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CONTENTS

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THE SOCIAL SCIENCES AS A FACTOR IN INTERNATIONAL COLLABORATION

IT is a feature of the reviews of the year's work of the Rockefeller Foundation which its president, Mr. Raymond B. Fosdick, is accustomed to give, that they provide not merely a picture of the activities of the Foundation but also of the fundamental needs and problems in the intellectual as well as the physical life of mankind that the Foundation is trying to serve or to solve. In this way these reviews have come to possess a value for assessing the importance or significance of trends in the scientific world or in the activities of other organisations that is almost unique. The review for 1946 admirably illustrates this characteristic, and will be read with interest and profit by those interested in the new World Health Organisation established under the United Nations, the development of the social sciences, the fostering of understanding between the West and the East, or the promotion of that full intercourse of minds in every field of intellectual effort upon which the advancement of knowledge depends.

The Foundation has made concrete contributions in all these fields during the year. Grants to the social sciences totalled 2,633,677 dollars, covering four primary fields. Those in the first field, of international relations, went to bodies conducting research and education designed to strengthen the foundations for a more enlightened public opinion and more consistent public policies; they included one to the Food Research Institute, Stanford University, for the preparation of a history and appraisal of the world's experience in handling food and agriculture during the War, and two grants dealing with the question of the social implications of atomic power. In the second field, of economic research, grants were made to the Economics Research Section, University of Manchester, the Department of Applied Economics, University of Cambridge, and the Institute of Economics, University of Oslo. In the third field, four or five modest grants were made in support of studies in the functioning of American political democracy; while in the fourth field, of research and training agencies, 216,000 dollars were voted to the Social Science Research Council, the Canadian Social Science Research Council and Johns Hopkins University. A final grant of 250,000 dollars was made for the erection of the giant 200-inch telescope on Mount Palomar in California, making a total appropriation of 6,250,000 dollars to the California Institute of Technology for this purpose.

Announcement of these grants, however, is not the most impressive feature of Dr. Fosdick's review. It is when he goes on to ask what is the justification for this huge expenditure of money and effort, and to discuss the implications of the unconquerable exploring urge within the mind of man, that Dr. Fosdick touches on the fundamental issues. He does not deny that knowledge is dangerous, but he insists that the answer does not lie in trying to curb science or to fix boundaries beyond which intellectual adventure

should not be allowed to go. The search for truth, he maintains, is, as it always has been, the noblest expression of the human spirit. Man's hunger for knowledge about himself, his environment and the forces by which he is surrounded, gives human life its meaning and purpose, and clothes it with final dignity. Civilization is not being betrayed by science: the danger lies in the failure to use science wisely.

This is the point of view which has prompted the Foundation to extend the support of the social sciences already noted. The lack of balance in research is admitted. Our knowledge of human behaviour and social relations is inadequate to give us the guidance we need through the rapid changes in our physical environment. The fundamental issue of our time is whether we can develop understanding and wisdom reliable enough to serve as a chart in working out the problems of human relations, or whether our lopsided progress will be allowed to develop to a point that capsizes our civilization in a catastrophe of immeasurable proportions.

What is needed, Dr. Fosdick continues, is a broader basis of research, a more vigorous backing of objective and competent efforts to define and analyse the intricacies of human relationships. We need to know what our social organisation is, how it operates, and how it will react to alterations and changes. In our interdependent society, issues are no longer simple, individual and local; they are complex, social and world-wide. Our real need is a mastery not of Nature but of man's social nature, and of the social consequences of physical and mechanical advances which are shaping our lives to undesired ends.

An encouraging feature in the situation is the increasing recognition of the importance of the social services, even although it has yet to secure the necessary expansion of effort in this field. Like the Clapham Report, Dr. Fosdick insists on the importance here of disciplined minds and the high integrity of objective scholarship. We must secure a continuous flow of first-class talent into these fields, for the standard of research will depend on the quality of the men just as much as it does in the physical sciences.

But while the Rockefeller Foundation concerns itself both with the endowment of research in specific fields and with the training of men, it is equally concerned with the conditions which make research fruitful, and the appropriations of the Foundation have been distributed internationally with the purpose of breaking down the isolation and intellectual stagnation which war brings. The flow of ideas across boundary lines, the free exchange of periodicals and books, and the cross-fertilization of minds working in the same scientific and cultural fields—the interruption of these are among the tragic losses of war the magnitude of which Dr. Fosdick rightly points out is impossible to assess. We shall never know the advances which might have occurred had there been contact during these years between the biologists, the biochemists, the physiologists and mathematicians of the United States and a dozen Western European countries, or if, for example, the energy and knowledge and unselfish co-operation which were devoted to making the atomic bomb had been applied instead to some of the great basic problems of biology and medicine.

It is implicit in Dr. Fosdick's review that war interrupts and hinders the advance of science; but the review shows unmistakably the determined effort the Foundation has made to assist the resumption of research and to link up the intellectual life of Europe with that of the rest of the world. Europe is still perhaps the world's greatest power-house in terms of brains and skill, of human values and creative talent, and the grants made by the Foundation in its chief divisions—natural sciences, medical sciences, humanities, social sciences—have been designed to provide equipment and support for universities, libraries and research centres as well as to create methods of communication by which such institutions can re-establish contacts with each other and with the rest of the world, as, for example, through a series of international conferences in such fields as chemical genetics, protein structure, enzyme chemistry and cellular physiology. Into this international stream it is important to bring Russian scientific thought, and a grant has been made for that specific purpose.

Dr. Fosdick does not claim that the Foundation has been able to do more than make a very modest contribution towards the initiation of efforts to solve the great problems which Europe's intellectual needs present, and he looks very plainly to the United Nations Educational, Scientific and Cultural Organisation for the major contribution in this field. If, as Prof. L. A. Du Bridge urged in an address to the Society of the Sigma Xi and since published in *The American Scientist*, the fundamental problem is to turn the great resources of science into the paths of peace, that problem can never be solved by one country alone. Prof. Du Bridge puts the freedom of science first in his programme, and insists that no measures for extending the training of scientific workers, educating the public as to what science could contribute to the welfare of mankind, and expanding and improving the resources for research in pure and applied science, must impair that freedom; and he recognizes that fundamentally the problem of science is not national but international. Science must be applied to the specific problems of human adjustment, and the conduct of affairs be guided by the scientific method of critical examination and evaluation of actual experience rather than by raw emotion, vested authority, or prejudice, not just in one nation, but in the relations of nations with one another.

No durable world order can be established until we approach this condition, and the real hope of the Educational, Scientific and Cultural Organisation of the United Nations lies in the contribution which its work can make to that end. Therein, perhaps, is the importance of the project for the creation of the International Institute of the Hylean Amazon, now to be examined by an international scientific commission The field work of the three scientific investigators who are going to Brazil for this purpose will constitute the first international co-operative scientific effort in a gigantic forest area, the natural resources of which, from the scientific point of view, are virtually unexplored. The proposed Institute will study the

botanical, zoological, chemical, geological, meteorological, anthropological and medical facets of this area and also its potentialities as a habitat of non-indigenous peoples.

It is no disparagement of the three major projects already approved by the Executive Board of the United Nations Educational, Scientific and Cultural Organisation for 1947—an educational reconstruction programme on behalf of devastated member countries; a campaign for the spread of fundamental education; and the promotion of international understanding, primarily in education—to suggest that such projects as this for the Amazon basin are of outstanding importance. The demonstration in such ways of the practical contribution of science to human welfare is one of the most valuable factors in the task of educating public opinion in all countries as to the place and value of the scientific approach. It may be that the way towards world order is through the slow growth of a series of social experiments on the lines of the Tennessee Valley Authority, with its demonstration of the possibilities and effectiveness of co-operation between the expert and the ordinary citizen. But while such experiments lie outside the field of the United Nations Educational, Scientific and Cultural Organisation, that Organisation can still do much to prepare the way and to promote the conditions of success. Nor should it be forgotten that the pursuit of science for its cultural value remains worthy of man's best effort.

Science, indeed, has a contribution to make to the cultural and moral equipment of mankind as important as that of any body of literature or art. Indeed, from the point of view of world order, the contribution of science is unique. Alone of man's major intellectual interests, science has no frontiers and no national varieties; like peace, science is one and indivisible. Dr. Fosdick's review in the annual report of the Rockefeller Foundation demonstrates admirably how science can help, unobtrusively but persistently, in the task, not merely of repairing the havoc of war and ameliorating man's material life, but also of promoting a wider understanding of human affairs, human values and motives. Upon these factors may some day be firmly based a true science of social living and a world order in which man's cultural and spiritual needs no less than his material wants find ample satisfaction.

KINETICS OF BACTERIAL GROWTH

The Chemical Kinetics of the Bacterial Cell

By Prof. C. N. Hinshelwood. Pp. x + 284. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 20*s*. net.

THIS book is not a treatise or a monograph. It is an essay, in which the author has expanded the main ideas which led to his own and his group's important work on the kinetics of bacterial growth. Actually this essay has one major theme on which attention is constantly focused: the cause and mechanism of 'adaptive' variation of enzymatic properties in the bacterial cell. Indeed, the importance of the problem could scarcely be overstated, since a clear understanding of these phenomena, as they occur in bacterial cells, might throw light on basic problems in other fields of biology, such as genetics and embryology.

A large body of interesting experimental results, mostly from the author's own laboratory, has been condensed in the book, the greater part of which is concerned with the acquirement and loss of the capacity to resist drug action, or with using new sources of carbon and nitrogen. This will no doubt prove very useful for future reference.

The main object of the theoretical discussions is to see whether, and to what extent, these experimental data may be interpreted in terms of rather simple models of linked enzymatic reactions, that is, whether various types of change of properties may be considered as resulting from an 'automatic response' to a new environment. Practically all the discussions and mathematical treatment of the data are based upon one fundamental assumption, which is that each individual metabolic reaction may be represented by an equation of the type:

enzyme + substrate = more enzyme + products.

Now, the exact meaning of this equation is not altogether clear, at least at first sight, and to realize all the implications of such an assumption requires, and merits, a good deal of thought. Assuming that all the enzymes of a cell are autosynthetic structures seems to be a very bold step indeed. The fact that bacteria do grow, generally, when supplied with the necessary foodstuffs does not seem to be quite enough to justify it. It might be regretted that such an essential point should not be discussed at length, and that no *direct* experimental evidence in favour of it should be presented. (Although, in the reviewer's belief, some such evidence seems to exist, at least in a limited number of cases[1].)

However, once this postulate is accepted, interesting conclusions follow, and it is shown that the behaviour of bacterial populations submitted to new or adverse conditions can be understood as resulting from automatic adjustments of the 'enzyme balance' within each cell. The experimental data leave little doubt that this view must be essentially correct in many cases. In others, however, the evidence is far less convincing. For example, it is shown, on theoretical grounds, that prolonged 'adaptation' may conceivably lead to an *irreversible* stabilization of the new condition. This is a highly important point, as it raises the question whether such changes would be reflected in the bacterial 'genome' the existence of which seems more and more certain. Experimental proof of this point, unfortunately, appears rather doubtful, since the results might be explained just as well (sometimes much better) through the action of selection on spontaneously arising mutants.

True, the occurrence of spontaneous mutations and the importance of selection as factors of bacterial variability are discussed at some length, the general conclusion being that it seems more 'profitable' and less 'arbitrary' to consider most changes as resulting primarily from adaptive reactions, rather than from spontaneous mutations. This type of discussion is not very convincing, however. It might be argued that the 'autosynthetic enzyme' hypothesis also appears somewhat arbitrary, and that the mutation hypothesis has actually proved highly profitable in a number of important recent contributions (such as Lwoff and Audureau's work on *Moraxella*[2], Luria and Delbruck's[3], and Demerec and Fano's[4] papers