of further study.

An equally persuasive case can be made for a study of the different vitamins in relation to the aging processes and to the various organic functions in postmature individuals. A modicum of information is

[1] For a recent discussion of the concepts of integrative evolution, see Novikoff (*3*). A discussion of the applicability of the concepts to a larger biological problem has been offered by the writer (*2*).