BOOK REVIEWS

POLICIES FOR SCIENCE

Criteria for Scientific Development

Public Policy and National Goals. Edited by Edward Shils. (A Selection of Articles from *Minerva*.) Pp. xvi+207. (MIT Press: Cambridge, Mass., and London, 1968.) n.p.

THIS selection of fifteen articles published between 1962 and 1967 in the journal *Minerva* provides a rather interesting cross-section of views on some of the more controversial aspects of science policy. The search for logically justifiable criteria which might be used by science administrators and governments in planning the future development of science provides a connecting link between the first ten essays, which are arranged in chronological order and in which the later contributions frequently contain criticism and comment on some of the earlier ones. Of the remaining five articles, four deal with the problems of science in underdeveloped countries, while the fifth, by M. Polanyi on "The Growth of Science in Society", is of a more philosophical nature.

The first four articles range in outlook from one extreme expressed by Polanyi in saying that "the aspiration of guiding the progress of science into socially beneficent channels is impossible and nonsensical" to the other by C. F. Carter, who believes that "if we do not have an economic policy about the distribution of scientific resources, we are unlikely to have any policy at all". In between come A. M. Weinberg with a well-argued case that criteria for scientific choice can be identified (and he proceeds to enumerate several "internal" and "external" criteria) and John Maddox, who has great faith in leaving all the decisions to the scientists because to him "it is apparent that the essential need is the exercise of scientific judgement, similar in every way to the judgement involved in the decisions which must be made on the conduct of individual experiments".

Next comes Stephen Toulmin on "The Complexity of Scientific Choice: a Stocktaking" in which he first reviews the preceding four articles. He criticizes very strongly the views of Polanyi and Maddox that the scientists or ad hoc (Royal Society) committees should be the sole judges in arriving at balanced judgements about scientific priorities; then, having brushed aside Weinberg's essay as "adding some important refinements to a similar general view" (that is, that of Maddox), he proceeds to develop his own view that "there is no single problem of scientific choice" and that, unless some administrative context is specified, there is inevitably "a plurality both of criteria of choice and of orders of merit". In order to avoid "measuring the merit of incommensurable scientific fields" (for example, space research against cancer research) he is led to the American system of departmental responsibility for a lot of separate budgets each appropriate for the science required to carry out the mission of that department, be it cancer research for the Department of Health or basic research in any field for the National Science Foundation. The final decisions between these budgets are then transferred to the President and his Cabinet, advised by the President's Science Advisory Committee (PSAC) and the Office of Science and Technology (OST). Although he does not say so explicitly, Toulmin has merely made the decision between incommensurables a *political* decision of the Cabinet instead of

an administrative scientific decision by a non-political group of experts on the scientific, economic and other consequences of that decision. How the politicians should make such a decision and what should be their criteria is not mentioned, for the functions of the PSAC and OST are as he says "not to supplant the ultimate political decisions but merely to make them better informed". In this respect, Weinberg seems to me to face up to problems which Toulmin eludes by passing them over to the politicians.

Three subsequent articles by Weinberg, Toulmin and Simon Rottenberg are concerned almost entirely with one special aspect of the priorities problem, that is, what Rottenberg calls "the warrants for basic research". Briefly, Weinberg concludes that it is neither practicable nor desirable to justify the budget for basic research as though the latter were a branch of high culture and prefers to regard the budget for "pure science" (which excludes "mission-related basic research") as an overhead charge on the entire technological system. He omits mention of any percentage figure for this overhead. Toulmin rejects this idea and would justify the expenditure on pure science as expenditure on "a tertiary industry" which provides employment but is completely non-productive in the traditional economic sense. Rottenberg makes the most thorough analysis of the logic underlying the various justifications for expenditure on "pure science" and comes to the conclusion that society seems to justify the expenditure of public money on pure science partly as an investment (in the hope of a future economic return) and partly as a necessary element of a high civilization.

On the complementary problem of the relation between expenditure on research and development and economic growth, there is a most useful contribution by B. R. Williams. He shows that there is no inherent virtue in spending a high percentage of the gross national product on research and development and that there is no general quantitative relation between what a country spends on R and D and its economic growth. The extent to which certain technologies should be imported rather than home grown can be a very important factor in determining the rate of economic growth, and he concludes that no country can afford to cover the whole field of industrial research and development.

The essays on science in the underdeveloped countries are by S. Dedijer, M. J. Moravcsik (two) and A. Salam. All of them emphasize the formidable problems which must be overcome to create vigorous and productive scientific communities in such countries in less than twenty-five years. Dedijer I found to be especially pessimistic, but Moravcsik and Salam put forward a number of practical and sensible proposals, the implementation of which would surely accelerate a transformation which, alas, is generally taking place far too slowly.

Such a highly condensed summary of some of the main ideas put forward by so many authors does not do justice to them. This would require at least a sixteenth article, and anyone seriously interested in science policy is strongly advised to read these essays, not only for their intrinsic merit, but also because he will be guided to much of the relevant literature through the excellent documentation provided by most of the authors.

GORDON SUTHERLAND

ICE AGES AND OVERKILL

Quaternary Paleoeecology

Edited by E. J. Cushing and H. E. Wright, jun. (Vol. 7 of the Proceedings of the VII Congress of the International Association for Quaternary Research, sponsored by the National Academy of Sciences, National Research Council.) Pp. vii+433. (Yale University Press: New Haven and London, 1967.) 135s.