

NATURE

No. 4122 SATURDAY, OCTOBER 30, 1948 Vol. 162

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Editorial and Publishing Offices

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number : Whitehall 8831

Telegrams : Phusis Lesquare London

Advertisements should be addressed to

T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2

Telephone : Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, inland or abroad

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SCIENTIFIC RESEARCH AND MAN-POWER IN THE UNITED STATES

ALTHOUGH the two earlier reports on "Research—A National Resource", covering both the "Relation of the Federal Government to Research" and "Industrial Research", not to mention the more recent report from Dr. Vannevar Bush, "Science—the Endless Frontier", have to some extent prepared the British reader to appreciate the scale of the research effort in the United States—an effort in which it is estimated that 137,000 scientific workers were engaged in 1946–47, some 30,000 of them in government laboratories—it is not easy to convey a concise picture of the scope of the five reports which Mr. J. R. Steelman, chairman of the President's Scientific Research Board, has presented under the general title "Science and Public Policy"*. The White Paper on "Scientific Research and Development" issued in Britain is too slight to be comparable; possibly Sir John Anderson's descriptive survey of government organisation for research in his Messel Memorial Lecture last July is a more useful comparative outline of British activities. From the critical point of view, the penetrating analysis of expenditure on research and development contained in the third report of the Select Committee on Estimates for the session 1946–47 makes that report the appropriate British document to set beside the Steelman reports, although the latter also contain features in common with the White Paper on the Scientific Civil Service and with the report of the Barlow Committee on Scientific Man-power. However, nothing of quite the same scope and nothing comparable in scale has yet been published in Britain, although it is equally true that the whole subject has been discussed very thoroughly and fully as intensively, if not as quantitatively, in books and reports from both public and private sources as well as in Parliament.

The first of these volumes, entitled "A Program for the Nation", sketches the position of the United States in scientific research and development, comparing expenditure in 1930 and in 1945, and presents a budget for the future as well as discussing the limiting factor of man-power. After considering questions of personnel and the Federal organisation, it details recommendations for action by the Federal Government to meet the challenge of science and assure the maximum benefit to the nation. In the second volume, "The Federal Research Program", details of the Government's programme for research and development are analysed. The bulk of this volume consists of statements from the individual departments or agencies, indicating the range of work and its organisation; and among the appendixes is a useful note on definitions of research.

* Science and Public Policy. Vol. 1: A Program for the Nation. A Report to the President by John R. Steelman. Pp. x+73. 20 cents. Vol. 2: The Federal Research Program. By John R. Steelman. Pp. viii+318. 55 cents. Vol. 3: Administration and Research. By John R. Steelman. Pp. viii+324. 55 cents. Vol. 4: Manpower for Research. By John R. Steelman. Pp. viii+166. 55 cents. Vol. 5: The Nation's Medical Research. By John R. Steelman. Pp. x+118. 25 cents. (Washington, D.C.: Government Printing Office, 1947.)

The third volume, "Administration and Research", is concerned with the administrative problems that arise in the departments, bureaux and laboratories in executing the Government's programme, more particularly that part conducted in the Government's own laboratories. Questions of control and scientific freedom, the planning and evaluation of research activities, the 'climate' for research, and the methods of financing government research are discussed here, and recommendations for changes are made. In the fourth report, "Manpower for Research", the shortage of scientific workers and the implications of that shortage are discussed, including changes in distribution and their causes, and the action required for training more of them. The final report, "The Nation's Medical Research", discusses, first, the general problems of medical research, and next the Federal programme and its particular problems, indicating the content and distribution of research projects and describing the existing agencies and facilities for medical research.

Even this comprehensive survey, however, is not quite complete. In the first place, the social sciences are excluded, although some projects were examined in which both physical and social scientists were working. In the second place, the research programmes of the War and Navy Departments, apart from their medical programmes, were only examined very generally, because the Research and Development Board is making a detailed study of these programmes. Again, the delays in establishing the Atomic Energy Commission made impossible a detailed examination of the research programme of that Commission at the present time, apart from questions of national security. Nevertheless, sufficient investigations were made to judge the relation of these programmes to the scientific effort of the Government of the United States as a whole, and to provide a basis for administrative recommendations.

The first of these five reports is of the most general interest, to some extent summarizing the remaining four and detailing the general recommendations of the Scientific Research Board; it is issued over the signature of its chairman, John R. Steelman. Moreover, side by side with the emphasis laid on research as the basis for an expanding economy and continued high levels of employment, as well as for progress in eliminating poverty and disease, there is in this report a remarkable emphasis laid on the importance of lending every possible aid to the re-establishment of scientific research and development in Europe. This emphasis is derived largely from the recognition that the strength of the United States has lain in the practical application of scientific principles rather than in original discoveries, and that further development must wait on the resumption of fundamental research which was everywhere largely in abeyance during the War.

The Steelman Report contends frankly that it is to the interest of the United States to make a maximum effort to restore the free exchange of ideas and the conditions of free international co-operation among men of science as it existed before the rise of totalitarian States, as well as to assist the recon-

struction of the devastated countries of Europe and Asia. Such self-interest is no reason for looking askance at American generosity; for it is equally to the national interest everywhere, as well as to that of the progress of science, to re-establish the conditions in which the advance of science and the cross-fertilization of minds can again proceed freely across national frontiers. As the report observes, the devastation of scientific work in Europe, the disruption of the normal international exchange of scientific knowledge and the suspension of fundamental work in important fields have altered every premise upon which our thinking about scientific research and development has been based.

This is the broad background against which the recommendations of the Steelman Reports have been framed, and it is clear that they have been influenced by very similar considerations to those which have determined policy in Great Britain, given the difference in emphasis and development between fundamental and applied research in Britain as compared with the United States. They recommend first that annual expenditure on research and development should be increased as rapidly as facilities and trained man-power can be expanded, so that, by 1957, at least one per cent of the national income, or more than 2,000 million dollars, is devoted to research and development in the universities and industry and by the Government. Greater emphasis should be placed on fundamental research and medical research; these expenditures should be quadrupled and tripled, respectively, in the next decade, while total research and development expenditure is doubled. Federal support of fundamental research in the universities and non-profit research institutions should be increased progressively to a level of at least 250 million dollars by 1957. These figures look almost astronomical beside the estimates for Government expenditure in Britain on research and development of about 76.5 million pounds, the distribution of which between fundamental and applied research and between civil and military research was reviewed by the Select Committee on Estimates in a report for the session 1946-47. The Steelman Report may well observe that with so much public money already being spent in furtherance of research and development, careful attention must necessarily be given to the manner in which it is spent; and while it is recognized that the limiting factor at present is trained man-power, a considerable amount of thought has been given to the way in which expenditure on research should be controlled and distributed.

This is, of course, the kernel of the debate during the last few years in the United States over a national science foundation. There appears to be little dissent from the view expressed in this report that at present too small a proportion of the total resources of the United States is devoted to fundamental research, to health and medicine, and of its development resources to non-military ends. The conflict of opinion occurs over the means by which the balance of the research and development programme is to be restored, and the manner in which Federal support should be given.

The Steelman Report expresses the emphatic opinion that the bulk of the expansion in fundamental research must be in the universities and colleges, and be financed by Federal funds. For this purpose it recommends the establishment within the Executive Office of the President of a 'National Science Foundation', headed by a director appointed by the President and assisted by a part-time advisory board of scientific men and educationists, similarly appointed, half of whom should be drawn from outside the government service, and half from within. No restrictions should be placed upon the fields of inquiry eligible for support, and part of the funds expended by the Foundation should be used to strengthen promising colleges and universities.

The establishment of a national science foundation is not, however, in the view of the Science Research Board, all that is required. Some overall picture of the allocations of research and development functions among the Federal agencies, and of the relative emphasis placed upon fields of research and development within the Federal Government, must be available. Provision should also be made for a central point of liaison among the major research agencies to secure the maximum interchange of information with respect to the content of research and development programmes, and with respect to administrative techniques. At a single point close to the President, it should be possible to bring into the discussion of high policy the most significant problems in the research and development programme of the nation as a whole.

The idea of establishing a department of science to handle these functions was rejected, after consultation with scientific men and administrators, no doubt for similar reasons to those which have led to the rejection of the idea of a Ministry of Science in Great Britain. The Steelman Report recommends instead that a Federal committee be established, composed of the directors of the principal Federal research establishments, to assist in the co-ordination and development of the Government's own research and development programme. In addition, the Bureau of the Budget should set up a unit for reviewing Federal scientific research and development programmes, and the President should designate a member of the White House staff for scientific liaison. (This interdepartmental committee and scientific liaison officer have since been appointed.) Moreover, one of the first tasks of the interdepartmental committee would be a full analysis of the relative advantages of contracts and grants as a means of supporting research, and a careful review of the advantages arising from, and the problems connected with, the establishment of research co-ordinating bodies within large Federal agencies.

As already noted, the Scientific Research Board recognizes that the limiting factor in the expansion of research or development facilities is at present man-power; and, besides suggesting that the Federal Government, without making direct grants to industry, should encourage the expansion of industrial research by taxation incentives and other recognized methods, the Board points out that any programme

of Federal assistance to the universities for research must be part of a broader programme of aid to higher education. Even a programme of scholarships or fellowships should not be established in the physical and biological sciences alone. The Board appears to lean to the support of fundamental research by grants rather than contract, and recommends that every Federal agency with major research responsibilities should have authority to make such grants, subject to the co-ordination by the suggested national science foundation. Furthermore, in time of peace, no secret or confidential research or development projects should, as a matter of policy, be placed with the universities; and the opinion of the Bush Report, "Science—the Endless Frontier", that complete freedom of inquiry must be preserved under any plan for government support of science is emphatically endorsed.

While the whole problem of university and college facilities was being examined independently by the President's Commission on Higher Education, the report of which has since been published, the Steelman Reports do not entirely pass by the question of university expansion. The section on "Manpower: the Limiting Resource", in this first report, points out that while between 1940 and 1947 United States expenditure on research and development increased by 335 per cent, the supply of trained man-power only increased by 35 per cent. It appears that the shortage of scientific man-power in the United States is even worse than in Britain, and particularly in the universities and colleges, where the urgently needed expansion of fundamental research is hampered, and there is danger that students will not receive the rigorous training required for such work. The report estimates that a further 15,000 instructors are required; but that there are enough students in the colleges and universities to double the supply of scientific workers within the next decade. Nevertheless, the balance in the research programme cannot be restored in the next year or two by expanding the programme for fundamental research or for non-military research and development without reducing expenditure on military or industrial research; and the Board, so far from being prepared to recommend such reduction, visualizes the possibility of having to increase research in the military sector.

On problems of personnel in science, the report says comparatively little, apart from stressing the importance of salary scales adequate to attract the ablest type of men, of associating the scientific worker with the formulation of policy, and of encouraging professional contacts. Appropriation by Congress of larger sums to enable scientific men in Federal service to travel to professional meetings is recommended, but the report is less searching in this respect than the Barlow report on scientific staff in Britain which was appended to the White Paper on "The Scientific Civil Service" in September 1945. The Select Committee on Estimates was also more penetrating in its report for the 1946-47 session already cited; but appended to the fourth volume of the series of Steelman Reports, "Manpower for Research", is a bibliography on scientific personnel,

not confined to American publications, which is of considerable interest. A more comprehensive bibliography on the administration of research is appended to the third volume of the series.

Despite, therefore, the impressive scale of research effort in the United States, both existing and prospective, study of the Steelman Reports does not suggest that, on the whole, Great Britain has much to learn from the United States as regards the organisation of research. Indeed, Britain is free from certain difficulties which the federal system involves, and while it is clear that in both countries the risks and limitations of planning research are fully appreciated, even the Steelman Committee does not appear to be quite sure as to the means to be adopted for the control and organisation of fundamental research. Distrust of government interference goes far deeper in the United States than in Britain; but in considering medical research, the Committee does raise the question whether medical research for the Services could be pooled, and recommends the creation in the United States of an advisory Medical Research Committee for the large-scale, long-range planning of a national medical research policy.

There is thus much that is of interest to British scientific men in these five volumes, and from the immense assembly of facts, data can be selected to support arguments in favour of particular policies or action in Great Britain. The comments on the manpower situation, and especially the facts and observations presented in the appendix to the fourth volume, "Manpower for Research", deserve careful study. When the Scientific Research Board appointed by the President of the United States takes such a wide view, and can still urge generous help towards the reconstruction of scientific institutions in Europe, it is worth remembering that the progress of science in Britain is equally dependent upon the re-establishment of a world community of science.

The Steelman Reports express the view that it is essential that the aid to be given to the research laboratories of Europe should be on terms which ensure the maximum contribution towards the restoration of pre-war conditions of the free exchange of scientific knowledge across national frontiers. The assistance contemplated is not limited to actual reconstruction; it includes encouragement for students from abroad to attend American universities and colleges, as well as the establishment of scientific missions abroad. The solidarity of British and American opinion in such matters as these, the clear recognition that, in the long run, science cannot flourish in the midst of a troubled world, the insistence on those cherished freedoms of expression and association which are the corner-stones of democracy, as they are conditions of scientific advance, are among the most welcome and outstanding features of these reports. For British readers they carry the corollary that our own efforts to foster international exchange of knowledge and understanding must be no less determined, positive and even sacrificial, in the hope that the two great democracies may work together for the good of the whole world.

PLANT LIFE IN BRITAIN

British Plant Life

By Dr. W. B. Turrill. (New Naturalist Series.) Pp. xvii + 315 + 72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 21s. net.

SO far as coloured illustrations are concerned, this most recent addition to the "New Naturalist" series is probably the most successful. They consist of fifty-three colour photographs by John Markham, Brian Perkins, F. Ballard and others. The close-up photographs of yew, black bryony and hawthorn in fruit and the ground pine in flower are excellent: that of the fleabane is not so good, the foliage being badly blurred and the flower-heads not very distinct. Moreover, the colour of the close-up of fritillaries has registered rather badly. Perhaps the most beautiful of all the plates is that of bluebells. Among the more distant views attention should be directed to that depicting heather in the fore- and middle-grounds with Scots pine in the background, and that depicting dandelions.

Great care has obviously been taken in the choice of black-and-white photographs by such well-known Nature photographers as John Markham, Eric Hosking, Brian Perkins, Robert Adam, Anne Jackson, etc.

Among the maps are one showing the botanical vice-counties of Great Britain and Ireland, and eight others illustrating the distribution of certain selected species of plant, from the hazel (*Coryllus avellana*), which necessitates shading the map of the entire islands, to the Cheddar pink (*Dianthus cæsius*), represented only by a small shaded patch in Somerset. (Is Cheddar deliberately spelt with a lower case 'c' on the map, following the strange modern craze? If so, then the same style should have been followed in the text on p. 54.)

The aforementioned characteristics of this book will have an immediate appeal to both amateur and professional botanist, for all are excellent. But there is much more in the book than this, namely, the text, written by one of Britain's leading authorities who is keeper of the Herbarium and Library at the Royal Botanic Gardens, Kew.

In no sense is the book a Flora; it is an erudite review of the wild vegetation made from those angles with which other research botanists have come to associate the name of Dr. W. B. Turrill.

Following an introductory chapter are four dealing with the vicissitudes to which the British flora has been subjected before attaining its present composition. From the origin of life itself we come to the beginnings of plant life, and are then led up to the very important changes induced during the Ice Age and the further changes which occurred during the Post-glacial Epoch. In the last-named, the most up-to-date methods of pollen analysis and the conclusions drawn from these studies are presented in a very clear manner.

In the review of the present position of the British flora we learn that there are about 1,500 seed-bearing plants, and a very useful list is given of 91 plant families together with the number of genera and species which constitute each, from Compositæ, containing 42 genera and 114 species, to families containing only one species, such as Cucurbitacæ—*Bryonia dioica* (white bryony); Loranthacæ—*Viscum album* (mistletoe), etc.

From then on, the author leads up, through geographical relationships, to an up-to-date study of