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ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY[1]

By Sir WILLIAM BRAGG

DIRECTOR OF THE ROYAL INSTITUTION

ACCORDING to our honored custom I preface this annual address by references to those of our fellows whom death has taken from us during the past year.

The past year has included many events which might well be mentioned in this annual address. One of them has, however, elbowed out most of the rest. The two numbers of *Notes and Records* which have begun a new enterprise contain interesting and informative accounts of our doings since last November. I believe that fellows have appreciated this social and intimate addition to the publications of the society, and that they will join with me in an expression of our gratitude to the officers who have produced it, and especially to the one who has on this, as on so many occasions, taken the lion's share of the work. The doings of the society are noted and recorded in this periodical more effectively than I could do in a presidential address.

I must now speak of an event which is surely uppermost in the minds of all who have received the nominations of council for next year. We are to lose the services of Sir Frank Smith. You may be surprised at his decision not to seek renomination when we would gladly have kept him for one more year. It happens, however, that two more of our officers must step down at the end of next year, and Sir Frank has pointed out that if three were to leave at one time the business of the society might be seriously affected. We can not, therefore, ask him to stay. We must take advantage of the opportunity thus given us to tell him how grateful we are for the work he has done for the society. His secretaryship has been distinguished by a rare exhibition of capable service. The place which the society fills in public life and its harmonious cooperation

[1] Given at the anniversary meeting on November 30, 1938. The address also contained obituary appreciations of the fellows who died during the year.

with other institutions are largely due to his wisdom and tact and his power to unite workers in a common effort. Indeed, it is impossible to think of what he has done for us, without reflecting at the same time that he has exercised his talents in a wider field, and that in the words that may seem simple but are full of meaning, he has been and is still, I am glad to say, a great public servant.

I should like to add a reference to one very interesting matter. As the result of a discussion between Dr. Krüss, head of the Prussian State Library in Berlin, and myself, when he attended the International Documentation Conference at Oxford in September last—a discussion initiated by Dr. Krüss—I have lately received a letter from Dr. Bosch, president of the Kaiser Wilhelm Gesellschaft, inviting the cooperation of the Royal Society in some scientific enterprise which would advance science and, at the same time, promote understanding and good will. Dr. Bosch asks that a few representatives from this side should be the guests of the Kaiser Wilhelm Gesellschaft for a week during this winter and hopes that we would play the part of hosts in return. During these interchanged visits, lectures would be given and consultations would be held; and it is reasonably to be hoped that some plan of a joint work would emerge. I feel sure that this gesture of friendliness will receive a warm welcome from the fellows of the society.

I will now say a few words on a subject which seems to me to exhibit a greater importance the more closely it is examined.

In recent years the very great increase in the output of the results of research has placed our scientific societies in a difficult position. There is correspondingly more to be published, and, at the same time, publication costs have increased. Consequently, the societies' finances are overstrained, and publication of worthy material is restricted. The Royal Society receives a government grant for publication purposes, far the greatest part of which is passed on to other societies. The grant is sufficient to meet only a portion of the applications for assistance that are made.

There is another reason why the increase in output presses hardly on our societies. In order that a proper standard of merit shall be maintained, it is customary to submit each paper, when it is sent in, to one or more referees. Now the number of possible referees is limited, and is even becoming relatively smaller as specialization increases. I may take this opportunity of expressing the gratitude of the society to those fellows who spend so much care on the examination of the papers submitted to them. The officers realize regretfully that they ask them for a considerable fraction of their time and energy.

Our shelves display the effects of increase. As we look at the long rows of bound periodicals in our studies, we realize not only that many years have slipped past since we began to collect them, but also that their very appearance is an item of history. A long time ago they were comparatively small and thin. But they grew: they shrank during the bad years of the war, but soon resumed their increase, and of late they have swollen until they have become unmanageable and must needs be divided. Still the papers come pouring in, and the rate of flow even increases. It is all to the good, and a healthy growth which we do not want to check; but there are practical difficulties which invite an attempt to solve them.

It seems to me that when we try to consider this matter from points of view all round it, we are driven to seek for a precise answer to the questions, "Why *do* we publish? Why do we submit papers and why does the society print them, if they are good enough?"

When a man submits a paper to the society he is, in the first place and quite rightly, anxious for the satisfaction of showing what he has done to those who will understand it. Another reason which has certainly grown in strength of recent years is that he wants to establish his reputation and position. Doubtless, he has also the wish that his work may be of service, though this desire may be relatively less obvious even to himself. To the society the opportunity for service is the principal reason; for it can not be held that the society exists in these days, only or even mainly, for the pleasure and profit of its fellows.

The existence of our society depends on our belief that knowledge is to be obtained by experiment. In that belief our founders of nearly three hundred years ago organized the rules and procedure on which we have acted ever since. Their foresight has been amply justified; but they could not have imagined how far experiment would carry their successors and others who have held the same belief. We have been led to the discovery of a natural world of vast extent; and without limits that we can see. Every part of it is of interest and every item of knowledge that we find there has a bearing on what we think and do. As we see and know, the results of the exploration have already been immense; modern life has been profoundly affected thereby. The natural knowledge which the Royal Society set out to improve has become one of the greatest influences of these times. The society and other bodies and individuals that have followed in its footsteps have, therefore, become possessed of certain most important opportunities, which are indeed duties. One of these is still, as it has always been, the encouragement of research, wisely conceived and well directed. A second is the preparation and presentment of the results of research, so that they can be sufficiently appreciated, and can be incorporated with

understanding into every activity, intellectual or physical, to which they apply. We are not, as discoverers, responsible for the uses that are made of our discoveries. We ought not to claim, in my opinion, to be given the direction of affairs in which our discoveries play a great part simply on account of that fact. But we are, at least, bound to see that our acquired knowledge is rightly stated so that it can be rightly used. We may also, as scientists, feel that we ought to help in putting knowledge to good use. This duty is actually discharged by numbers of men in these times.

It is curious to think that the feeling of responsibility is of recent growth. There was even a time when a discovery could be considered a private possession, to be withheld from general knowledge if thought fit. Newton, Hooke, Cavendish and many others were often in no hurry to give to the world what they had found; they were influenced by indifference, by fear sometimes, even by impish playfulness, as when truths were hidden in anagrams. They did not then look upon natural knowledge as an inheritance belonging to mankind, which when discovered ought to be shared.

Rumford, at the end of the eighteenth century, was one of the first to accept and proclaim his responsibility, and act upon it, when he tried to apply the laws of heat to the economy of fuel. His first attempt in London was made at the Foundling Hospital. The Royal Institution, in its first form, was his attempt to give concrete expression to his idea. The founders of the British Association were urged in their work by a similar motive and were to some extent under the belief that they were repairing a defect of the Royal Society. The vigorous action of the association in these days is a most commendable extension of its original purpose. The Royal Society undertakes a special part of the general responsibility. It is concerned with affording opportunities for the publication and discussion of original discovery, it also encourages discovery by the administration of funds entrusted to it for that purpose. And, of course, it represents officially the scientific activities of the nation, acting as an adviser on such matters in public affairs. In this field it has full opportunity for the exercise of all its powers. This limitation of service does not free the society from the need to attend always to the one great purpose, more fully realized of recent years, that of opening to mankind the new fields of natural knowledge. The new fields are not merely to be penetrated, they are also to be made public. There is, of course, a well-known saying that praises knowledge because it is useless. This cryptic statement would seem to be an ethical injunction to the researcher; it certainly does not mean that the most desirable knowledge is of no use to any one but the discoverer.

Even within the range of activities to which the Royal Society confines itself, in which contact with the general public is not often made, regard must be paid to the future exposition of discovery. Because the results of research have become so voluminous and so important, the manner of stating them, of arranging and storing them has also become important. We have to bear this in mind when we think of the arrangement on our shelves.

At the present time, the volumes of our *Proceedings* and *Transactions* have a certain resemblance to a building site on which the contributors of materials have shot their goods: and it must be said that the shooting is often done without regard to convenience of subsequent handling. He who would construct for himself a whole building finds it difficult to make use of the materials provided. Any one who has completed a piece of research and hopes that it may be accepted and published by the Royal Society or any society of learning is in the first place at pains to describe what he has done, the methods he has used and the inferences that he draws from his results. The manner of telling his tale will depend on the purpose he has in mind. He may think that he ought to set out his facts in full detail, so that any reader who is interested shall at least find all that he wants. If he is on the threshold of research work, he will often be influenced by the desire to prove his knowledge and ability; and may be led to make his tale long and complicated. It is very likely that he has not before him a mental picture of the man for whom he is writing; if he has, it is probably that of an expert, who is working in the same narrow region as himself, who knows all the technical terms and is familiar with the hidden difficulties of the subject (which, therefore, must be discussed in full), and will pick holes if he can. It is true that writing of this kind is of the highest value: expert must talk to expert.

Nevertheless, such writings make dull and difficult reading for the great majority of those who are interested in scientific discovery. How few there are who can critically study a paper of a certain type is only too well known to our secretaries and the chairmen of our sectional committees who must find referees to judge its merits, and to referees themselves who accept their often laborious task. When such papers are read at a meeting of the society, the paucity of the attendance and the lack of good discussion are obvious and distressing. In fact, it has been found well to take vast numbers of such papers as read, and even then the discussion of the few that are left is often disappointing.

It is on this account that greater stress has been laid recently on the provision of opportunities for organized discussions in which some important subject of recent development is considered by the workers in that

subject. The discussion ranges over a wider field than that of a single worker's account of his new discoveries. It is much more interesting and informing to the general body, as the very satisfactory attendances have shown. Clearly there is a desire to understand the main purpose and the principal achievements of each growing subject.

I believe that fellows, and others, have welcomed the recent plan of publishing summaries of papers as an appendix to the *Proceedings* as soon as the papers are received, publication of the papers themselves being deferred until approval has been given in the usual way. Not merely is an earlier announcement of discovery made on this plan, but the collection of summaries presents the general trend of research to those who are not specialists.

Summaries are the expression of a natural reaction to the difficulties caused by the growing specialization of research. They represent a certain recognition of the principle that discovery must be accompanied by exposition, the principle that has been little regarded in past years, but now demands acceptance.

The ideal summary is more than a mere digest or shortened form of the paper. It differs from the paper itself in that it is addressed to a wider circle of readers which may include the experts but contains also many others who should, in fact, receive the principal attention. For this reason it may be more difficult to write than the paper itself, because it must take into account the interests and the understandings of those who will rarely read the original paper, even if they could do so, but will gladly absorb the meaning and the information of the summary, especially if there is a connection with their own work. When the summary is written with this wider view it becomes literature, though the paper itself may be no more than a record.

Another reason for greater attention to the writing of summaries is that specialization quickly takes explorers out of sight of each other and out of sight of the main body. It is natural for them to talk to each other only and to forget every one else. Consequently, it becomes difficult to incorporate their work into any general scheme. Also it is dangerous for researchers to be so far out of reach. It is natural for them to lose a sense of proportion and to imagine, each one, that his is the main line, or at least a very important line of advance. Who is to call a halt when this happens, unless the work that is going on is so far appreciated that a general opinion can be formed as to its advisability? It would, of course, be impossible to put the direction of all research into the hands of an elected committee or a dictator. Yet a certain degree of control is required, and this is best exercised by general opinion reflected in the minds of those who direct in various ways the expenditure of money on research. The only way to facilitate the growth of a general opinion which is sound is to insist that a general account shall be given which is intelligible to a sufficient number.

These considerations tempt me to ask whether it is necessary that our *Transactions* and *Proceedings* should contain so much as they do at present. When a new departure in experiment or theory is made or a new fact is discovered or a new correlation, it is right that a careful and complete explanation should be given; and if this is not too long, it is excellent that it should appear in the *Proceedings*. If the novelty leads, as it often does, to a steady output of observation, extension, confirmation and illustration, with many figures and bulky tables, there must come a time when complete publication to the world becomes unnecessary and even tiresome. What the scientific world wants is a general account of progress made, so that its bearing may be clear. A mass of details in continuation is of interest to other workers engaged in the same research, but very few others want the full account. The *Proceedings* should contain papers of original discovery or fresh departure; as regards continuation papers, as they might be called, summaries properly written should be enough. Continuation papers should, of course, be preserved and at least be available on demand; still better, a few hundred full-sized photograph copies could be made. This could be done at a fraction of the cost of printing, especially if the printing is difficult, full of figures and symbols. The *Proceedings* would then be much reduced in size, and would be more handy, interesting and useful.

There is a further consideration of no small practical importance. A largely attended conference on documentation was held a few months ago at Oxford. The subjects with which it dealt were of comparatively modern importance, but were clearly of the greatest interest in a number of places, particularly in patent offices, and in the libraries of industrial research associations. The summaries of papers in scientific journals came in for much adverse comment, comment which seemed to be entirely just. The point was that summaries were written for the expert only and were often barely sufficient at that.

Finally, if the scientific worker is no longer to be content merely to observe and to record, but also to share his knowledge with the world in general, he needs certain qualifications and a certain education which are much less necessary in the more restricted field. He is dealing not only with facts but with men: his work enters the humanities. This is really a very great matter. It draws its importance from the tremendous consequences of the increase of the knowledge of nature which are now obvious. Lord Rayleigh has

lately shown the absurdity of the charge that scientific men are responsible for the evil uses that are sometimes made of their discoveries. But this responsibility is theirs, that they shall explain what they find so that their fellow-men know how they stand. The scientist can not be expected to see that discovery is rightly used, but no one except himself can rightly describe it. It is not to be expected that the best use will be made of what is imperfectly understood.

These are problems of tactics. They can not be fully solved while school and college still maintain an artificial division between two forms of teaching, naming one of them science and the other "humanities." They have far more in common than is generally recognized. There must, of course, be specialization, a divergence in the later stages. But the men of different types of mind must be kept together more than at present, so that when they meet in after-life they can understand each other. It happens too often now that the administrator makes mistakes because he can not understand his technician's advice, and the technician is incapable of expressing himself so that his administrator understands him. There ought not, in fact, to be a sharp distinction between the two. It is a fundamental point that humanities and science have joined hands in the service of mankind.

SUMMARY STATEMENT OF THE ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL, 1937–1938

By Dr. ROSS G. HARRISON
PRESIDENT
and
ALBERT L. BARROWS
EXECUTIVE SECRETARY

BORDERLAND PROBLEMS

AMONG new activities of the National Research Council during the year, 1937–1938, a number of undertakings reflect the consideration which has been given in the Council for several years to so-called "borderland problems." These problems lie on the fringe of interest of the traditional fields of the fundamental sciences or in between these fields. Perhaps they might better be called problems of the combined sciences, since it is frequently the contributions from several adjacent fields which are amalgamated into the solution of these problems. They seem to arise particularly at this time partly because of the rapidly expanding range of scientific interests and partly because of the necessary use of knowledge from several sources in order to meet the increasingly complex social and technological questions of the day.

In the life sciences, for instance, due to the discussion of problems of common interest in conferences of the preceding year and to suggestions from other sources, several new combination projects have been undertaken. Among these is a reorientation of previous concern of the Council in parasitology under a new Committee on Medical Problems Common to Animals and Man. Others relate to the genetics of pathogenic organisms; to problems of cellular physiology and the changes in organisms due to old age; to aerobiology; and to the bearing of the results of studies of experimental neuroses upon problems of neurotic behavior and other researches in psychiatry.

In the relationships between physical and earth sciences certain problems of geology have led to undertaking the preparation of a handbook of the physical and chemical constants of the materials with which geologists have to deal, and to the coordination of studies of the movement of water currents of different densities through reservoirs and lakes. The scrutiny, itself, of the field of geology in the light of its physical and chemical phases has led also to the definition of a considerable list of other geological problems.

FELLOWSHIPS

A recently published list of the fellows of the Council for the past twenty years names 1,146 past and present fellows. Of these 263 (about 23 per cent.) carried on their fellowship work abroad or will do so. The total group was derived, with respect to undergraduate training, from some 260 educational institutions in the United States and Canada and from about twenty-five educational institutions abroad. The fellows have worked in about fifty universities and at many of the research institutions on this continent and at a large number of educational and research institutions abroad, mainly in European countries. Most of the past fellows are engaged in research work and over three fourths of the group are connected with research or educational institutions. For the current year 42 fellows are under appointment, selected last spring from 189 applicants. The fellowships are supported by funds provided by the Rockefeller Foundation.

SCIENTIFIC AIDS TO LEARNING

In the spring of 1937 the Council appointed a Committee on Scientific Aids to Learning at the suggestion