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ACADEMIC SCIENTIFIC MEN AND CONSULTANT WORK

IN the Nuffield College Statement on "Problems of Scientific and Industrial Research", as well as in other reports in which the relations between industry and university men of science have been considered, the question of the extent to which university scientific workers should undertake advisory or research work on behalf of private firms and receive payment for such work has been discussed in some detail. The important part which the academic man of science has played in the team-work which has been responsible for so many of the striking developments during war-time—of which we need instance no more than radar, the utilization of atomic energy and penicillin—make it almost certain that the nation will be reluctant to forgo in the post-war years a partnership which proved so fruitful and valuable. Moreover, apart from the value of such co-operation in stimulating creative work, the shortage of scientific man-power and the necessity of using our resources to the best advantage will provide a further impetus to closer relations between industry and the universities ; and the more especially since, to provide the increasing number of research workers and other scientific and technical men which industry will need, it will probably be necessary for a time to give the staffing of university departments for teaching and research a priority over industrial demands.

Under such conditions, it will be imperative to maintain an unusually careful watch to ensure that there is no neglect of fundamental research at the universities, and that no practices are allowed to develop which would involve any restrictive conditions or diversion from that primary function. Even if every precaution is taken in that respect, problems are bound to arise in peace-time which did not arise, or not to the same extent, in the prosecution of co-operative research in connexion with the war effort. Questions of publication or the exchange of information were so dominated by the overriding necessity of avoiding disclosure to the enemy that the questions of patenting or priority which would normally arise in development in peace-time were of secondary or negligible interest.

There can be little doubt that industry as a whole appreciates the vital importance of the fullest and widest publication of the results of fundamental research to a much greater extent than was the case a generation ago, and there is no evidence that British industry is any more reluctant to publish the results of scientific investigations carried out in its own research laboratories than is American industry. While it is therefore improbable that there will be any disposition on the part of industry to withhold permission to publish the results of investigations carried out in university laboratories at its instigation or charges, there may still be some danger of university departments falling, even unconsciously, too much under the influence of particular firms or industries. Accordingly, the formulation of a general

code of conduct recognized as applying to university scientific workers undertaking outside industrial research for private firms is even more imperative than when the Nuffield Statement was first issued, and especially in view of the general agreement which is now evident as to the desirability of much easier and greater interchange of research workers between industry, the universities and Government departments.

It has been suggested that the professional institutions should take the initiative in formulating the principles of such a code of practice. It is therefore welcome news that the Joint Council of Professional Scientists has prepared a report* on the subject which was approved last November both by the Council of the Royal Institute of Chemistry and the Board of the Institute of Physics. This report sets forth the reasons why, and the occasions when, in the view of the Joint Council, consulting and similar work should be undertaken by academic men of science, and details five principles by which acceptance of such work should be guided. Of the reasons given, the first will command general agreement: it is clearly in the national interest that industry should be able to obtain the best and most up-to-date scientific advice, and no scientific worker able and willing to provide such advice or assistance should be unreasonably restrained from doing so. It is also true that men of science employed by a firm, or by a research association of which it is a member, are unable to meet all demands. Even with a greater expansion of industrial research, the resources of the smaller firms may still be wholly inadequate.

While such circumstances may become less frequent, some external help may legitimately be needed and much of it would naturally come from members of the staffs of universities and technical colleges. It may, of course, also come from independent consultants, and recent inquiries made by the Royal Institute of Chemistry show that a very wide range of advice or assistance can now be obtained from independent consultants in chemistry and chemical engineering. Such consultants may have specialized knowledge and experience in particular fields or in relation to particular branches of industry, and have at their command special apparatus and equipment for particular kinds of experimental work; but in other branches of science, except those special sections of engineering which may be regarded as applied physics, the position is different.

There may be sensed a general tenderness for the independent practitioner which leads to the consultant receiving rather more prominence in this matter than is justified, the more particularly as it might well be argued that as industry pays more attention to research there will be a diminishing call for his services. None the less, it is undesirable that members of the staffs of universities and technical colleges should compete directly with independent practitioners, except in fields where the latter are clearly unable to meet the needs of industry. Any such consulting work undertaken should, moreover, not be such as to interfere with the proper discharge of the primary duties of the university man of science of teaching and of advancing his science by the prosecution of research. Since, however, the services required by an industrial firm may range from routine testing to long-range investigations of an essentially academic nature, and vary in purpose from settling a specific scientific question to developing a new process to the stage of full industrial operation, such consulting work may often accord with the discharge of these primary duties at least as well as it is likely to do with the services which the independent consultant can render. Apart from this, it is recognized that the knowledge of industrial and other modern applications of science which the academic man of science can gain by engaging in some outside work may be of considerable benefit to his teaching and research in fundamental science. Many academic men of science, by virtue of their knowledge and experience in specialized fields, have important contributions to make to industrial development which could not be provided from other sources. Universities and technical colleges also often possess special apparatus and equipment which is not otherwise available, and it is in the public interest that its use should be made available, particularly to local industry.

The first principle which, it is suggested, should guide the acceptance of outside consulting work by scientific workers in academic institutions is that the work should be investigatory in character; routine testing should be undertaken only in very exceptional circumstances. Secondly, when research work is carried out in an academic institution in connexion with the consulting work, the scientific results should normally be published, subject to an agreed delay to allow the firm paying for the work to have priority in the application of the results, and subject to collaboration with the firm being duly acknowledged. Thirdly, no agreement should be made with a firm which would restrict the services of a man of science in an academic institution to any one firm, except in respect of the specific problems considered. Fourthly, when a fee is paid, the remuneration of those who have shared in the work should be decided on the particular merits and circumstances, having regard to any conditions laid down by the governing body of the academic institution concerned; and fifthly, if there is a possibility of patents arising from the work thus carried out, the arrangements to be made with the sponsors of the work should be considered in the light of the normal practice of that body.

The application of some of these principles might have to be modified with reference to research or development work undertaken for Government departments. Moreover, the statement suggests that it is reasonable that some control over such paid outside work as regards its suitability, non-interference with the performance of teaching and research duties and suitable payment for use of the institution's equipment should be exercised by the employing institution, normally acting through the chief academic official. This is in accordance with criticism

* Copies of the report are obtainable from the Joint Council of Professional Scientists, c/o The Institute of Physics, 19 Albemarle Street, London, W.1.

advanced by Bruce Truscot in his two books on "Redbrick University". While such control need not, in theory, be irksome or derogatory to members of the staff, as their approach would normally be made through the head of the department to the chief academic official, whose opinion regarding the proposed acceptance of outside work should be easily ascertainable, nevertheless in practice, if Bruce Truscot is right, the danger of friction cannot be discounted. The decision should be reported to the body representing the employing authority, to which, if necessary, the member of the staff would also have direct approach; and in any event modification of the administrative structure of the universities, where necessary, in the direction suggested by Bruce Truscot for other reasons should go far to remove the difficulty here.

Copies of the report have already been sent to the vice-chancellors and principals of universities and colleges, and it equally deserves the attention of industrialists and other professional bodies besides those represented on the Joint Council of Professional Scientists, as an encouraging attempt to frame a clear code of professional conduct in a field which is likely to become increasingly important in the years immediately ahead.

ESSAYS ON GROWTH AND FORM

Essays on Growth and Form presented to D'Arcy Wentworth Thompson

Edited by W. E. Le Gros Clark and P. B. Medawar. Pp. viii+408+13 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1945.) 21*s*. net.

THE production of a *Festschrift* is not a usual practice in Britain; but there are some men whose influence has been so decisive in stimulating the widespread exploration of a scientific problem which they were unequivocally responsible for pointing out, that a tribute to their insight comes spontaneously to the minds of their followers when the occasion arises. Few British biologists who are concerned with the general problems of anatomy would hesitate to include D'Arcy Thompson in this category, or to feel a wish, on some suitable occasion, to make an acknowledgment of their debt to him. The occasion which has been chosen for the presentation of this volume of studies is the completion of his sixtieth year as professor, first in University College, Dundee, which later became incorporated in the University of St. Andrews.

During this long incumbency of his chair, D'Arcy Thompson has written with scholarship and grace on many subjects; he has shown himself an erudite classicist as well as a mathematician, field naturalist, oceanographer, pedagogue and archæologist. But it is in the field of analytical anatomy that his writings have had their most important influence on the work of his younger contemporaries. The publication, in 1917, of the first edition of "On Growth and Form" presented biologists with a demonstration both of the nature of the analytical approach to these problems and of the wide range of material to which such methods could be applied. Before turning to the volume of essays under review, which shows something of what biologists have achieved in following up D'Arcy Thompson's suggestions, it will be well to examine more closely what were the main directions of inquiry which he indicated. The most important were, perhaps, three in number. "On Growth and Form" brought together into a single extended discussion the many diverse attempts which had been made to give a mathematical account of the phenomenon of growth, or simple increase size or weight. Secondly, it showed that many examples of animal form are geometrically similar to configurations which are taken up by non-living materials of various kinds under the action of known physical forces. Thirdly, it suggested the value of using the technique of transformation of co-ordinate systems to summarize the comparison between the shapes of related organisms. The common characteristic of all these lines of thought, and the characteristic which gave them their power to inspire other workers, was an insistence on the necessity for mathematical analysis. In the essays now presented to D'Arcy Thompson, nearly thirty years later, the mathematical equipment is used frequently and unself-consciously by biologists who have, in the interval, come to accept its value as a matter of course. But, in nearly all the essays, one notices the authors being driven, by the nature of their material, towards the adoption of two points of view which were only partially adumbrated in the Thompsonian directive; these are, first, a concern that the analysis shall be in terms of entities which are causally significant, and secondly, a conception of animal shape as essentially in process of development.

There are, admittedly, certain essays which do not show these two new characteristics. Lotka contributes a brilliant account of "Population Analysis as a Chapter in the Mathematical Theory of Evolution", a subject which D'Arcy Thompson[1] judged to "lie just outside the scope" of his book, but which the reader will welcome none the less. Astbury again, in his general, and as he says somewhat informal, account of "The Forms of Biological Molecules" is dealing with a subject which did not fall within D'Arcy Thompson's purview—indeed could not, since what Astbury is recounting is the advance made during the last twenty years in our understanding of the ultimate entities from which biological forms are constructed.

It is in the series of essays on growth that the inspiration of Thompson is most direct, and at the same time the necessity to develop beyond his point of view most pressing. Reeve and Huxley on "Some Problems in the Study of Allometric Growth", Medawar on "Size, Shape and Age", and Richards and Kavanagh on "The Analysis of Growing Form", are all concerned to carry forward the mathematical expression of growth, and to synthesize this with the other strand of D'Arcy Thompson's thought, the geometrical consideration of changes in shape. Much progress has been made in both endeavours, and a considerable body of knowledge has grown up around the original nucleus. But all the authors conclude that the situation is still as it was when Gray made his penetrating analysis in 1929; no analytical expression for the curve of growth can be found to which one can attach a causal, as opposed to a purely descriptive, significance. In all three essays, the Thompsonian analysis of changes of shape is applied not only to the comparison of related forms, but also to the development of a single individual; but again, even in the detailed study by Richards