Reflections

Introduction

Theodosius Dobzhansky was a prolific writer and, in addition to his technical writing in evolutionary genetics, also wrote extensively on the possible role that our knowledge of evolutionary biology could play in helping to shape the future of humankind. We reproduce below excerpts of an article that Dobzhansky wrote in 1961 in which he discussed many issues that are still relevant today, such as the interdependency of biological and cultural evolution in humans, the distinction between notions of equality of individuals versus equality of opportunity for individuals, and the contrast between adaptation through plasticity (the ability of an individual to alter its behaviour or physiology in response to environmental conditions) and adaptation in the classical evolutionary sense through cumulative changes in the genetic composition of populations under the influence of natural selection. He also touches upon controversial issues such as eugenics and, once again, much of this discussion is still relevant even though in some respects it is a little dated now that genetic medicine is on the verge of becoming a realizable goal. The numerous thought-provoking and extremely quotable statements to be found throughout this article should also give the reader some feel for the elegance and clarity of Dobzhansky's thought and exposition.

Amitabh Joshi

Man and Natural Selection

Theodosius Dobzhansky

Man's Evolutionary Uniqueness

By changing what man knows about the world, he changes the world he knows; and by changing the world in which he lives, he changes himself. Herein lies a danger and a hope; a danger because random changes of the biological nature are likely to produce deterioration rather than improvement; a hope because changes resulting from knowledge can also be directed by knowledge.

The human species, Homo sapiens, mankind, is the unique and most successful product of biological evolution, so far. This has sometimes been questioned, I suspect without too much conviction on the part of the doubters, perhaps only to mock man's pretensions or to challenge his values. But man is the most successful product of evolution, by any

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reasonable definition of biological success. Man began his career as a rare animal, living somewhere in the tropics or subtropics of the Old World, probably in Africa. From this obscure beginning, mankind multiplied to become one of the most numerous mammals, for there will soon be about three billion men living. Numbers may not be an unadulterated blessing, but they are one of the measures of biological success of a species.

Moreover, man has spread and occupied all the continents and most islands, except for the frozen wastes of Antarctica and of the interior of Greenland; he has learned to traverse seas and oceans and deserts; he is well on the way towards control or elimination of the predators and parasites which used to prey on him; he has subdued and domesticated many animal and plant species, made them serve his needs and his fancies, broadened enormously the range of utilizable food supplies, and learned to make use of a variety of energy sources. Modern man lives no longer at the mercy of the wild beasts and vagaries of the climate; he has reached a status where his continuation as a species is in no danger, except perhaps as a result of man’s own folly or of a cosmic accident.

The evolutionary uniqueness of man lies in that in mankind the biological evolution has transcended itself. With man commences a new, superorganic, mode of evolution, which is the evolution of culture. Culture is a tremendously potent instrument for adaptation to the environment. A very large part of the evolutionary progress, both biologically and culturally, has come from adversity. Life faces environments which are more often niggardly than bountiful, more frequently inimical than benign. For life to endure, it must develop defences and adaptations. Biological adaptation occurs through natural selection; new genes arise through mutation, sexual recombination creates new combinations of genes, and natural selection acts to multiply the successful genetic endowments and to reduce the frequencies of the unsuccessful ones. In man and in man alone, adaptation may occur also through alteration of culture. Many species of mammals have become adapted to cold climates by growing warm fur; man alone has achieved the same end by donning fur coats. Birds have mastered the air by becoming flying machines; man has conquered the air by building flying machines.

Biological and cultural evolutions of man are not independent; they are interdependent. The superorganic has an organic basis. Formation and maintenance of culture presuppose a human genotype. Even the most clever ape cannot learn human culture. Some writers have jumped to the conclusion that the genetic development of the human species was completed before culture appeared and that the evolution of culture has replaced biological evolution. This is not true. The two evolutions go together, interacting and usually mutually reinforcing each other. There is feedback between genetics and culture. Culture
is an adaptive mechanism supplemental to, but not incompatible with, biological adaptation. To be sure, adaptation by culture proved to be more efficacious, and, before all else, more rapid than adaptation by genes. This is why the emergence of the genetic basis of culture was the master stroke of the biological evolution of the human species. The genetic basis of culture should be improved or at least maintained. It should not be allowed to deteriorate.

**Natural Selection, Struggle and Fitness**

Man has not only evolved; for better or for worse, he is also evolving. Is he to become a superman or a demigod? Or will the fate in store for him be like that of so many successful species of the past, which eventually declined and became extinct? Long-term prophecies do not expose the prophets to the risk of being proved wrong too soon. I nevertheless do not wish to indulge here in prophecies or in designing utopias. I wish rather to investigate some of the evolutionary forces currently at work in the human species.

According to the theory set forth by Darwin and Wallace more than a century ago, adaptation occurs in biological evolution by way of the process of natural selection. Does natural selection operate in modern mankind? This has to be answered obviously in the negative, if by "natural" you mean a world uninhabited and uninfluenced by man. But it is here that we must proceed with the greatest caution. What, indeed, is selection, and when is a selection "natural" and when is it not? Darwin said that natural selection is the outcome of the survival of the fittest in the struggle for life. "Struggle" suggests strife, contention, competition. Darwin himself wrote that "... From the war of nature, from famine and death, the most exalted object we are capable of conceiving, the higher animal, directly follows".

However, natural selection does not ineluctably depend on any of these things. Birch has defined competition thus: "Competition occurs when a number of animals (of the same or different species) utilize common resources the supply of which is short; or if the resources are not in short supply, competition occurs when the animals seeking these resources nevertheless harm each other in the process." Natural selection may, however, take place when resources are not limiting, if the carriers of some genes possess greater reproductive potentials than others. Some cases have been observed in experiments with animals and plants when a genotype superior under competition is inferior in the absence of competition, or vice versa.

And who is the "fittest", whose survival results in natural selection? Does natural
selection make us fit for life in the society of other men, or for wisdom, or for good will, or for unselfishness? It does not necessarily ordain any of these qualities. Darwinian fitness is a measure of the reproductive proficiency. Its guiding principle is “be fruitful, and multiply, and replenish the earth.” It is quite indispensable to distinguish Darwinian fitness from excellence in human estimation. The two may go hand in hand, but sometimes they may be in opposition.

It is man and man alone who can probe, scrutinize, and question the wisdom of the evolutionary process which brought him into being. He may improve what nature hath wrought. When man chooses the individuals who are to become parents of the succeeding generation he practices artificial selection. According to Lerner, artificial selection is a process which has a goal that can be visualized. Any selection which is not artificial is natural selection.

**Diversity and Equality**

Adaptations by way of plasticity and by way of genetic diversity are not mutually exclusive. They are complementary. Culture is by far the most potent adaptive mechanism which has emerged in the evolution of life. Its potency is due to its being transmitted by teaching and learning, instead of by genes. The ability to be trained, and to become competent in whatever occupation a person meets his opportunity, increases the social and usually also the biological fitness. Genetic specialization for one vocation may confer very high fitness for that particular vocation. But educability permits a choice of vocations, and thus confers fitness in complex and changeable environments. In an evolving culture new occupations constantly arise. Who needed aircraft pilots a century ago, but how many blacksmiths are now needed in technologically advanced countries?

Culture is, however, an adaptive contrivance to make people diversified, not to make them alike. If uniformity were advantageous, genetic fixity would most likely have emerged in evolution. Genetic diversity or polymorphism joins force with developmental plasticity. I could have probably learned many kinds of jobs other than that I actually fixed upon. But no amount of effort and training could make me a first-rate wrestler or sprinter or painter or concertmaster. I just do not possess the genetic wherewithal for these occupations. Other people do, and this genetic diversity enriches the store of man’s capabilities. It is the leaven of cultural progress.

The facts of biology are compatible with the lofty vision of human equality. All men have been born equal; they certainly are not all alike. It is nonsense to think that only identical
twins can be equals. Human equality is not predicated on identity, or even on identity of ability. It presupposes, however, something approaching an equality of opportunity to develop whatever socially useful gifts and aptitudes a person’s genes have provided him with, and which he may choose to develop.

Culture fosters a multitude of employments and functions to be filled and served; equality of opportunity stimulates division of labor rather than sets it aside; it enables every person to choose among occupations for which he is qualified by his abilities. It is wrong to think that equality of opportunity makes genetic variation unimportant. It does precisely the opposite. It makes the difference between people reflect meaningfully their genetic differences. Inequality of opportunity acts, on the contrary, to hide, to distort, and to stultify the genetic diversity.

**Are Culture and Natural Selection Compatible?**

We have seen that several forms of natural selection operate in modern mankind. But they certainly do not operate as they did during the Stone Age, or even as they did a century ago. Neither does natural selection operate always in the same way in wild and “natural” species, quite “unspoiled” by culture. This is inevitable. Natural selection depends on environments, and environments change. Human environments have changed a great deal in a century, not to speak of millennia.

The real problem is not whether natural selection in man is going on, but whether it is going on towards what we, humans, regard as betterment or deterioration. Natural selection tends to enhance the reproductive proficiency of the population in which it operates. Such proficiency is however not the only estimable quality with which we wish to see people endowed. And besides, a high reproductive fitness in one environment does not even insure the survival of the population or the species when the environment changes.

Normalizing selection is, as we have seen, not the only form of natural selection. The relaxation of some of its functions is, however, a cause of apprehension. Medicine, hygiene, civilized living save many lives which would otherwise be extinguished. This situation is here to stay; we would not want it to be otherwise, even if we could. Some of the lives thus saved will, however, engender lives that will stand in need of being saved in the generations to come. Can it be that we help the ailing, the lame, and the deformed only to make our descendants more ailing, more lame, and more deformed?

Suppose that we have learned how to save the lives of persons afflicted with a hereditary
disease, such as retinoblastoma, which previously was incurably fatal. In genetic terms, this means that the Darwinian fitness of the victims of the disease has increased, and that the normalizing selection against this disease is relaxed. What will be the consequence? The incidence of the disease in the population will increase from generation to generation. The increase is likely to be slow, generally no more than by one mutation rate per generation. It may take centuries or millennia to notice the difference for any one disease of malformation. However, the average health and welfare of the population are liable to show adverse effects of relaxed selection much sooner.

The process of mutation injects in every generation a certain number of harmful genes in the gene pool of the population; the process of normalizing selection eliminates a certain number of these genes. With environment reasonably stable, the situation tends to reach a state of equilibrium. At equilibrium, the mutation and the elimination are equal. If mutation becomes more frequent (as it does in man because of exposure to high-energy radiations and perhaps to some chemicals), or if the elimination is lagging because of relaxation of normalizing selection, the incidence of harmful mutant genes in the population is bound to increase. And take note of this: If the classical theory of population structure were correct, all harmful mutations would be in a sense equivalent. For at equilibrium there is one elimination for every mutation, regardless of whether the mutation causes a lethal hereditary disease like retinoblastoma, or a malformation like achondroplasia, or a relatively mild defect such as myopia.

The problem is, however, more complex than this theory would suggest. It calls for research in what Wright describes neatly as “unfortunately the unpopular and scientifically somewhat unrewarding borderline fields of genetics and the social sciences”. Although at equilibrium there may be one genetic elimination for every mutation, it is unrealistic to equate the human and social consequences of different mutations. The elimination of a lethal mutant which causes death of an embryo before implantation in the uterus is scarcely noticed by the mother or by anyone else. Suffering accompanies the elimination of a mutant, such as retinoblastoma, which kills an infant apparently normal at birth. Any mutants, such as haemophilia or Huntington's chorea, kill children, adolescents, or adults, cause misery to their victims, and disruption of the lives of their families. There is no way to measure precisely the amount of human anguish; yet one may surmise that the painful and slow death of the victims of so many hereditary diseases is torment greater than that involved in the elimination of a gene for anchondroplasia owing to the failure of an anchondroplastic dwarf to beget children.
Looked at from the angle of the costs to the society, the nonequivalence of different mutants is no less evident. Myopia may be inherited as a recessive trait. Increases of the frequencies in populations of the gene for myopia are undesirable. Yet, it may become more and more common in future generations. However, only a fanatic might advocate sterilization of the myopics or other radical measures to prevent the spread of this gene. One may hope that civilized societies can tolerate some more myopics; many of them are very useful citizens, and their defect can rather easily be corrected by a relatively inexpensive environmental change — wearing glasses. The effort needed to eradicate or to reduce the frequency of myopia genetically would exceed that requisite to rectify their defect environmentally, by manufacturing more pairs of glasses.

Diabetes mellitus is, given the present level of medicine, more difficult and expensive to correct than is myopia. Some diabetics may nevertheless be treated successfully by insulin therapy, helped to live to old age, and enabled to raise families as large as nondiabetics. The incidence of diabetes may therefore creep up slowly in the generations to come. Now, most people would probably agree that it is better to be free of diabetes than to have it under control, no matter how successfully, by insulin therapy or other means. The prospect is not a pleasant one to contemplate. Insulin injections may perhaps be almost as common in some remote future as taking aspirin tablets is at present.

Towards Guidance of Human Evolution

Are we, then, faced with a dilemma — if we enable the weak and the deformed to live and to propagate their kinds, we face the prospect of a genetic twilight; but if we let them die or suffer when we can save them we face the certainty of a moral twilight. How to escape this dilemma?

I can well understand the impatience which some of my readers may feel if I refuse to provide an unambiguous answer to so pressing a problem: Let me however plead with you that infatuation with over-simple answers to very complex and difficult problems is one of the earmarks of intellectual mediocrity. I am afraid that the problem of guidance of human evolution has no simple solution. At least I have not found one, nor has anybody else in my opinion. Each genetic condition will have to be considered on its own merits, and the solution which may be adopted for different conditions will probably be different. Suppose that everybody agrees that the genes causing myopia, achondroplasia, diabetes and retinoblastoma are undesirable. We shall nevertheless be forced to treat them differently. Some genetic defects will have to be put up with and managed environmentally; others will have to be treated genetically, by artificial selection, and the eugenic
measures that may be needed can be effected without accepting any kind of biological Brave New World.

Let us face this fact: Our lives depend on civilization and technology, and the lives of our descendants will be even more dependent on civilized environments. I can imagine a wise old ape-man who deplored the softness of his contemporaries using stone knives to carve their meat instead of doing this with their teeth; or a solid conservative Peking man viewing with alarm the new fangled habit of using fire to make oneself warm. I have yet to hear anyone seriously proposing that we give up the use of knives and of fire now. Nor does anyone in his right mind urge that we let people die of smallpox or tuberculosis, in order that genetic resistance to these diseases be maintained. The remedy for our genetic dependence on technology and medicine is more, not less, technology and medicine. You may, if you wish, feel nostalgic for the good old days of cave-dwelling ancestors; the point of no return was passed in the evolution of our species many millennia before anyone could know what was happening.

Of course, not all genetic defects can be corrected by tools or remedies or medicines. Even though new and better tools and medicines will, one may hope, be invented in the future, this will not make all genetic equipments equally desirable. It is a relatively simple matter to correct for lack of genetic resistance to smallpox by vaccination, or for myopia by suitable glasses. It is not so simple with many other genetic defects. Surgical removal of the eyes is called for in cases of retinoblastoma; this saves the lives of the victims, but leaves them blind. No remedies are known for countless other genetic defects. Human life is sacred; yet the social costs of some genetic variants are so great, and their social contributions are so small, that avoidance of their birth is ethically the most acceptable as well as the wisest solution. This does not necessarily call for enactment of Draconian eugenic laws; it is perhaps not over optimistic to hope that spreading biological education and understanding may be a real help. Make persons whose progeny is likely to inherit a serious genetic defect aware of this fact; they may draw the conclusions themselves.

The strides accomplished by biochemical genetics in recent years have led some biologists to hope that methods will soon be discovered to induce specific changes in human genes of our choice. This would, indeed, be a radical solution of the problem of management of the evolution of our species, and of other species as well. We would simply change the genes which we do not like, in ways conforming to our desires. Now, if the history of science has any lesson to teach us, it is the unwisdom of declaring certain goals to be unattainable. The cavalier way in which the progress of science often treats such
predictions should instill due humility even in the most doctrinaire prophets. The best that can be said about the possibility of changing specific genes in man in accordance with our desires is that, although such an invention would be a great boon, it is not within reach yet. And it cannot be assumed to be achievable.

Let us also not exaggerate the urgency of the problem of the genetic management of the evolution of our species. Another problem, that of the runaway overpopulation of our planet, is far more immediate and critical. If mankind will prove unable to save itself from being choked by crowding it hardly needs to worry about its genetic quality. Although the problems of number and of quality are not one and the same, yet they may be closely connected in practice. As steps towards regulation of the population size will begin to be taken, and this surely cannot be postponed for much longer, the genetic problem will inexorably obtrude itself before people's attention. The questions "how many people" and "what kind of people" will be solved together, if they will be solved at all.

Some people believe that all would be well with mankind, if only natural selection were permitted to operate without obstruction by medicine and technology. Let us not forget, however, that countless biological species of the past have become extinct, despite their evolution having been directed by natural selection unadulterated by culture. What we want is not simply natural selection, but selection, natural and artificial, directed towards humanly desirable goals. What are these goals? This is the central problem of human ethics and of human evolution. Darwinian fitness is no guide here. If, in some human society, genetically duller people produce more progeny than the brighter ones, this simply means that, in the environment of that particular society, being a bit thick-headed increases the Darwinian fitness, and being too intelligent decreases it. Natural selection will act accordingly, and will not be any less "natural" on that account.

Human cultural evolution has resulted in the formation of a system of values, of human values. These are the values to which we wish human evolution to conform. These values are products of cultural evolution, conditioned of course by the biological evolution, yet not deducible from the latter. Where do we find a criterion by which these values are to be judged? I know of no better one than that proposed by the ancient Chinese sage: "Every system of moral laws must be based upon man's own consciousness, verified by the common experience of mankind, tested by due sanction of historical experience and found without error, applied to the operations and processes of nature in the physical universe and found to be without contradiction, laid before the gods without question or fear, and able to wait a hundred generations and have it confirmed without a doubt by a Sage of posterity."