

Global
Impacts
of
Applied
Microbiology

PREFACE

The event reported in the present volume took place in Stockholm from July 29 to August 3, 1963. This coordination conference, bearing the ambitious title, "Global Impacts of Applied Microbiology" (GIAM), carried also the subtitle, "A Projection of the Microbiological Research of Today to the Needs of Tomorrow". Since the future needs of the world undoubtedly will be most urgent in the developing areas, it was natural for this conference to focus upon microbiology as applied to the solution of problems indigenous to such regions. In this sense, the Stockholm GIAM conference might be regarded as a continuation—within one particular field—of the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, held in Geneva in February, 1963.

The GIAM conference was conceived, gestated, and born during the VIII International Congress for Microbiology held in Montreal in August, 1962. Parallel Scandinavian and international committees organized and coordinated the undertaking, which was sponsored by the Section for Economic and Applied Microbiology of the International Association of Microbiological Societies and the Royal Swedish Academy of Engineering Sciences. It was co-sponsored by the World Academy of Art and Science.

Without the energetic management of our untiring Secretary-General, Dr. Martin Tveit, GIAM would certainly have succumbed prematurely. We are grateful for financial support from the United Nations Educational, Scientific and Cultural Organization, the International Union of Biological Sciences, the Council for International Organizations in the Medical Sciences, the Swedish Government, the Swedish Agency for International Assistance, the Royal Swedish Academy of Engineering Sciences, and the National Science Foundation of the United States of America, as well as from other private and public sources. For aid in the transmutation of raw manuscript to book text and in the preparation of the indices, we are indebted—beyond the expressive powers of mere words—to Miss Beryl V. Daniel and to Dr. Nancy L. Baigent.

This conference was an interesting and quite unique experiment in that it brought together from about 30 countries some 350 specialists who represented such seemingly unrelated disciplines as soil microbiology,

medicine, fermentation, phytopathology, immunology, food technology, economics, and science administration, to name but a few. It was structured to provide a forum for varying viewpoints and to generate programs for action which could be presented to different governmental and international agencies.

The concern about the population crisis, which pervaded the conference, is evident even in the remarks made at the opening session, wherein was cited the latest United Nations report on population increase, with its disturbing news that earlier demographic prognoses had been too low. Certainly, our globe has increased its food production but, during the 1950's, the productivity per inhabitant had remained essentially constant. In 1962, the Food and Agricultural Organization estimated, in accordance with the United Nations forecast, that our continued growth in population would necessitate doubling the world supply of food by 1980, and trebling it by the turn of the century. It is a matter of grave concern to the GIAM speakers and confrères that half of the peoples of the world are suffering from hunger and disease.

The popular notion that scientists are indifferent to the social consequences of their work is belied by the fact that the Stockholm conference was initiated by scientists. The eager participation of numerous world figures illustrates the widespread feeling of responsibility and concern for the present trends in science administration and societal-political development. These factors are much too dynamic to be steered unerringly by shortsighted local planning. Furthermore, the potentialities of technology are now so enormous that the consequences may be disastrous if decisions are left solely to power-seeking and parochially oriented individuals. No doubt the freedom of action, "the political latitude", is shrinking in an environment in which the general training level is high and whose complex social structure requires specialists at the highest levels. Unless administration is accompanied by wisdom, the applications of science clearly involve dangers, not only in the developing nations, but, for that matter, everywhere.

In his effort to deal with the ubiquitous microbe intelligently, man has learned to combat many of the dangerous microorganisms and is now considering how best to use the beneficial ones. Producing food for the coming millions must be among his foremost objectives. Scientists who—together with the international agencies of health and welfare—share the responsibility for the present imbalance between mortality and fertility, must continually think in terms of re-establishing and maintaining the steady-state. As rational and compassionate human beings, scientists cannot leave this restoration to the blind forces of war, famine, and pestilence. That microbiology affords prospects more constructive than these horrors

will be seen from the many imaginative examples presented in this volume.

Some of these prospects, albeit feasible from the bioengineering standpoint, are confronted with seemingly immovable roadblocks in the cultural arena. Experience has shown that acceptability is a factor of the first magnitude in the consumption of food, and even a weakly unpleasant odor or taste may be enough to prevent the utilization of any substance as a human food. Where customs and taboos are important factors in limiting acceptability, as is true both of food yeast and algae, their large-scale use is made very difficult. However, one should not regard the cause as lost, because the quality and palatability of many food products can be improved by the application of microbial enzymes which can remove undesirable trace substances and add desirable flavor components. Spoilage, too, is a rather subjective expression which also must be considered in a cultural perspective. The same microbiological processes which would be regarded as a spoilage in one culture might yield what are considered highly desirable products in another.

Just as education may be a necessary factor in securing acceptance of microbial foods, so is it an equally important one in making immunization programs acceptable to developing countries, as well as in determining the future of applied microbiology generally in such areas. Undoubtedly, the practical benefits will come first to those societies that provide for adequate research and have the wisdom to use the results; such attributes involve training and education, not only of the scientists and of the administrators on all levels, but also of the populace. Indeed, education of the masses is the key to wise management of all resources.

Microbiological investigations not only help solve the materialistic problems of man's existence, but also satisfy his creative curiosity about the nature of life itself. Many of the significant breakthroughs in the biochemical sciences have originated in attempts to solve "practical" microbiological problems. Science and the applications of science are intermingled inseparably and interact interminably.

There is a tremendous need for international efforts in microbiology on all levels, and such efforts are being made by the International Association of Microbiological Societies with its numerous specialized sections. This organization originally concentrated its efforts on arranging international congresses and symposia, on matters of taxonomy and nomenclature, and on the coordination of culture collections, but many more functions have now been added. These newer activities are related to the growing importance of international and regional efforts in general, in all areas of science. It is clear that specialized international conferences, such as GIAM, are very significant components of this effort.

The need for a re-evaluation of priorities in the allocation of the world's resources, both of money and of scientific manpower, was stressed by GIAM participants; concern was expressed by many speakers over the detrimental effects of the "space race". It is felt that the priority list must be radically revised before world science and technology becomes further engulfed in the "moon illusion".

A sense of unity is provided by the unquestioned belief that micro-organisms are a prime natural resource of all mankind, regardless of national boundaries. If man makes the effort to understand, control, and utilize this resource, it may well affect his future most profoundly.

Mortimer P. Starr
Carl-Göran Hedén

Stockholm, March, 1964.

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INTRODUCTION AND OPENING OF THE CONFERENCE

I

A. TISELIUS

On behalf of your Swedish hosts, may I extend to you all a hearty welcome to Stockholm and to this conference. The initiative to this meeting came from a group of microbiologists who felt the need of a closer contact between administrators and research specialists in questions concerning the future well-being of man, especially as regards the fight against hunger and disease. The idea met with much approval and, as the plans materialized in the hands of the International Association of Microbiological Societies, Stockholm was chosen as the site of the conference, The Royal Swedish Academy of Engineering Sciences offered its services in organizing the meeting. Later, the World Academy of Art and Science entered as co-sponsor. Thus, the meeting has a truly international background, and this is reflected in the presence this afternoon of representatives of many countries.

I would like to interpret the spirit of this international gathering as another expression of the increasing feeling of responsibility among scientists toward the world situation and especially toward all the suffering of which we are increasingly aware. At the same time, all of us have witnessed the recent tremendous development in such fields of pure and applied research which are particularly apt to give us new and powerful arms in combating starvation and disease. Those laymen and politicians who judge only from headlines may be under the impression that today's research is dominated by the atomic nucleus and by space. They overlook, then, the recent revolution in biological research which is perhaps particularly striking in microbiology and in related fields. In other fields of research we have seen how careful planning and efficient support can mobilize our resources and lead to results of the greatest practical and theoretical significance. It is my belief that a mobilization of resources in the biological fields similar to what we have experienced in the fields of atomic energy and space research would, more than anything else, help in relieving the world of much suffering. I believe that such an over-all effort in the biological fields will come in the near future. The ground has to be prepared, however, and conferences like this which we start today should be instrumental in such a development.

II

S. BROHULT

In wishing you welcome to this conference on "Global Impacts of Applied Microbiology" may I say how gratifying it is that so encouraging a body of

scientists has assembled from so many countries. You have had short notice, for the microbiological societies felt it important to hold a more specialized congress as soon as possible after the conference held last February by the United Nations on "The Application of Science and Technology for the Benefit of the Less Developed Areas". The fact that so many scientists have attended, nevertheless, underlines the importance of discussing the social consequences of your work and shows that you are not indifferent to your responsibilities.

The conference has been called to deal with microbiological methods and their uses in general, but the programme includes those special aspects of the science which may help to solve some of the problems in the developing countries. As we all know, one of the most important questions today is how to raise the standard of living in these countries and how to meet their food requirements. The latest United Nations statistics reveal an increase in world population by some 500 millions during the 1950's. That is an increase by 19 per cent as opposed to the 17 per cent forecast in 1958. In 1960, the total world population was said to be 3000 millions, and this too is 75 millions more than the highest figure forecast in 1958. During the decade there has been a relative increase of over 20 per cent in most areas, with 29 per cent in Middle America and 28 per cent in Southwest Asia. Asia's share of the total world population increased to 56 per cent. One of the main factors behind the unexpectedly large increase in world population is believed to be that the mortality rate in Africa and large parts of Asia is lower than was estimated.

These latest reports show just how uncertain long-term prognoses can be. They also indicate that the acute problem is, in fact, even more acute, and that by 1970 there will be something like 100 million more people in the world than had previously been expected: 100 million more people to provide for.

The development of food production also seems to be depressing. During the 1950's food production has increased about 30 per cent in Latin America and 20 per cent in Africa, but by per capita it is almost exactly the same; in the Far East there has been an increase of 15 to 20 per cent, calculated on a per capita basis. Even so, the food standard is not above the level of the 1930's.

Another aspect of the same problem came up at the United Nations Conference: at present the developed countries have an average income that is eight times greater than the developing countries. By 1980, it will be, not eight, but twelve times as large.

It is not that these problems have been overlooked. On the contrary, they have been the subject of close attention and extensive discussions in the United Nations and its organizations, in the developed and developing countries, and also in the international scientific organizations. No ultimate solutions have been discovered, however, and there is still a great deal to be done in the planning and organization of international aid.

A major problem is how to allot the available and limited resources between immediate technical aid based on existing knowledge on the one hand, and long-term research and development of new methods on the other. Let me say at once that there can be no doubt whatsoever that immediate extensive aid is essential and that if this is reduced or cut off the results will be

catastrophic. This dilemma will always be met when a programme of assistance is started, and there is no way out of it. In Sweden, as in many other countries, in which a special board has been formed to administer development assistance, the desire to give maximal assistance immediately competes with the need to make the greatest possible contributions for long-term research and development, and no plan for organizing participation of scientists has yet been drawn up. But, in this as in so many cases, it is not possible to choose only one approach. Efforts for immediate relief are certainly necessary, but the developing countries must be enabled to take advantage of science and research. A sizeable part of the available resources must be used to this end—even though such a decision may be difficult to reach.

Microbiology and its applications is the subject of this conference, but these other problems should also be taken up in order that research work and the interest of scientists may be enlisted in grappling with world problems. How, for instance, can development work in fields such as microbiology best be organized and how can individual countries best contribute. The research workers themselves should be heard in this matter and now is a good opportunity, since this is the first conference for scientists to have been organized since the United Nations Conference in Geneva.

What is needed are proposals for working out a research programme that covers all the essential fields and also includes the problems besetting the different countries. This is not, of course, the proper forum for producing such a programme. On the other hand, a conference should be able to produce the basic material which can then be entrusted to a smaller committee. Discussions in both UNESCO and OECD bear witness to the interest in such a research programme; work of this sort is also relevant to the International Biological Programme and to Japan's recent demand for an international survey on current microbiological questions, which initiated the activity in UNESCO.

National institutions could apply this programme in planning their projects, and regular conferences on the lines of this one could be held to coordinate and report on the work in hand.

This conference is being held at a time when much is expected of microbiology. Our science has advanced far, but our knowledge has not yet been fully exploited by industry. The time should now be ripe for a new period in which the results of microbiological research are broadcast and used and I hope that this conference will be able to contribute to this end.

In this way, scientists could really be given a chance to assist in designing the pattern of development aid. A suitable medium for stimulating scientific and technical participation might be meetings of this type. To arrange such meetings might be a way for different institutions and organizations to contribute to development aid, and the Royal Swedish Academy of Engineering Sciences has certainly appreciated being able to participate in the preparation of this conference.

If, however, the working programme and subsequent results are to benefit the developing countries, it is essential that these countries participate in the work. It is indeed a pity that they have so few delegates at this conference, and it serves to underline the importance of maintaining contact if the results of research are to be properly harnessed.

This applies, of course, not only to conferences but also to the use of

grants for the training of scientists and for the financing of study trips and other forms of international exchange. We must also learn to anticipate and to plan the setting up of institutes in developing countries so as to ensure independent research, development, and training.

No definite proposals have been made for tackling these questions, nor should there be any call for them at this stage. Yet, even though these questions of organization and planning are not explicitly included in our programme, they are nevertheless relevant to every concrete proposal regarding microbiology and the livelihood of the world's population. They must be answered before the technical solutions can be applied.

They should therefore be discussed among us so that on the final day of the conference, we shall be able to make a more definite statement. Naturally, the planning aspects should be relevant to the field of microbiology; at the same time I hope there will be proposals and decisions which will be of value in other spheres of activity with the same aim: to relieve the hunger and want in the world.

III

S. MUDD

This conference on "Global Aspects of Applied Microbiology" is symptomatic of the new age in which we are living, and is an early step toward adjusting to that age. For the necessities of our lives have not outgrown our traditional loyalties. The fundamental necessities under which our species has evolved have been loyalties to the survival group into which we have been born: family, clan, tribe, city-state, nation, empire, religious institution. As individuals we have learned loyalty to our families, our schools, our countries. But now we find ourselves, ill-prepared, in a world of instantaneous communication, jet propulsion, and the possibilities of creation of new values or of destruction of all values, for which there is no precedent in all history or experience. As Dr. Brock Chisholm has pointed out so cogently, the survival group has become mankind as a whole, the human species. And for this our minds and our consciences have no traditional preparation. We are on our own in a strange world of terrible risks and also of glowing possibilities.

It is entirely appropriate that this conference should have been organized in Sweden. For the Scandinavian peoples, whose Viking ancestors were not always entirely peaceful, in later times have had a most remarkable record of peaceful cooperation. In the other great crisis of our time, the disturbed equilibrium between population growth and natural resources, Sweden has also exerted a fine leadership. The Swedish government is the only one that so far has dedicated a considerable portion of its foreign aid toward the population problem. This basic problem cannot be solved in haste, and meanwhile the peoples must be fed, clothed, housed, trained, and educated.

This conference will, of course, acquire meaningfulness through the participation of all who have come to share in it, as well as through the contributions of those on the formal program. The seeds sown here, we may hope, will bring forth fruit in many distant lands, as all of us return to our own countries. It is particularly gratifying also that the International Association

of Microbiological Societies and the World Academy of Art and Science have united their efforts in this auspicious endeavor.

Exploration of the possibilities of applied microbiology on a global scale is certainly one of the necessary steps in better conservation, utilization, and development of world resources. The Swedish government, the Section on Economic and Applied Microbiology, the Royal Swedish Academy of Engineering Sciences, and all who have made this conference possible certainly deserve our grateful acknowledgement and thanks.

I

Some philosophies of applied microbiology