Population Problems

The following two articles—by Alan Gregg and Curt Stern—are based on papers given by the authors in the symposium on "Population problems," held in Berkeley, California, on 28 Dec. 1954, which comprised the second part of the general symposium on Science and Society. *The other two parts of the general symposium were devoted to "Natural resources: power, metals, food" and "Science in human thought and action." Articles based on the papers presented in these sessions will appear in subsequent issues.*

A Medical Aspect of the Population Problem

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THE medical aspects of what is called the population problem defy condensation into a brief paper. Even the relatively few factors we know something about are too numerous and too intricately involved with one another and with external circumstances to lend themselves to summary exposition. For this reason I propose to offer only one idea regarding the population problem. It hardly deserves to be called a medical aspect: it is rather the view of one who has had a medical training—a single idea around which subordinate reflections of a rather general sort present themselves.

In exposing this one idea I recall the Spartan custom of exposing infants to the rigors of the weather, in the conviction that such a practice weeds out the weaklings. To expose an infant idea to the rigors of a scientific atmosphere before providing the poor little thing with the support of experimental evidence or with the power of demonstrated predictive value may seem like Spartan treatment. But if the idea dies of exposure, its exit will be at least more dignified and permanent under AAAS auspices than under any other I could invite or invent. I should therefore witness its death with a very fair semblance of Spartan parental fortitude.

The way in which physicians estimate, by a sampling procedure, the number of white blood cells in the blood of a patient is generally known. In essence, it involves diluting a carefully measured amount of blood in a carefully measured amount of water, counting the number of cells found in a defined cubic volume of the blood thus diluted, and then computing the number of cells per cubic millimeter of blood. A similar method is applied to counting the red cells of the blood. Although such cell counts vary somewhat among individuals and in any one individual under varying conditions of activity, any variation of the order of 400 percent or more would usually justify the suspicion of being pathological. If, for example, a patient's white-cell count moved up within a month from 5000 to 23,000, a physician would think of the possibility that he was witnessing an early stage of leukemia—an uncontrolled growth in the numbers of white blood cells.

Now new growths of any kind (popularly called cancer) involve an increase in the number of some one kind of cell and, hence, a corresponding increase in the size of the organ or tissue involved. However, not all increases in the size of organs are the result of new growths: the heart hypertrophies—that is, grows larger—to make up for leaky valves and its lost efficiency as a pump; the uterus grows in volume remarkably during pregnancy; the organs and tissues of the growing child also present obvious increases in cellular numbers. But in these increases there appears to be a limit at which further cell reduplication stops or is in some way inhibited. Indeed, one has the mystified impression that there is a process involved that in its effect resembles self-restraint or self-limitation. One cannot, of course, attribute a sense of decorum to cells, even though we can give no better answer than ignorance to the question of why organs show a relative uniformity of size and shape in the normal state. But the fact remains that, in all but one instance, organs and tissues in their growth seem to "know" when to stop.

The exception, of course, is the whole category of new growths, or neoplasms (popularly called cancer), of which there are two main sorts—the benign and the malignant. Fibroids of the uterus furnish a good example of benign tumors; cancer of the stomach, of the malignant. I shall return to some of the more important characteristics of new growths, but now I would like, at this point, to introduce another set of considerations more apparently related to the population problem.

If we regard the different forms of plant and animal life in the world as being so closely related to and dependent on one another that they resemble different types of cells in a total organism, then we may, for the sake of a hypothesis, consider the living world as an organism. I would not merely admit that this is a hypothesis—I would insist that it is only a hypothesis. Perhaps more cautiously one would say that such a hypothesis is no more than a scaffolding. For a scaffolding may serve, but does not enter into, the final structure of established fact.

Let us look, then, at the different forms of life on this planet as a physician regards the federation or community of interdependent organs and tissues that go to make up his patient. What would we think if it became evident that within a very brief period in the history of the world some one type of its forms of life had increased greatly in number and obviously at the expense of other kinds of life? In short, I suggest, as a way of looking at the population problem, that there are some interesting analogies between the growth of the human population of the world and the increase of cells observable in neoplasms. To say that the world has cancer, and that the cancer cell is man, has neither experimental proof nor the validation of predictive accuracy; but I see no reason that instantly forbids such a speculation. If such a concept has any value at the outset, we should quite naturally incline to go further by comparing the other characteristics of new growths with the observable phenomena related to the extraordinary increase now noted in the world's population. An estimated 500 million in A.D. 1500 has grown, in 450 years, to an estimated population of 2 billion today. And the end is not in sight—especially in the Western Hemisphere.

What are some of the characteristics of new growths? One of the simplest is that they commonly exert pressure on adjacent structures and, hence, displace them. New growths within closed cavities, like the skull, exert pressures that kill, because any considerable displacement is impossible. Pressure develops, usually destroying first the function and later the substance of the normal cells thus pressed upon. For a comparison with a closed cavity, think of an island sheltering a unique form of animal life that is hunted to extinction by man. The limited space of the island resembles the cranial cavity whose normal contents cannot escape the murderous invader. Border warfare, mass migrations, and those wars that are described as being the result of population pressures resemble the pressures exerted by new growths. We actually borrow not only the word *pressure* but also the word *invasion* to describe the way in which new growths by direct extension preempt the space occupied by other cells or types of life. The destruction of forests, the annihilation or near extinction of various animals, and the soil erosion consequent to overgrazing illustrate the cancerlike effect that man—in mounting numbers and heedless arrogance—has had on other forms of life on what we call "our" planet.

Metastasis is the word used to describe another phenomenon of malignant growth in which detached neoplastic cells carried by the lymphatics or the blood vessels lodge at a distance from the primary focus or point of origin and proceed to multiply without direct contact with the tissue or organ from which they came. It is actually difficult to avoid using the word *colony* in describing this thing physicians call metastasis. Conversely, to what degree can colonization of the Western Hemisphere be thought of as metastasis of the white race?

Cancerous growths demand food; but, so far as I know, they have never been cured by getting it. Furthermore, although their blood supply is commonly so disordered that persistent bleeding from any body orifice suggests that a new growth is its cause, the organism as a whole often experiences a loss of weight and strength and suggests either poisoning or the existence of an inordinate nutritional demand by neoplastic cells—perhaps both. The analogies can be found in "our plundered planet"—in man's effect on other forms of life. These hardly need elaboration—certainly the ecologists would be prepared to supply examples in plenty of man's inroads upon other forms of life. Our rivers run silt—although we could better think of them as running the telltale blood of cancer.

At the center of a new growth, and apparently partly as a result of its inadequate circulation, necrosis often sets in—the death and liquidation of the cells that have, as it were, dispensed with order and self-control in their passion to reproduce out of all proportion to their usual number in the organism. How nearly the slums of our great cities resemble the necrosis of tumors raises the whimsical query: Which is the more offensive to decency and beauty, slums or the fetid detritus of a growing tumor?

One further analogy deserves attention. The individual cells of new growths often show marked variations of size, shape, and chemical behavior. This may be compared with the marked inequalities of health, wealth, and function so conspicuous among the human beings in overpopulated countries. Possibly man's invention of caste and social stratification may be viewed in part as a device to rationalize and control these same distressing discrepancies of health, wealth, and status that increase as the population increases.

By now the main posts and planks of my scaffolding must be obvious. In the history of science there have been hypotheses that, although not true, have led to truth. I could hope that this somewhat bizarre comment on the population problem may point to a new concept of human self-restraint. Besides ennobling human life, it would, I think, be applauded by most other forms of life—if they had hands to clap with. Or are we deaf to such applause?

And finally, I submit that if some of the more thoughtful cells in, say, a rapidly growing cancer of the stomach could converse with one another, they might, quite possibly, reserve some afternoon to hold what they would call "a discussion of the population problem."

If Copernicus helped astronomy by challenging the geocentric interpretation of the universe, might it not help biology to challenge the anthropocentric interpretation of nature?

Qualitative Aspects of the Population Problem

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THE title of this paper might also have been "A geneticist's comments on the population problem." Although the viewpoint expressed is essentially that of the genetic student of populations, I shall not refrain from giving some opinions and raising some questions that relate to more general aspects of human populations.

Human beings are different from one another. Therefore, changes in the number of people who make up the world's population are likely to involve changes in the proportions of different kinds of people. That such changes have occurred and continue to occur is a matter of record. Thus, Kirk's graphs of world population growth show that in 1650 the people of Asia and Africa were about 4 times as numerous as those of areas settled by Europeans; that in 1950 the ratio had declined to 1.6 : 1; and that in 1980 it may be expected to rise again to approximately 2 : 1. Still more obvious are the changes in the proportions of different kinds of people when one considers, not the earth's population as a whole, but the populations of more restricted areas. The change in Tasmania in the ratio of Tasmanians to Europeans from 100 : 0 to 0 : 100 percent took place in less than 30 years. In South Africa, within a few centuries, Europeans and Indians grew to considerable proportions of the total number of inhabitants, and all through the ages similar immigrations and colonizations, if not wars of extinction, have changed the qualitative composition of populations. To a lesser degree, such changes very likely have also affected the qualities of the home populations who furnished the emigrating groups. In general, these emigrating groups are not random samples of the populations at their places of origin, but vary from the nonemigrating group in age, sex, health, education, and social status. Obviously, such selective emigration leaves a qualitatively changed group at home.

Qualitative changes occur even within self-contained populations. Short-time variations as well as secular variations in birth and death rates affect the age distributions. Differential fertility of different subgroups, together with social mobility within one generation and the rise and fall of individuals of successive generations in the social hierarchies, all make it impossible for a population to remain static in its composition. Changes in quality of populations usually cannot be measured easily and meaningfully on a scale of values. Diversity rather than uniformity is an essential element of human society, but the right balance between these two relative attributes cannot be defined because of our ignorance of the innumerable factors involved and the complexities of their interactions. Moreover, there must be very many different equilibriums between uniformity and diversity. One is reminded of Sewall Wright's model for the evolution of species that conceives of an infinite number of adaptive peaks in a multidimensional landscape of mountains and valleys of adaptive elevations.

Many of the most significant changes in the qualities of the populations in the world are primarily of cultural nature. The entry of hundreds of millions of Asians and Africans into the technologic areas of Western civilization is bound to change fundamentally the proportion of culturally differently oriented individuals. The end of the cleft between colonizers and colonial dependents, the imminent abolition of illiteracy in the world, the increasing domination exerted on people everywhere by the media of mass communication, and the natural emphasis in the economically underdeveloped countries on material improvement are factors that alter the quality of humanity deeply. Many of the changes should be greeted with enthusiasm. Others may be regretted. Thus, to single out two of the latter, the sudden entrance of millions of Asians and Africans into the cultural heritage of the West is in part accompanied by a loss of their own heritage. And the emphasis on the applied aspects of Western culture that the West itself has experienced may be still more strengthened by newcomers who can easily acquire the technologic skills but only slowly recreate the basic concepts and values.

With regard to changes in the *genetic* constitution of mankind, one might be inclined to say that the changes of which we have knowledge are of minor interest and those that are of major importance are unknown. The changes of which we have knowledge are the external characters of color of skin, hair, and iris, of hair shape, of size, and of anatomical features that distinguish people from one another. They also include such normal differential traits as blood groups and the numerous genetically caused abnormal traits that afflict mankind. It is probably of minor consequence for mankind that the relative number of genes for dark skins will increase again or that the proportion of people with blood group O will decrease. Yet the last word has not been said about the deeper significance of such traits. Thus, it has only recently been shown by English workers that blood-group-O people have a greater likelihood than others to develop peptic ulcers, while group-A persons are somewhat more susceptible to cancer of the stomach. But, however fateful such genetic facts may be for a few individuals, the prospects of populations will not depend on them. Nor will this be true to any appreciable degree with a genetic phenomenon that is the result of the wider choice of mates which the improvement of transportation and various other social changes have brought about. Where formerly each national or regional population was actually made up of a multitude of relatively separate subgroups with a strong preference for intragroup mating, a breakup of these semi-isolates has taken place in recent decades.

Now, it is the nature of genetic population phenomena that different isolates come to possess some differences in genic content. One of the few obvious results of such differential content is the variable frequency of hereditary anomalies in different isolates. Group I may have relatively many individuals afflicted with disease A and few with disease B, while, inversely, group II may rarely be afflicted with disease A but more frequently with B. With the breakdown of isolation, not only a more equal distribution of diseases A and B over the whole population will come about, but also, if they are recessive diseases, a considerable reduction in the actual numbers of those afflicted by either disease A or disease B. Here, then, is a biologic basis for desirable aspects of the intermingling of the genic content of formerly separated groups. In the future, public health statistics are likely to give evidence for this aspect of population changes.

If isolates differ somewhat from one another in their content of clearly undesirable genes, it may be presumed that they also differ in desirable genes. This likely fact is difficult to demonstrate. The genetic causation of amaurotic idiocy is easily established and the negative value of the condition is beyond doubt, but neither the genetic basis nor the social desirability of many other traits are the subjects of general agreement. This is an area where some feel serious concern. Are the different racial groups of mankind equally endowed with creative ability? Do their genetic endowments enable them to create equally well in different spheres? Many sermons have been preached on alternative answers to these questions, but the answers have not been based on solid facts. The histories of human groups are experiments with many unknown variables and no control. A natural scientist who would derive final answers from such data obtained in his laboratory would be rejected by his profession. The part that biologic determinants play in the history of mankind remains unknown. My private supposition is that it is a small part and that the inertia of historical trends in different nations is predominantly culturally conditioned. Each event, however initiated, seems to limit the range of possible further events. Whether or not this view is correct, the future course of human affairs cannot help being influenced decisively by the changes in the quality of the world's populations. Whether or not, for instance, Asian cultures are bound up with genetic differentials of Asian people, their rise in world importance assures a growing influence of their thought and of their social antecedents.

The differential growth of various parts of the whole world's population finds a counterpart within many of the subgroups. For a century at least different socioeconomic segments of the populations of many western countries have shown different rates of reproduction. It is generally known that a negative correlation exists between the educational level of the parents and their rate of reproduction. In recent years the gap between the reproductive rates of the so-called higher and lower socioeconomic groups—a grouping that is closely allied to educational levels—has narrowed considerably. Family planning has become widespread in those groups who, in the past, did not limit their births, and a voluntarily larger number of children are being raised by those other groups who had formerly stringently restricted their reproduction. If one assumes that some of the causes that place an individual in a specific socioeconomic group are genetic, then one may be inclined to conclude that the differential reproduction of these groups should have led to a change in the quality of the population, namely, to a loss of genes involved in certain types of intelligent behavior. This argument always lacked complete cogency since the trend of reproductivity within each group remains relatively unknown, and, thus, the possibility is left open that, within groups, a positive correlation exists between genetic endowment and the number of children. Such a positive hypothetical intragroup correlation would counteract the supposed loss of genes from intergroup differential fertility.

Two new developments have recently been brought to bear on this problem of a possible deterioration of specific elements of the genetic endowment in populations with differential fertility. One involves an observational approach, and the other a conceptual approach. The former is most thoroughly represented by the Scottish survey of the test intelligence of school children conducted in 1932 and in 1947. No decline in the mean test performance had occurred during the interval between the two comprehensive studies. This was contrary to some predictions, but it cannot be adduced as evidence for genetic stability. It is possible that educational and social circumstances during the intervening 15 years would have led to some improvement in the test responses of individuals with identical genotypes, and there is evidence in the data that some changes in the responses did occur. Since the direction and degree of such changes in response cannot be measured accurately, the interpretation of the observed mean scores remains uncertain. They could be evidence either for lack of genetic change or for genetic change compensated by change of response.

The conceptual approach to the problem of differential fertility in relationship to the genetic status of a human population has usually rested on the assumption that differential fertility is a recent anomaly brought about by civilization. Penrose has considered the opposite assumption and has set up a model that would assure constancy of genetic endowment by means of differential fertility. In this model, a superior group is homozygous AA, an inferior group is heterozygous *Aa,* and a third group of infertile weaklings is homozygous *aa*. If it is further postulated that the inferior heterozygotes are much more fertile than the superior homozygotes, an equilibrium will result in which the lower fertility of the superior types will be balanced by the still lower fertility of the weaklings. In a population with such a genetic equilibrium, the mean test score would remain constant from generation to generation. Moreover, if the fertility of the superior group is below its own replacement value, the continued existence of the population would depend on the higher fertility of its inferior component.

The formal success of such a model must give one pause even though it should not be taken too literally. The idea that heterozygosity is an essential property of populations that assures them stability has attractive features and, for some special cases, experimental support. It is, however, not yet known how widely spread this phenomenon is. In particular, it is hardly true that the fertility of the better-endowed layers of a human population is intrinsically insufficient to replace its genic content. Therefore, the physical persistence of populations could at least be equally assured by the increased fertility of its better-endowed members and by the lowered fertility of its less-well-endowed members than by the present method. Moreover, reversal of the present order of fertility would lead to genetic improvement with regard to the traits discussed while, without reversal, at best an equilibrium would be maintained.

It has been argued that, at whatever mean level of performance, a population must, by definition, contain a group of subnormal individuals and that an upbreeding of humanity would never solve the problems posed by the instrinsic spread of any frequency distribution. As far as it goes, the argument has much in its favor, but it hardly justifies a laissez-faire attitude. Evolution has always involved the existence of an inferior tail end in the distribution of fitness, and the statement that "there must always be a tailend" is not an argument against the desirability of wisely directed evolutionary trends.

It is, of course, the basic assumption of the preceding discussion that there *are* genetic differences among different socioeconomic layers within a large population and that these differences are positively correlated with certain values accepted by the society. Endowment for intelligence, although not adequately measured by test scores, is at least partially estimated by them, and its value, although not admitted universally, is taken for granted here.

The more immediate premise of the existence of genetic differentials among social layers is often disputed. Social factors, such as education, wealth, and opportunity, are undoubtedly determinants in social status as well as in intelligence-test performance. Any correlation between status and performance, thus, contains *non*genetic elements. The question remains, however, of whether *genetic* elements are also involved in such a correlation, both as independent agents and in specific interactions with the environment. It seems to many geneticists that this question must be answered affirmatively at least for societies with appreciable social mobility, that is without rigid caste systems. If this is granted, then the large and differential growth of populations in such societies must necessarily result in changes in the quality of these populations. This may be less so in the more permanently stratified societies where this stratification is mainly historically frozen instead of being recreated in successive generations. Although a differential endowment may also exist here, perhaps high social status may as likely be correlated with high genetic endowment as with low genetic endowment. Moreover, in the absence of continuously new stratification of the over-all genic content of the population, it is probable that genetic differentials concerned with social attributes are relatively small. It will be noted that these statements contain many reservations—an indication of the uncertainty of our knowledge and an incitement to further research.

The geneticist cannot doubt that the complex and changing patterns of the reproduction of human populations are of significance for the quality of their genetic endowment. These patterns of reproduction are partly the result of incompletely understood motives and are partly under the control of social forces which themselves are subject to planned manipulation. The danger of any interference in patterns of reproduction is great, but it should not exclude a rational consideration of both the harm and the good that may come from it. Again it must be emphasized that a do-nothing attitude also has its specific consequences, for better or worse.

What then can be done? Little, I believe, in the immediate future. The burst of population growth of which we are witnesses is like the outbreak of an epidemic. All that we can hope at the moment is to keep it in bounds and see that its dangers are minimized. But we must prepare for less stormy times. When an equilibrium between births and deaths is approached again, mankind should be ready to wisely direct its reproductive patterns so that at least a deterioration of the quality of the species is avoided; better still, that it is improved. Men are not cattle, and no one should treat them as such. But must we really, in the long run, renounce the benefits that come from positively selective reproduction, or should we rather learn to devise methods compatible with individual responsibility and voluntary action?

There is no magic in a specific number of inhabitants for a country or for the whole world. Those who fear that our resources will prove inadequate to support the billions of the future at a desirably high level may possibly underestimate man's creative abilities. But it can be said with much greater certainty that the growth of population must stop at some stage. Any generation, therefore, that increases its number does this at the expense of a later generation. If some countries base their economies on a growing population, rather than on a steady population, because it is easier, they thereby deprive future generations of this advantage. If other countries with low living standards and scarce resources now suffer under the load of population growth, their inability to control their population may make it more difficult to attain the desirable improvements of civilization.

The time may come when population policies will tend toward a reduction of stabilized population sizes. Then the ancient desire of many parents to have at least their own number replaced by their children will have to remain unfulfilled because earlier generations indulged in an irresponsible fertility. The problem of the quality of the future populations will then arise in a more painful form than before since it will mean not only differential restriction but differential renunciation of parenthood. Such renunciation is by no means unknown, witness the history of Ireland's population during the last century.

The quality of human populations is difficult to define and still more difficult to control. This is the reason why considerations of quality have been overshadowed by those of quantity. It can only be hoped that men will not be deceived by awe of mere numbers. In the meantime, biologic and social knowledge will be increased so that it may be applied to the improvement of the world community.

Warder Clyde Allee: Ecologist and Ethologist

THE death of Warder Clyde Allee on 18 March 1955 in Gainesville, Fla., has deprived biology of a leading student of animal ecology and behavior. Since his retirement as professor emeritus of zoology from the University of Chicago in 1950, Dr. Allee had been head of the department of biology at the University of Florida. He was planning to retire from formal academic responsibilities in 1955 and to devote himself to writing and further researches on the social life of animals. Death resulted from an infection, with heart involvement, only 2 days after his admission to the hospital. His health was good in recent years, considering the fact that his legs and lower abdomen were paralyzed as a result of a benign tumor in his spinal cord that developed approximately 25 years ago. In spite of confinement to a wheel-chair, he had continued active teaching, research, and administration, and had accepted many lecture engagements in this country and abroad. He usually spent his summers at the Marine Biological Laboratory, Woods Hole, Mass.; he was a member of the board of trustees of that institution.

Allee was born of Quaker parentage on a farm near Bloomingdale, Ind., on 5 June 1885. He maintained a loyal association with the Society of Friends throughout his life and had a justified pride in the ideals and history of the group, as well as in its international interests and services. He found his scientific and religious convictions entirely compatible.

Allee attended Earlham College, which granted him a bachelor's degree in 1908. He later became a member of the college's board of trustees and received an honorary LL.D., from Earlham, in 1940. He met Marjorie Hill at Earlham and they were married in 1912. They had three children. The first, Warder, was killed in a street accident at the age of eight—a shock from which his parents never wholly recovered. Two daughters, Barbara and Mary, are married and mothers of his grandchildren. Marjorie Hill Allee died in 1945 after having written many fine books for children. She collaborated directly and indirectly in many of her husband's writings. Allee married Ann Silver 2 years ago, a charming person who rapidly became identified with his new career at the University of Florida.

Allee pursued his graduate work in zoology at the University of Chicago, where he received the Ph.D. degree in 1912 under the direction of Victor E. Shelford. He was successively on the teaching staffs of the University of Illinois, Williams College, the University of Oklahoma, and Lake Forest College, before he returned to the University of Chicago in 1921 as assistant professor of zoology. He was professor of zoology at Chicago from 1928 until his retirement in 1950. He directed the doctoral researches of about 38 students during his career, many of whom now fill important academic positions. Allee also taught at the Marine Biological Laboratory during the summers, at the University of California during the winter of 1923, and at the summer school in Logan, Utah, from 1924 to 1926.

He was a member of the National Academy of Sciences and held numerous offices in scientific organizations among which were the vice presidency (Section F) of the American Association for the Advancement of Science in 1942, the presidency of the Ecological Society of America in 1929, and the presidency of the American Society of Zoologists in 1936.

Allee succeeded Charles M. Child as editor of *Physiological Zoology*. Besides being the author of many articles in scientific journals in the fields of physiology, ecology, animal aggregations, behavior, and animal sociology, he was also the author or coauthor of many books, including *Jungle Island, Nature of the World and of Man, Animal Aggregations, Animal Life and Social Growth, The Social Life of Animals, Ecological Animal Geography,* and *Principles of Animal Ecology.* His most notable researches dealt with the analysis of the physical factors in marine, fresh water, and terrestrial environments—both in temperate and tropical climates—and pioneering experiments on aggregating and social be-