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Our Reproductive Potential

Fairfield Osborn

The "reproductive potential" of the human race is at last being recognized as perhaps the most basic and certainly one of the most ominous problems facing the world today. It is, of course, overshadowed by the more immediate crises between freedom-loving peoples and the authoritarian forces of Communism. It is also secondary to the question, "Shall there be war or peace?" Yet, in the search for peace there is mounting evidence that the pressures resulting from rapidly growing populations are, without question, a major cause for the great majority of conflicts between nations. For my own part, I will go a step further and express my belief that the hope for world peace is remote, or even unattainable, until the pressures resulting from population growth are relieved.

Natural Checks to Population Growth

What is meant by *reproductive potential?* In a literal sense it expresses maximum fecundity. For our purposes here, we can better think of it in the more general sense of representing population trends within existing environments, both physical and cultural. The existing population problem is an anomaly, because man's capacity to reproduce himself rapidly is extremely low when compared with any other form of life. With the exception of a few of the higher mammals, man is the slowest "breeder" on earth, owing to a long gestation period culminating, usually, in only one offspring. Without overstressing the parallelism between man and other forms of life, it is well to recall that, in nature, overpopulation is prevented by three factors: starvation, disease, and natural enemies, the last, in human terms, being war. With regard to starvation and disease, great progress has been made in modern times in reducing the toll they both take upon human life. Consequently, these two checks to population growth have been largely eliminated, although near-starvation in the form of extreme undernourishment is today still prevalent with the majority of most people on the earth. With regard to warfare, we still fail to abolish it, or the threat of it, despite the universal yearning for peace. Here, again, it must be remembered that the numerical loss of human life in the last two great world wars was relatively inconsequential when measured against the total populations of the countries at war. In fact, the wars of the last century have had virtually no influence in restraining population increase in the countries engaged.

World Population Increase

In summary, then, the three natural controls upon population increase either have been largely removed or are of small influence. The consequence is that there has occurred a violent and completely unprecedented increase in populations throughout the world during the last century or more. Further, the *rate* of increase continues to accelerate. These facts are well known, but in order to highlight them I should like to remind you that during the last 100 years the world's population increased from 1200 million to 2400 million, or an average of 12 million per year. By comparison, some 300 million people have been added to the earth's numbers within only the last 10 years, or an average of 30 million a year. One does not need a computing machine to figure out that this means more than 80,000 each day. At present the daily increase is estimated to be nearer 100,000 each day. These figures represent man's reproductive potential as of this time.

Within these over-all figures of world-population increase there are, of course, considerable variations in rates of growth between different regions and countries. It is noteworthy that the most recent upsurge in population is the result of the entry of most underdeveloped countries into the explosive phase of the demographic cycle.

It is a disconcerting irony that this extraordinary increase in human numbers has come about principally through the beneficent influence of medical science and public health measures, resulting in greatly reduced death rates. The question therefore is: How long can we accept this boon without facing up to the need for equivalently reduced birth rates?

Strangely enough, it is only within recent years that wide attention is being focused upon the far-reaching implications of this essential human problem. In historical times, it is true, various societies of people were acutely aware of the question of overpopulation, and not infrequently strict controls were enforced. In modern times the problem has been obscured for a number of reasons, including cultural, religious, and national attitudes. Further, during the last century or more, population pressures, especially in the Western world, have been relieved by new methods of transportation which aided migrations; by industrial development in many countries that absorbed ever larger labor forces; and, finally, by the fact that the settlement and development of the Western Hemisphere provided an outlet to great numbers of people in overcrowded countries. These reliefs can no longer be counted upon to any important degree.

The author is president of the Conservation Foundation and the New York Zoological Society. This article is based on an address which he delivered at a symposium on resource development and population growth, at the AAAS meeting in New York, 28 Dec. 1956.

Awakening of Interest in the Population Problem

In view of the fact that scant attention has been given to this world-wide question until recently, it is the more notable that, today, there is a great awakening to the seriousness of the situation. Within the last few years several governments, to which I shall refer shortly, are undertaking specific action toward population control. Further, the United Nations has given at least an initial nod to the existence of the problem by sponsoring, successively, two world conferences—the first, the United Nations Scientific Conference on Conservation and Utilization of Resources, held at Lake Success in August 1949, and more recently, the World Population Conference, held in Rome in August 1954. Quite apart from governmental interest, there have appeared in recent years a growing number of books, articles, and other publications on the subject, and many conferences by various groups have taken place, including discussions such as that recently held in New York under the auspices of the American Association for the Advancement of Science. Yes, action and interest are both "sharpening"—and, I might add, it is high time.

Schools of Thought

As one might expect, there are differences of opinion concerning this great question. In our country these have tended to crystallize into two schools of thought. Summarized, one school seems to assume that rapid and continued increase in populations throughout the world is inevitable and, consequently, that we should prepare for the time when the present world population may be doubled, or even tripled. Further, this school anticipates that it will be possible to provide for the physical needs, including food-supply, of such greatly increased populations largely through technologic means which, I might observe, are as yet scarcely, if at all, defined. Among the ranks of this group are physical scientists, engineers, and those engaged in the business and industrial world. These adherents deal with physical matters. Social and political consequences do not readily fall within their first interest.

The other school of thought does not and will not concede that rapidly increasing populations are 'inevitable throughout the indeterminate future. It will not concede this because it contends that, unless population growth is controlled, the human race will be entering into a mounting series of crises—social and political as well as physical. Expressing these warnings, representatives of this school have sometimes been referred to as "the prophets of doom" and more generally as "the pessimists." Within this group will be found social scientists, political scientists, a growing number of historians, a limited number of economists, an occasional rebel from among the physical scientists, and, it might be added, most of the biologists. The adherents of this school tend to think in social and biological terms rather than in purely physical terms. Actually the members of this group are the optimists, because they hold to the belief that human society, when fully aware of the consequences of unrestrained population increase, will take positive steps to stabilize human numbers. This is already beginning to happen.

Action by Governments

Here let me refer to a few governments, the pioneers, that have started to take positive action toward restraining population growth. One of them is India, whose second five-year plan, issued in 1956, states, "The problem of regulating India's population from the dual standpoint of size and quality is of the utmost importance to national welfare and national planning." This statement is being made effective through the plan to establish 300 urban and 2000 rural clinics, under government supervision, to encourage birth-control. Another case is Japan, where abortion is legalized, and clinics for parent guidance have been established. It is estimated that between 1.5 and 2 million abortions were performed in Japan in 1955; this means that there were about as many abortions as live births—a distressing situation resulting from the fact that no more dependable means of birth control is as yet readily available to the people of that country. A third example, and an extraordinarily interesting one, is the change-about that has occurred in Communist China. Here there exists a basic conflict between Marxism, which holds that "the Malthusian theory of population is the most reactionary among the theories of the social sciences in capitalist society," versus the cold reality that a population of 600 million people, increasing at 2 percent per year, places an insuperable obstacle to the government's efforts to industrialize, to advance consumption levels, and to raise educational standards. Out of this welter of ideas and purposes the net result is that the government of mainland China has now accepted the extension of planned parenthood as one of its legitimate functions.

These three examples, evidence of governmental responsibility for the population status of the several countries concerned, have all occurred within the last few years and are in themselves remarkable episodes in modern history. The question is, will this trend continue and how widespread will it become—and how rapid? An unparalleled opportunity, not yet accepted, is presented to the United Nations to take a position of world leadership in recognizing and becoming a focal center for coping with this problem that now so evidently affects the welfare of the peoples of every country.

Population Pressures and War

I stated earlier that population pressures are a principal factor in bringing on wars. There are, of course, other causes for war, including the "power complex" of ambitious leaders and governmental groups. However, Hitler used the need for *Lebensraum* as his excuse. Italy attacked Ethiopia to gain room for its rapidly expanding population, and Japan had imperative need for more space for a population that had increased from 47 million in 1900 to 73 million in 1940. This large and growing population was contained within Japan proper, a country equal in size merely to the state of Montana.

A vivid illustration of the tensions produced by a country's population pressures is provided by the present "hot spot," Egypt. This is an agricultural country depending mainly on the export of cotton for foreign exchange. Between 1937 and 1954 the Egyption population grew from about 16 million to more than 22.5 million persons. During this period live births increased slightly, to 45 per thousand, and death rates fell from 25.7 to 17.7 per thousand. Over a period of three decades the average annual rate of population growth has been nearly 2.5 per cent—more than enough to double the population in 40 years.

Egypt's present population of more than 23 million is contained within the narrow strip of the Nile valley, an area of approximately 13,000 square miles (about that of Connecticut and Massachusetts). The population density is more than 2300 persons per square mile of arable land, and the struggle for the barest subsistence is acute. A people such as this, with little or nothing to lose, is an easy prey for dictatorship and aggressive action by its leaders.

If the controversial high dam were to be built at Aswan, and if all the impounded waters were to be used to increase the amount of cultivated land, the irrigated acres would be increased by one-third. Should this development of the productive base to the maximum limit take place, there would, even then, be only enough agricultural land to carry

the increment in population at present rates for a period less than a generation, without allowing for any rise whatsoever in level of living. As Stanley Cain recently expressed it: "Here is the stark biological problem—the race between production and reproduction that can't be won in Egypt by production alone."

Historian's Opportunity

These examples in very recent times indicate the degree to which population pressures contribute to international tensions and even war. Situations such as these, and many similar previous ones, present a fine opportunity for the present-day historian to go much deeper in analyzing causes of the great conflicts in human history instead of dealing principally with effects. Up to this time, too, many historians have "missed the boat" in this respect. Aldous Huxley, in one of his recent essays, "Tomorrow and Tomorrow and Tomorrow," writes, with understandable irony, "In the index at the end of the sixth volume of Toynbee's *A Study of History,* Popilius Laenas gets five mentions and Porphyry of Batamaea, two; but the word you would expect to find between these names, Population, is conspicuous by its absence. In his second volume, Toynbee has written at length on 'the stimulus of pressures'—but without ever mentioning the most important pressure of them all, the pressure of population on available resources."

It is heartening to realize that Arnold Toynbee, learned man and eminent historian, has finally come to a full realization of the importance of what we are discussing here. In a broadcast, last October, he stated: "The abolition of war, working in combination with the lowering of the death rate through our recent vast improvements in public hygiene, is going to raise, in an acute form, the problem of population. . . . Is mankind going to rid itself of two of its three traditional scourges—war and pestilence—only to be done to death by the third scourge, famine? Surely we are not going to be so stupid as that. Yet, when we have done all that science can do to increase the world's food supply, the only way left open to us for coping with the continuing increase in population through the reduction of the death-rate will be to offset this increase by a corresponding reduction in the birth-rates."

Situation in the United States

There is a persistent tendency in our part of the world, the western world, to think and talk of the population problem as if it were peculiar to the Far East and, more vaguely, to "underdeveloped" countries. There are grave errors in this attitude. One of them is that a number of countries in Europe are themselves faced with the problem, some to an aggravated degree. Another is that, if the Western world is going to assume any leadership in dealing with the problem as a whole, it will need, by its example, openly and avowedly to recognize its own involvement. Otherwise our motives—and this applies perhaps especially to us in the United States—will be subject to grave suspicion throughout the rest of the world. Why not, then, a candid examination of the situation in our own country?

Assuming that present rates of increase continue, we shall have 60 million more people in our country within 20 years. Our rate of increase, by the way, is greater than that of India, and even higher than the world average. Our prevailing attitude is one of taking it for granted that such an increase is desirable. There is much talk of "more sales," "expanding markets," and ever higher "standards of living." Fortunately our country has the benefit of enlightened leadership within the business and industrial world—an enlightenment that is steadily spreading, as evidenced, for instance, by the increasing support given by large corporations to "general welfare" projects such as education. Of late, business leaders and economists are beginning to analyze this "rising standard of living" theory and are questioning its validity. As Earle L. Rauber, director of research of the Federal Reserve Bank of Atlanta, aptly observed in a recent article, "it now takes all the running we can do to stay in the same place."

I believe that such benefits as may come to our country through a much larger population will be outweighed by the disadvantages and problems that will arise. Whether or not we shall be able to maintain our present standard of living is certainly open to question. There are related questions, such as: Will world conditions enable us to draw from other countries the continuing supplies of raw materials that today are essential to our economy? No one can answer this question with assurance. At the present time, with less than 10 percent of the free world's population and 8 percent of its land area, the United States has come to consume almost half the free-world volume of materials. One thing is sure—the greater the demand arising from the needs of an ever-larger population the more this question will press upon us, and the less likely it is that the answer will be affirmative.

On the domestic front we shall not actually run short of food, though, in all probability, surpluses will be a thing of the past, even within the next few years. The great technical advances in forest management will presumably provide enough fibers, or substitutes will be developed. With regard to these two basic resources we need not have, perhaps, too great concern. The real pinch will come in water supply, already an acute problem for some 50 million people in various regions of our country. If the question were asked, "Can we solve this problem of insuring adequate amounts of these basic natural resources?" I think the answer would have to be a qualified *Yes,* because the natural richness of our country, the technical skills to be drawn upon, and the adaptability of our people are of such a high order. The qualification, however, is a major one—namely, that the larger our population, the more difficult the solution, the greater the threat to our economy, and, finally, the greater the chance of actual distress to large segments of the American people in the event that adequate solutions cannot be found.

These are material considerations. How about our environment and the cultural, psychological, and social situation in a "new America" with 75 or 100 million more people. Here indeed our thoughts must tread the tenuous tightrope of ideas and preconceptions. What kind of land, what kind of life do we want? Every city will be almost twice its present size; countrysides will become suburbianas; the traffic trickles and streams of 1956 will become ever-flowing rivers in the "80's"; the sky above us will be full of jets, with silent lake and mountain-valley hidden beyond "the last horizon." Perhaps this is what we want—or do we? It is all in the point of view, and we have not given it our thought as yet.

But there are more immediate and evident obstacles to making this "new America" a place for our children. Recently the *New York Times* carried a headline, "School outlook reported bleak." This news item had to do with the report of the National Education Association, which had just been issued and contained the following statements: "Our school systems still are employing about 80,000 teachers who are not fully qualified; enrollments in teachers' colleges are not gaining fast enough to meet the need for qualified new teachers, which this year is about 180,000"; and, finally, "at least 840,000 children are on half-day or similar part-time arrangements." Our colleges are in a similar position; unable to respond satisfactorily to the constantly increasing demands being made upon them. Virtually all our public services, hospitals, courts-of-law, other institutions, are, year by year, finding it increasingly difficult, in many cases impossible, to provide the quality of service that the public has a

right to expect. In these essential phases of our national life, with all our running, we cannot even stay in the same place!

There is no ready answer, nor is there any quick solution because our present attitude towards family size will compound these difficulties in the years immediately ahead. The choice lies with each parent. The individual is the nation. The choice, however, cannot be made until we formulate an opinion on what we want for our country. In our inner thoughts we may be thankful that the problems which force this choice upon us are not as desperate as those facing the great majority of people in other countries. We can even dare to hope that they never will be. This, however, will depend on the decision we make—a decision which can serve our own interests as well as the interests of other people throughout the world.

A Social and Political Question

Above all, we should keep in mind the fact that the question of population growth, and the pressures it creates, whether considered from a national or an international point of view, is not merely a physical problem of resources and people. Even more essentially, if that be possible, it must be thought of as a social and political problem of world-wide magnitude.

Bacterial Particles in Oxidative Phosphorylation

Arnold F. Brodie and Clarke T. Gray

The biochemical function generally considered most characteristic of mammalian mitochondria is that of oxidative phosphorylation. While it cannot be said with certainty that bacteria possess subcellular elements which should be called mitochondria, recent studies (*1, 2*) have shown that cell-free extracts of mycobacteria and corynebacteria fulfill the most exacting requirements for oxidative phosphorylation. These include (i) oxidation of Krebs-cycle intermediates with P/O ratios greater than 1.0, (ii) formation of adenosine triphosphate (ATP) (*3*) from inorganic orthophosphate in the presence of a phosphate-acceptor system, (iii) absence of phosphate esterification under anaerobic conditions, and (iv) the uncoupling of phosphorylation from oxidation by known uncoupling agents. Microbial systems that couple phosphorylation to oxidation have since been described by Tissieres and Slater (*4*), Rose and Ochoa (*5*), and Hartman *et al.* (*6*) in extracts of *Azotobacter vinelandii,* while Nossal *et al.* (*7*) have obtained active preparations from yeast. In the foregoing systems the participation of subcellular particles has been demonstrated.

In contrast with the mammalian preparations, the bacterial systems studied (*4, 8–10*) have lent themselves to fractionation and reconstruction. In the latter, oxidative phosphorylation is dependent on (i) a particulate fraction which functions only as a highly organized structural unit (*9*) and (ii) supernatant factors (*4, 8, 10*) required to complete terminal electron transport and coupled phosphorylation (*11*).

Since any system which can be fractionated and reconstituted facilitates analysis of the essential components, it appears that bacterial systems will play an increasingly important role in elucidating the mechanisms involved in oxidative phosphorylation. It seems useful, therefore, to characterize the labilities and also certain of the enzymatic and chemical constituents of bacterial particles that are capable of participating in oxidative phosphorylation (*12*).

Effects of Sonic Treatment

Active cell-free extracts were obtained by treating 11-milliliter aliquots of *Mycobacterium phlei* [500 milligrams of wet cells per milliliter of 0.1*M* tris (hydroxymethyl) amino-methane (Tris) (*3*) at *p*H 8.0] in a 10 KC Raytheon magnetostrictive oscillator at 2°C for 4 minutes, followed by centrifugation of 20,000*G* (*2*). The effect of sonic vibration on cell disruption was measured by determining the rate of protein liberation. Protein was liberated rapidly during the first 4 minutes and but slowly thereafter (Table 1). The attendant solubilization of enzymes associated with the particles indicates that extended treatment served primarily to fragment the debris and particles initially released.

Prolongation of vibration not only failed to increase the yield of protein, but it was also particularly deleterious, since it brought about a continuous decline in the capacity of extracts to esterify phosphate in the presence of succinate or fumarate (Fig. 1). Losses in the capacity to oxidize these substrates, however, differed quantitatively and qualitatively. Succinate oxidation was negligible after 40 minutes of treatment because of the apparent particulate nature of this oxidase. With fumarate as electron donor, about 60 percent of the initial oxidation remained. This residual oxidation with fumarate may be attributed to the solubilization of dehydrogenases and flavoproteins which transport electrons to oxygen by a series of noncoupled oxidative reactions. Such interpretation is supported by the more rapid decline of P/O ratios with fumarate and the increased cyanide-resistant residual oxidation with preparations that were treated for 40 minutes. Similar conclusions have been reached by other workers. Nossal (*13*) noted the solubilization of the fumarase system associated with yeast granules, while Utter and Kreech (*14*) obtained lowered P/O ratios when these granules were exposed to increased disruptive treatment. These observations with microbial systems parallel those concerning the lability of the mammalian mitochondrial system to sonic oscillation (*15*).

Distribution of Dehydrogenase Activity

A comparative analysis of the distribution of oxidative enzymes between particulate and supernatant fractions was investigated after these components had been separated from 4- and 40-minute sonic extracts. Crude cell-free extracts obtained by centrifugation at 20,000*g* were recentrifuged for 90 minutes at 140,000*g* in a Spinco preparative centrifuge (*16*). The particulate fraction was

Dr. Brodie and Dr. Gray are associate biochemist (enzymologist) and biochemist, respectively, Leonard Wood Memorial, and research associates in the department of bacteriology and immunology, Harvard Medical School, Boston, Mass.