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Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

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Science and Leadership.

SOME instruction in science is now provided at most of the secondary schools in Great Britain. Such instruction, in the case of the boys' schools, usually takes the form of an introduction to chemistry and physics, while in girls' schools botany and chemistry are frequently the only branches of science taught. For various reasons, which have so often been the subject of reference in these columns that they need not be repeated now, those pupils who show any aptitude for science are mostly led for the last two years at school to tread the path of specialisation on their journey to the universities. They arrive at the universities embryo chemists, physicists, or botanists, where they are hatched out as full-fledged specialists destined to act as guides to others along the same narrow paths, or to apply their specialised knowledge to industry or in one or other of the public services. Only the comparatively few forsake the paths of specialisation and find scope in leadership and control for the exercise of the particular qualities of mind engendered by the study of science.

The demand for early specialisation in science is as vicious in principle and as harmful in its effects as the demand for any form of early vocational training for the children of the less favoured classes of the community. The revolt against the old-fashioned classical education was successful because the teaching of the classics had become so specialised that the main object of the study was obscured. It encouraged the worst forms of pedantry: it was de-humanised. There is abundant evidence that the teaching of science is suffering from the same disease. The spirit of science, the systematic observation of facts, the conception of hypotheses, to be discarded if they cannot be verified over a complete range of observations, or enunciated as universal if they stand such test, the constant challenge to established precedents and authority, is apt to be obscured by a mass of technical trivialities which passes for scholarship. The influence of scientific discovery upon man's outlook and activities is too often ignored by teachers of science. They incline to look at their several subjects from the inside, and thus not only lose sight of the unity of purpose of the whole range of scientific study, but also fail to appreciate the important impacts of this study upon our common stock of ideas.

At the recent meeting of the Science Masters' Association, Prof. W. A. Bone opened a discussion on "Industrial Openings in Scientific Technology."

He reminded his audience that the profound change in conditions during the past twenty-five years had increased the need in every branch of industry for scientific control and direction, not only in the actual processes of manufacture but also over the whole range of activities precedent and subsequent to the production of finished goods. The nation that could think farthest ahead and adjust its system accordingly was the nation that would deserve success. It behoved us, therefore, as a nation, to ensure that our industrial leaders were men trained in scientific method and in modern scientific thought, who could foresee change and prepare for it. At least seven years' training was necessary, three years studying fundamental science subjects before graduation, to be followed by four years of specialisation.

Within the limits of the subject under discussion, it was obviously difficult for Prof. Bone to deal with the more general applications of the principles he enunciated for industry. This is a pity. As we have already suggested, the teaching of science in schools and most universities is vitiated by over-specialisation, with the resulting tendency to produce experts in the narrowest sense of the term. What is most needed at the present time is an appeal to the science masters in our schools to break with a bad tradition, and by broadening the basis of instruction in science, particularly by the inclusion of biological studies, to extend the mental horizon of their pupils. University teachers will then be the better enabled to equip science students for the responsibilities attaching to the most coveted positions, not only in industry and finance but also in the spheres of higher administration in State and local government services, the various colonial services, and even the judiciary.

Most of us will subscribe to the view that no person can be considered well educated who lacks the equipment to discern the principal forces which are operating to mould our environment. Undoubtedly some knowledge of science and some training in scientific method are essential for such discernment. For the control and direction of affairs, more than this general training is and should be required. It is doubtful whether anyone who lacks the capacity for independent and perspicacious inquiry should be entrusted with the cares of leadership. The field of research is sufficiently extensive to provide abundant opportunity for testing such capacity. It behoves us to follow some such procedure in choosing our leaders, rather than continue to leave it to chance circumstance to produce them.

To prevent misunderstanding, let us state definitely that it is not contended that the creative research workers of any country should be hampered by administrative duties. Such research workers are sufficiently rare to be given every form of encouragement to extend the bounds of knowledge. Their requirements are met by giving them all the facilities they need for their work, the greatest amount of freedom from external control, and freedom from pecuniary worries. It does not follow that we agree with the oft-repeated assertion that such men are unfit for administrative control. The success of Newton as Master of the Royal Mint is by no means the exception which proves the accepted rule. Our view is that no country can afford the luxury of diverting them from the pursuit of new knowledge and its dissemination. Their gift of vision is the world's greatest asset: their function is leadership in a supreme degree. Happy the community that is intellectually equipped to appreciate their genius and possesses the will to follow them.

It is the other types of research workers for whom we consider more varied and abundant opportunities should be given for the exercise of their talents. They may be concerned with the critical examination of discoveries being made in a particular field of knowledge with the view of their application, or they may be engaged on what is embraced by the term 'development work.' But because of the existing prejudice in Great Britain against the so-called experts, they are rarely placed in a position to accept full responsibility for the execution of their ideas. Possibly this prejudice is more ingrained in the hierarchy of the Civil Service than elsewhere. Cases are on record where administrative officers have come to decisions on technical questions without even consulting the technical advisers of the department. It is repeatedly asserted in administrative circles that a man with intensive knowledge of a particular subject is incapable of unbiased judgment on any matter within its scope upon which there may be difference of opinion. Consequently, when a Royal Commission was appointed to inquire into the state of the coal industry, its members included no scientific authority. It is true that the Commission was assisted by a scientific assessor, but no actual member of the commission was competent to examine the scientific experts who gave evidence before it. We are assuming, of course, that finance and economics cannot be regarded as exact sciences.

Obviously there are historical reasons for the prejudice against the expert in the State service.

The prejudice, however, should be attributed to the expert's virtues rather than to his vices. The State machine is activated by bias—the bias of one or other of the political parties. The scientific expert who is faithful to his training must deal with facts objectively and not subjectively. Like the lawyer, it is his function to weigh evidence, but unlike the lawyer it is not his function to select only those facts which support his preconceived hypotheses. If the weight of evidence is against his hypotheses, he must find others. It is only natural that the politician, and the administrative head of a department who has to serve him, often to the exlent of writing a memorandum demolishing all the arguments in a memorandum on the same subject which he had prepared a few months before under a different regime, should display a preference for the legalistically minded adviser. The scientific expert cannot be expected to be so accommodating.

Ethical considerations apart, let us assume that the present machinery of government is such that it demands for the smooth working of certain of its parts a type of administrative officer whose function is to serve as a buffer to lessen the shock of impact of impartial judgments on the political heads of the State machine. It does not follow that every part of the machine must be subject to the same control. The State has made itself progressively responsible for providing certain services, the efficient administration of which is entirely dependent upon the way our available resources of technical skill and scientific knowledge are utilised. It is farcical to pretend that they can best be utilised by those who are ignorant of those resources, any more than it is safe to assume that the ignorant will seek impartial advice or be unbiased in their judgments. We suggest that the present machinery of government is in need of overhaul. An attempt should be made to differentiate clearly between those departments whose principal functions are political, and those whose activities are governed solely by financial considerations. It is not denied that successful administration depends upon a knowledge of the administrative system, but we fail to understand why this knowledge cannot be acquired by those who have had the advantage of the broad training we suggest in the methods and principles of science.

As we have already said, many desirable changes in the teaching of science would be effected if the choice of career of science students were not so limited. Their predetermination to specialisation is bad for them and worse for the country which has built up the tradition. In the continental countries there is no such tradition. Men trained in science occupy the highest positions in the State and industry. This may account for the rapidity with which the scientific discoveries of our countrymen are applied to industry in Germany, and possibly afford an explanation for the slow development of the tropical possessions of Great Britain in comparison with the rapid development of those of the Dutch.

It is high time a survey were made of the positions for which candidates, in addition to that ill-defined quality—personality—should possess a sound knowledge of science. We can think of none where this knowledge would not be an advantage. It would lend reality to finance, to the direction of industry, to the administrative services, and even to politics. It would increase our respect for the law if the judges in the special courts dealing with technical matters were themselves able to differentiate between what is and what is not science. It would be worth while trying the experiment of appointing scientifically trained men as governors of our non-self-governing dependencies, instead of distinguished soldiers, sailors, or politicians. But it is unlikely that any such survey will be made until there are far more members of the House of Commons who have a knowledge of and abiding interest in science and faith in its methods. It would hasten the day if more teachers of science appreciated the social implications of their studies and led their students to realise that modern statecraft must be based upon a comprehensive study of the sciences.

The Clinician and Chemotherapy.

Principles and Practice of Chemotherapy: with Special Reference to the Specific and General Treatment of Syphilis. By Prof. John A. Kolmer. Pp. xvi + 1106. (Philadelphia and London: W. B. Saunders Co., 1926.) 55*s*. net.

HITHERTO most of the literature of chemotherapy has been written by chemists, or at least by investigators with a bias towards chemistry. It is wont to consist of descriptions, in series, of complex organic compounds contributed by the chemist, to which his biological colleagues, the pharmacologist and the parasitologist, add 'toxicities' and 'curative doses,' the latter being the minimum quantity of each substance found necessary to cure some particular infection induced experimentally in one of the lower animals. If the ratio between the two factors is favourable for any member of the series, that substance becomes a possible candidate for clinical trials, so that the clinician has the last word in deciding whether the work of his chemical and biological colleagues is