Microbiology and the Developing Areas

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Global Impacts of Applied Microbiology (Almquist and Wiksell, Stockholm; Wiley, New York, 1965. 586 pp., $15) contains the proceedings of an international conference, held in Stockholm from 29 July to 3 August 1963, sponsored and financed by a number of national and international organizations, and attended by about 350 specialists in various disciplines from some 30 countries. The main purpose of the conference was to "focus upon microbiology as applied to the solution of problems relating to developing areas." An extensive summary, by Carl-Göran Hedén, chairman of the Organizing Committees, and Mortimer P. Starr, editor of this volume, has been published in *Advances of Applied Microbiology* (**6**, pp. 1 to 24, 1964), to which the reader of this review may refer for particulars.

In his opening remarks Tiselius characterized the conference as "another expression of the feeling of responsibility among scientists toward the world situation and especially toward all the suffering of which we are increasingly aware." It is understandable that many of the authors stress the growing imbalance between population and adequate nutrition as a major cause of this suffering, and view the application of diverse microbiological processes as a promising means of ameliorating the grim prospects. Meat, fish, and other proteinaceous materials can now be preserved by ensilaging, following the addition of cheap carbohydrates which ensures the rapid development of lactic acid bacteria (Nilsson and Rydin, this volume, pp. 358 to 362); the nutritional value of foodstuffs deficient in some amino acids can be upgraded through microbial action; and abundant but non-nutrient materials, such as cellulose, petroleum, and waste products, can be converted into microbial cells, which can be used either directly or indirectly as human food. Borgstrom even envisages that "the mounting waste heaps that follow in the wake of growing urbanization offer the opportunity for breaking the tyranny of seasonal production by shortening growth cycles to periods of less than a year, through the recycling of their organic matter. The sewage plants are therefore the future food-producing centers in which algae, fungi, and bacteria are the chief livestock, possibly supplemented by insects, fish, ducks, and other animals which may be more controllable" (p. 162). Such a development would also aid enormously in solving some of the problems caused by the frightening pollution of natural resources; Baalsrud and Ormerod conclude their report on water microbiology: "Insofar as this conference directs its efforts toward increased food production, of course the water—however pure and tasty—has not much to offer in terms of calories! But if the goal is a world of healthy and wealthy people, we, in Working Group VI, consider that applied water microbiology is a most important field. Not only is water considered to be nutritional element number one, but pollution of this natural resource is a threat to civilization" (p. 269).

The technical papers comprise the summary reports of nine working groups and many individual contributions, covering a wide range of topics: documentation and retrieval of information, taxonomy and legal aspects of industrially important microbes, food and agricultural microbiology, microbial genetics, enzyme production, immunology, insect control, and bioengineering. On the whole, the papers are well written and informative. Some, like Werner Braun's excellent survey of microbial genetics (pp. 74 to 92), present important new results, while others contain sound criticism of current practices or develop new ideas. For example, Katznelson, in "The role of microbes in agricultural practice" (pp. 201 to 217), rightly questions the significance of isolating and growing particular microorganisms for the purpose of adding them to soil. Since this is their natural habitat, he asks: "Can they not do the same things in the soil as after soil or seed inoculation?" He continues with this comment: "They probably can and do to a greater or lesser degree provided they are furnished with food and energy in the form of organic matter" (p. 214). Hence he advocates modifying the soil environment by such additives as would bring about the natural development of a desirable microflora. I find L. L. Ingraham's "Microbes as organic chemists" (pp. 369 to 381) exciting because of his, to me novel, approach to enzyme chemistry.

Microbiological transformations of steroids are dealt with in four different papers (pp. 298 to 306, 409 to 412, 421 to 438, and 439 to 448); the redundancy seems the more striking because the treatment in each case is strictly empirical and covers information that has long been available.

Due attention is paid to the problems inherent in attempts to introduce industrial microbiology in developing countries. Three aspects are commented on in several places, most clearly and concisely in Gaden's paper "Process and equipment design for less-developed areas" (pp. 338 to 343). The first is the need to consider the availability of raw materials: "Raw materials which perform excellently in the laboratory and are attractive in every way simply cannot be gathered in one place and in amounts and regularity adequate for plant operation" (p. 342). Next is the replacement of the highly developed apparatus used in industrialized countries by simple equipment, especially because the capital required for initial investment in machinery is not available, and labor costs are of a very different order of magnitude. Finally it is urged that full advantage be taken of local talent, with the encouraging remark: "Too often engineers from the 'developed' areas make the assumption that they alone can contribute good technical ideas. American engineers working in Latin America who have been reasonably sensitive to the aspirations and feelings of their local colleagues, have found them to

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be clever and imaginative problem solvers. There is a clear economic incentive in offering the local engineer a real partnership in the technical effort, over and above the personal satisfaction and personal values which accrue" (p. 343).

But, as Gaden also writes, "Perhaps the greatest difficulty will be psychological, not technical." As long as the meaning of science is not understood, and human attitudes and activities are governed by irrational beliefs, little advance can be expected. And this is why I consider the inclusion of papers such as those by Eban, Birkeland, Myrdal, Foster, Mrak, and Mudd as perhaps the most valuable part of the book. They present a clear and compelling picture of the nature and significance of science, which I should like to illustrate by quoting at some length from the masterly article "Science and politics" (pp. 28 to 37) by Abba Eban, then Deputy Prime Minister of Israel.

"A society in which scientific truth is held in respect must be, or must ultimately become, a free society. Scientific empiricism cannot be reconciled with social dogmatism. On the one hand, scientific enquiry needs more and more help from governments. On the other hand, there is danger in the situation in which a growing proportion of research is officially directed, especially if it is directed for military ends.

"Statesmen must somehow be inhibited in their tendency to demand what are called 'practical results' from scientific research. When governments support scientific research in the hope of receiving economic or military results, they are doing the right thing for the wrong reasons. Science should be fostered primarily for its humanizing influence, for its emphasis on reason and order and truth, for its caution in relation to unproved assumptions, for its experimental audacity, and for its respect towards the mystery of nature. . . .

"But the investment in science must be initially disinterested. Creativity cannot be commanded by governmental order any more than a government can, by the allocation of huge funds, decree that Hamlet or the Book of Job shall be written on its soil.

"As the scientific community within each state and across the world grows more numerous and more influential, the insistence on conditions for free uninhibited thought will grow stronger, and the allurements of authoritarian government will decrease. This, I think, is the ultimate social and political effect of a diffusion of scientific knowledge. The evidence of history is strong, that those societies are most creative and progressive which safeguard the expression of new ideas. Skepticism and dissent, which are the essence of science, are also the heart of political freedom. . . .

"Therefore, an understanding of scientific method and of scientific history is an indispensable part of any liberal education. This involves new thinking on traditional concepts of educational method and curriculum. Access to the world of scientific ideas is no longer the prerogative or the burden of a specialized elite, it is for the great mass of people. It is the first condition of creative citizenship, of economic productivity, of political consciousness, of technical capacity, and of social understanding. . . . Even for elected politicians, a discreet measure of literacy is no longer regarded as an insuperable handicap. And literacy today includes an affirmative understanding of scientific ideas and their social effects. These ideas can no longer be excluded from the humanistic curriculum. . . .

"In many respects, all nations are similar. But it is that diversity, in which each nation finds something specific and distinctive in itself, which may constitute its main contribution to the universal treasurehouse of culture. The need, however, is strong and urgent to reconcile cultural diversity with a broad, universal solidarity. And it is here that I must conclude with a politician's ultimate tribute to the scientist: You have achieved what is remote from us, the basis of a universal community of thought and action, respecting national differences, but also transcending them. The easy flow of discourse, the conceptual affinity, the unspoken sense of fraternity, which pervade the scientific world, may perhaps be the heralds of our highest ambition, to establish a family of nations, bound together in a covenant of freedom and peace" (pp. 34 to 37).

Along with Stuart Mudd's comment that "the necessities of mankind, in this age of nuclear warfare and of explosive population growth, have outgrown our ancient loyalties. The dangers, the maladjustments, the solutions sought relate to mankind, not only to this or that segment of mankind. The unit of survival has truly become the human species" (p. 471); these ideas might profitably be pondered by those who are responsible for making policy decisions which, alas, are all too often based on considerations that show an unfortunate lack of understanding of the scientific enterprise.

Experimental Flame Research

Flame Structure. R. M. Fristrom and A. A. Westenberg. McGraw-Hill, New York, 1965. xiv + 424 pp. Illus. $17.50.

The authors, who are on the staff of the Johns Hopkins Applied Physics Laboratory, have been in the forefront of experimental flame research for more than a decade. This book is a scholarly and well-organized summation of their own techniques and results, already more or less familiar to their co-workers in the field through their many publications and lectures, integrated with closely related work by others, and made intelligible to nonspecialists by the provision of background material.

In its chosen primary area of coverage, the microstructure of stabilized, laminar, premixed, hydrocarbon-oxygen flames, this is easily the most comprehensive treatment available. The minutely detailed descriptions of experimental techniques and methods of data analysis, the many carefully prepared figures and tables, and the compilation of some 500 references to the literature deserve favorable mention.

However, it is necessary to add a warning for the benefit of those readers who seek detailed coverage of flame structure other than coverage of one-dimensional, laminar, premixed, gaseous flames. Detonations, turbulent flames, cellular flames, cool flames, dust flames, droplet flames, soot-forming flames, metal flames, solid propellant flames, diffusion flames, monopropellant liquid-strand flames, and the like are either superficially mentioned or completely ignored. The authors clearly prefer, in their choice of experimental work and in their writing, to exhaustively treat a single important phenomenon rather than to become involved with every type of flame which may occur in practical situations. Their success in clarifying understanding of funda-