4 January 1957, Volume 125, Number 3236 SCIENCE

Uniqueness of Man

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Although man's widening horizons of understanding have made it increasingly clear that his own importance as measured in terms of cosmic space and time is vanishingly small, it is still true that on the planet earth his attainments and influence have been matched by no other species. Among the many other respects in which he is unique, he alone is able to investigate his evolutionary past and to speculate intelligently about those aspects of it that he cannot directly explore.

The quest for his own origins has led man to the concept of organic evolution, a concept that is surely one of his greatest intellectual achievements. It is a concept that challenges him to push further and further backward, in his search for understanding, to the very beginning of life on earth—and beyond that to the prelife evolution that must have been before. Short of the origin of the universe, there is no point in the process beyond which his urge to explore no longer extends.

There is as yet no general agreement among cosmologists on how, exactly, the universe is built, or how it began. Some would believe that it began some 5000 to 7000 million years ago as a giant explosion of an enormously dense "primeval nucleus" (*1*). The present expanding universe is then believed to be a continuation of that explosion. Others prefer to believe that matter is being and always has been created continuously and that the universe is in a steady state of expansion, without beginning and without end (*2*).

Observational evidence is being accumulated by astrophysicists that may before long answer such questions. Whatever the answers may prove to be, there is increasing reason to believe that the elements have evolved and are now evolving in orderly ways, beginning with hydrogen. The detailed mechanisms by which they thus arise are becoming more and more clearly understood as nuclear physicists and astrophysicists continue their collaborative investigations (*3*).

Chemical Evolution

At the time the crust of the earth became solid, presumably some 4000 to 5000 million years ago, conditions favored the accumulation of molecules, and these in turn went through an evolutionary sequence as the environment changed. In the early phases of the molecular stage of evolution, only simple molecules were formed. At one period, there were probably present in abundance such gases as hydrogen, ammonia, methane, and water vapor—with perhaps little or no free oxygen (*4*). Later, more complex molecules, such as amino acids and perhaps simple peptides, were formed (*5*).

In the more advanced phases of this period, it is believed that there appeared a molecule with two entirely new properties: the ability systematically to direct the formation of copies of itself from an array of simpler building blocks, and the property of acquiring new chemical configurations without loss of ability to reproduce. These properties, self-duplication and mutation, are characteristic of all living systems and they may therefore be said to provide an objective basis for defining the living state.

Evidence is accumulating that the nucleic acids of present-day organisms possess these two properties (*6*), and it is perhaps no longer useless to speculate that the first "living" molecule might have been a simple nucleic acid, perhaps protected by an associated simple protein. From such a viruslike system it is possible to conceive how present-day organisms might have evolved. Although the details were surely complicated far beyond the ability of man in his present knowledge to comprehend, it is possible that no principles other than those known to modern biology have to be invoked to explain the entire process.

Through mutation and aggregation of these first "living" molecules, which might be called primitive genes, multimolecular forms that depended for reproduction on preformed building blocks would be expected to arise with the ability to catalyze some of the reactions by which their building blocks were derived from simpler molecules. In a stepwise manner, with each step consisting of a mutation conferring a selective advantage, complete autonomy could be achieved (*7*). The single-celled green algae represent such an evolutionary stage, with each cell perhaps containing tens to hundreds of thousands of times as much replicating genetic material as did the original ancestral form. This phase of evolution may have lasted 1000 million years or more.

The evolutionary gap between unicellular forms and the most complex multicellular organisms may have been much more easily and rapidly bridged than was that between the unimolecular and unicellular systems. Presumably the early stages in the origin of multicellular plants and animals consisted of simple colonies of like cells. Division of labor among such cells—cellular differentiation, biologists call it—was a logical next step.

In the animal line of descent, differentiation of cells and subsequent evolution of tissue and organ systems made possible the nervous system. It is the extraordinary development of this system in man that sets him apart by such a wide

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gap from all his contemporary species. It underlies the remarkable development of his intellect, his ability to carry through complex reasoning processes and his highly developed systems of communication.

Cultural Inheritance

The ability to acquire and communicate knowledge has enabled man to supplement biological inheritance with cultural inheritance. No other species has ever developed this type of inheritance to any appreciable extent. The reactions of individuals and groups of the human species to various environmental situations are obviously a result of complex interactions of the two types of inheritance (*8*).

Although cultural inheritance may have had its first beginnings a half-million years or more ago, it has expressed itself most spectacularly in the last half-dozen millenia. Ancient and modern civilizations with their technologies, arts, music, literatures, sciences, and religions are its products.

Modern technology and science have evolved within a period of a few thousand years. They in turn have made possible the industrialization that has in the past few centuries developed to such a high degree in a few nations of the world.

The recent evolution of cultures, especially in technologic and industrial directions, has created for man an entirely new set of opportunities together with a closely interrelated group of problems. As agriculture provided more food, populations grew. Further technology was catalyzed. Tools evolved, first of stone and wood, then of bronze and copper, and finally of iron and steel. Manpower was supplemented by domestic animals and by machines driven with the energy of burning wood, coal and oil. At the same time, the art and science of medicine was responsible for spectacular increases in life-expectancies. This helped populations to grow still more rapidly.

All this is an old and well-known story. It is also well known that with urbanization, industrialization, and improved health practices, birth rates tend to fall off, but only after a lag of several generations. This lag is especially marked in those cultures in which for one reason or another education and accompanying industrialization develop very slowly. This is because in general it is easier to introduce drugs and physicians to such cultures than it is to raise markedly their levels of education and technology. Thus, as the demographic transition is made in one culture after another, populations tend to increase sharply and then become stable.

War

For a world with half its nations industrialized and half not, and with its natural resources very unequally distributed, the present population of more than 2500 million is far too large. More than half the people of the world are underfed, are poorly housed, receive little modern medical care, and are inadequately educated. It is small wonder that populations who see so little hope in other directions can be so easily stirred to rebellion and led to war by power-hungry demagogs, charlatans, and other persuasive men of little wisdom.

Overcrowding of hungry people who see little hope for a brighter future is by no means the only cause of war, but it is surely an important one. And without the slightest doubt, war is the most serious of civilization's immediate problems.

Human warfare is as old as man himself. As a part of man's culture, it has evolved from primitive forms of man-to-man combat through the many intermediate stages to its present highly perfected state. During this course, wars have become progressively larger and more devastating.

With the development of nuclear weapons, we see a significant discontinuity in this evolutionary sequence. Up to this point wars were largely self-regulating in one way or another, usually through the achievement of victory, hollow though it might have been, by one party. With wars of nuclear weapons, it is entirely conceivable that there will no longer be victors. Participants and onlookers, too, may perish from blast, radiation, and starvation.

This is why a war of nuclear weapons is said to be unthinkable—why there is now "no alternative to peace." Logically it is so. But war never has been logical. In the present state of armament, there can be no guarantee that an illogical lunatic or madman in a position of power will not pull the trigger that will set one off.

Aside from the fact that the present maintenance of peace through mutual threat of annihilation is intolerably dangerous, the pyramiding cost of supporting superior military strength and defenses against potential enemies seriously competes with alternative activities that would decrease the probability of war. It is no new thought that if the intelligence, imagination, creativity, and drive that now go to maintain military might, not to mention the raw materials and energy devoted to the same purpose, were wisely used for peacetime purposes, the incentives to wage war could be largely abolished.

In spite of the fact that there is wide agreement with the thesis that war is more nearly than ever synonymous with madness and that decreasing its likelihood is the greatest need of our time, progress is made with discouraging slowness. The obvious solution through mutual disarmament fails because there is no mutual trust among nations.

Food and Population

Although the task of preventing a major war in the immediate future is assigned to the statesmen of the world, with special responsibility in the hands of those of the more powerful nations, there are many ways in which science can and must contribute toward basic and long-term solutions.

It is difficult for men with empty stomachs to know right from wrong. If the presently available scientific knowledge of agriculture were applied on a world-wide basis, hunger could become unnecessary. But the economic, political, and social problems inherent in doing so are made enormously more difficult by the fact that they must be solved in terms of a world divided into many nations. Solutions are possible, and every possible effort should be devoted to attempts now being made to arrive at them.

In the time required to increase food production sufficiently to feed more than 2500 million people adequately, there will, unfortunately, be many more than that to feed. With the present excess of births over deaths, the world's population is annually increasing by 30 to 40 million. Food production must therefore more than catch up with present needs. This will require that efforts be stepped up by even larger factors. More land must be brought under cultivation, and yields must be increased. This means more fertilizer, more water for irrigation —perhaps through recovery from sea water—and more plant and animal breeding. The food of the oceans will have to be harvested in increasing amounts, and the practicability of entirely new methods of agriculture, such as those of algal farms, will have to be explored.

All this will require more technology and a great extension and evolution of industry. Consumption of raw materials and energy will rise markedly. The general level of education will have to be raised on a world-wide basis. Better use of manpower resources, especially at the intellectual level, will be increasingly necessary.

If the peoples of the world can somehow be induced to work together, there is no apparent reason why all of this cannot be done (*9*). While it is being done, what will be the trend of popula-

tion growth? With the spread of technology and education, will birth rates in fact fall off until populations reach approximate equilibrium in size? It is a widespread belief that they will. The decreased birth rates that accompany education are attributed to an increased desire to limit family size plus greater knowledge of birth control techniques. If so, education and the discovery and development of improved methods of birth control may in time largely solve the quantitative problem of population growth.

However, the hope that prosperity and education will continue automatically to lead to population stabilization through voluntary birth control has been considerably dimmed by the marked postwar increases in birth rates in the United States and other industrialized nations. Indeed this phenomenon raises the question of whether Malthus was not fundamentally right (*10–12*), in spite of his many detractors of recent times.

Whether or not the present high birth rates in industrialized nations are temporary and will in the long run be smoothed out at a lower level, the whole question of the adequacy of voluntary family limitation in regulating the growth of populations will have to be faced sooner or later. This is because the problem of control may not be a wholly quantitative one. Because it will inevitably be uneven in its application, voluntary and individual family control is bound to lead to changes in population composition. Differences in net reproductive rates may depend on such factors as genetic background, cultural history, and economic status. Whatever their cause, they may well produce population changes of the greatest significance to man's future. For example, it has many times been pointed out that under a system of voluntary birth control the less fit intellectually may be lacking in social responsibility and might therefore have a higher than average net reproductive rate. If differences in intelligence of this kind have an important genetic component, there is a theoretical possibility that progressive intellectual disintegration could become an important factor in shaping the nature of future populations.

Alternatives to population control through voluntary decisions on the part of individuals—society-imposed family quota schemes, to mention one conceivable possibility—raise religious, moral, and ethical questions of such magnitude that no responsible society has ever given them serious consideration except under the most unusual and special circumstances. It could well be that societies may eventually be forced to face this unpleasant problem more realistically than they so far have (*11, 12*).

At the same time that solutions are being sought to problems of population growth, food production, raw material supplies, energy resources, and the training of manpower, effective ways must be found to abolish the threat of war that has so long and so constantly plagued man. All responsible statesmen know this, and they have pointed out repeatedly that the one formula most likely to succeed is the development of a union of nations in which authority and power are commensurate with responsibility (*13*). There appears to be no other way to protect individual nations against those unwise and irresponsible acts of other nations that are the precursors of violence. It is, of course, now a common hope of many nations and many individuals that the United Nations will evolve into just such a union. If it is to do so, the hope must spread widely and grow to the intensity of a demand.

There is no reason why individual nations under such a union cannot continue to approach their internal problems in a variety of ways and with the hope that ultimately the wide gaps that now exist among nations of differing political, social, and economic ideologies will be closed through convergent social evolution.

Cultural and Biological Self-Direction

Man's evolutionary future, biologically and culturally, is unlimited. But far more important, it lies within his own power to determine its direction. This is a challenge and an opportunity never before presented to any species on earth.

It has been clear for a long time that man is potentially capable of cultural self-direction—that he could, to a much greater extent than he now does, consciously select his cultural objectives. What is not so obvious is that it has now become possible to exercise a comparable degree of control over his purely biological evolution.

Through the understanding of heredity that man has gained within the past half-century, he has acquired the power to direct the evolutionary futures of the animals he domesticates and the plants he cultivates. At the same time and in the same way, he has won the knowledge that makes it possible deliberately to determine the course of his own biological evolution. He is in a position to transcend the limitations of the natural selection that have for so long set his course (*8*).

But knowledge alone is not sufficient. To carry the human species on to a future of biological and cultural freedom, knowledge must be accompanied by collective wisdom and courage of an order not yet demonstrated by any society of men. And beyond knowledge, wisdom, and courage, faith, too, will be essential. Man must have faith in himself. He must have faith in the rightness and goodness of his goals. And many would add that he must continue to have spiritual faith.

Faith, belief, and the urge to go on and on have themselves come out of man's past as a part of the evolutionary pattern that has fashioned him into the unique being he is. In his uniqueness, he is capable of attaining heights far greater than his most magnificent cultural achievements of the past.

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