SCIENCE

VOL. 93 FRIDAY, JUNE 20, 1941 No. 2425

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

SCIENCE, NATIONAL AND INTERNATIONAL, AND THE BASIS OF COOPERATION[1]

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I SHOULD be the last to claim that we scientific men, as a class, are less liable to prejudice on grounds of self-interest, race, politics or religion than other educated people; and we should deceive ourselves, and perhaps some uncritical members of the public, if we were to assume (as some of us seem to do) that scientific eminence, or the scientific habit of mind, as such, or even scientific notoriety, give any special virtue to our opinions on more ordinary topics. It is, nevertheless, a fact that the nature of our occupation makes scientific men particularly international in their outlook. In its judgments on facts science claims to be independent of political opinion, of nationality, of material profit. It believes that nature will give a single answer to any question properly framed, and that only one picture can ultimately be put together from the very complex jigsaw puzzle which the world presents. Individual and national bias, fashion, material advantage, a temporary emergency, may determine which part of the puzzle at any moment is subject to the greatest activity. For its final judgments, however, for its estimates of scientific validity, there is a single court of appeal in nature itself, and nobody disputes its jurisdiction. Those who talk, for example, of Aryan and non-Aryan physics or of proletarian and capitalist genetics, as though they were different, simply make themselves ridiculous. For such reasons the community of scientific people throughout the world is convinced of the necessity of international collaboration;

[1] Read at the Annual General Meeting of the Parliamentary and Scientific Committee held in the House of Commons.

has practiced such collaboration for many years, indeed along the centuries; and has built up an elaborate system of congresses and unions of standards, units and nomenclature, and of abstracting journals, together with a wide-spread interchange of research workers and ideas from one country to another.

In no other form of human activity, therefore, has so complete an internationalism spread throughout the national structure of society: in no other profession or craft is there so general an understanding or appreciation of fellow workers in other parts of the world. This implies no special merit or broadmindedness on the part of scientific men; it is their very good fortune, a good fortune which involves obligations as well as privileges. For example, when the Nazis in 1933 began their persecution of Jews and liberals in Germany, it was the scientific community in many other countries which came most quickly to the rescue of their colleagues: not out of any special generosity but because *firstly* they had personal knowledge of those who were being persecuted, and *secondly* they realized that such persecution struck at the basis of the position of science and scientific workers in society. Again, in the treatment of aliens in this country during the present war, the scientific community more than any other, and quite regardless of political complexion, has stood for a liberal and reasonable policy: desiring both to maintain the high tradition which the world of learning has inherited from the past and also to make use of the willing help of people whom it knew personally to be loyal to the cause of freedom for which we are fighting. Again, in the United States to-day there is no section of the public so unanimously concerned for the victory of British arms as the community of university and particularly of scientific people. These realize that the basis of all progress in science and learning is international cooperation, and they can not conceive how such cooperation could be possible under a Nazi domination of the world.

It may well be, then, that through this by-product of international cooperation science may do as great a service to society (just as learning did in the Middle Ages) as by any direct results in improving knowledge and controlling natural forces: not—as I would emphasize again—from any special virtue which we scientists have, but because in science world society can see a model of international coperation carried on *not merely for idealistic reasons, but because it is the obvious and necessary basis of any system that is to work.*

One of the great tasks lying before scientific people after the present war will be to rebuild, and to rebuild on a firmer and better foundation, the international scientific organizations which have come into being in the last 70 years, particularly during the present century. The earliest of these was the International Bureau of Weights and Measures, established in 1873. An International Geodetic Association followed, and in 1903 an International Seismological Association on the same lines. Arising from the initiative in 1898 of the Academies of Munich and Vienna, together with the Royal Societies of Gottingen and Leipzig, which had all been in the habit of meeting annually, the Royal Society (of London) undertook to approach a number of foreign academies with a view to the formation of an international association of academies. As an independent institution, not subject to state control as were so many of the academies, the Royal Society was in a very favorable position for opening such negotiations. As a result the International Association of Academies was formed, which held five meetings in all, the sixth at St. Petersburg being cancelled owing to the outbreak of war in 1914. It never met again.

These meetings were not limited to natural science, many of the academies being concerned both with the scientific and the humanistic side of learning. It is interesting that as one result of this movement, and in order to represent Great Britain on the literary philosophical and historical sides, the British Academy was formed and incorporated by Royal Charter in 1902. We of the Royal Society have always hoped that the British Academy will ultimately take the same place in national life in respect of humanistic studies as the Royal Society has long had in respect of "natural knowledge." There is need for such independent bodies of high standing and disinterested outlook, particularly when so many functions are being taken over, often quite suddenly and without any one noticing, by the state. The Royal Society, in spite of its independence, has always, since its foundation in 1662, had close relations with the Government, and it would take a small book to recount the many occasions on which its advice has been asked. It has recently been given still another privilege and duty, under the Lord President, in advising the War Cabinet on scientific matters through its president and secretaries, who are members of the Scientific Advisory Committee. One hopes that in some form or other, this function, no less necessary in peacetime, will continue after the war. *Could not a similar provision be usefully made now for those complementary studies which the British Academy represents?* This is an interpolation, not strictly relevant to the thesis of this address, but I feel it is of some importance. The reconstruction of Britain and of our international relationships, in learning and the arts of peace, as well as in social and economic directions, is a matter of great concern about which we should be thinking already. In so doing, a disinterested body of high standing such as the British Academy is, with no particular political axe to grind, might render the greatest possible service to the state. Science will have

a special part to play, now and in the future, in national and international affairs, and it is right that independent science should have access to the chief center of government. Other branches, however, of disinterested learning, have an equal if different application, and one would like to see for them a similar machinery created. Science is at last coming into its own in relation to social, national and international affairs. The older branches of learning, too long contemptuous, have begun to realize the situation: but that need not mean that social, historical, economic, literary and philosophical studies will have their influence diminished; only that the influence of learning as a whole will be increased.

To return to my story. Just before the end of the last war, in 1918, representatives of the academies of all the allied countries met in London, and later in Paris, to discuss the formation of a new international scientific organization. In July, 1919, the first General Assembly of the International Research Council, as it was to be called, met in Brussels. Representatives of the Central Powers were not invited, and a misunderstanding which then arose was made an excuse for declining an invitation which was sent to each of them a few years later. This unfortunate state of affairs persisted. German professors who feel themselves insulted are difficult people to appease, and indeed the fault was not all on their side. International Unions for Astronomy, Geodesy and Geophysics, Chemistry and Mathematics (this last no longer in existence) were formed; and at the next General Assembly in 1922, for Physics, Scientific Radio, Geography and Biology. Some of these unions have functioned well and have held important international congresses and done important work; others have done little. The ones that have worked best, *e.g.*, Scientific Radio, are those which had a more practical international task to fulfil.

These unions always had an official or semi-official flavor: official delegates, official hospitality, official finance, official business, have tended to put independent science into a somewhat subordinate position. Physiologists have held international congresses for fifty years, and great value these have had, as we know, who have taken part in them: but physiologists have always insisted that they came as independent scientists, to meet, to hear and to discuss things with their colleagues; not as representatives of some state institution or interest. Other scientific groups have held similar informal congresses based on the same idea. There is grave danger, as was found by the Physiological Congress meeting in Italy in 1932, and in the Soviet Union in 1935, of a congress being used as an opportunity for political propaganda: in 1938 this was altogether avoided by the tact and understanding of Swiss colleagues, as it had been avoided at meetings prior to 1932. Political considerations are hard enough to avoid anyhow, but they are much worse if a congress is not genuinely independent.

In this country and in America, the great strength and the high position of the independent scientific societies make it easy for them to take charge of the proceedings of a congress, or of an inquiry of international importance, without danger of state control —either in appearance or reality. But this is not so easy, indeed it has been impossible in recent years, in many countries. In order to preserve the integrity of science in our own country, it is very important that those strong independent scientific bodies should be maintained: and for the sake of international scientific relations it is desirable that in other countries also, so far as we can influence them, the domination of the state over science should be tempered by public appreciation of the part played by independent scientific agencies and institutions

In some form or other, not, one may hope, exactly in their present form, these international unions must be started up again some day. This time, at any rate, we shall not be prevented from following our better judgment by the intransigence of French colleagues: though it may be hard enough for us this time to take a detached view. My own feeling is that in this matter we should rely, as far as possible, upon the help and advice of our American scientific friends. Their views about science, for its own sake and in relation to the state, are much the same as ours, and they (at present at least) are further from the battle. I know they would regard it as a sacred trust of friendship to bear a large part of the burden of starting off again the international cooperation in scientific endeavor which was so unhappily ended by the events of the last years.

In America, as in Britain, science is largely independent of the state. There, as here, great scientific organizations work under government auspices; there, far more than here, the great corporations maintain their research departments; there, as here, free universities and free endowments are engaged in promoting the advance of scientific knowledge; there, as here, free and independent science is able to cooperate with the scientific agencies of government and industry, to the great advantage of all. There is a high idealism in America about international cooperation in the field of science and learning, and a very great regard for British science and British scientists. If the war goes ultimately as we expect, in the downfall of dictatorship and tyranny, it will be our job to start off again, on broader and better lines, the complex system of international scientific cooperation: and in starting it off I am sure that we shall be able to call

for the help and coperation without stint or limit, of our scientific friends in America.

I have spoken several times of the necessity of guarding the independence, the spiritual integrity of science. In many countries to-day science is wholly subservient to the state: its soul is not its own. I do not deny for a moment the importance, indeed the necessity, of scientific organizations within the framework of government, or of liberal support by the state of scientific research. One can only welcome such recognition by the public of the importance of scientific knowledge and scientific discovery—and ask for more. There are several things, however, which one may fear. *Firstly,* the condition of stagnation and complacency which tends to develop in any scientific department or establishment which is cut off from outside criticism or ideas: we have far too many examples of this already, formidable examples, and if we are not careful they will multiply; the reduction of science to official routine can be a real menace. *Secondly,* the danger that science will be planned by administrators in offices instead of by young men with their sleeves rolled up, in laboratories or workshops. *Thirdly,* the disadvantage of separating teaching from research, to the great loss of the next generation who may miss the inspiration of seeing discovery going on in the places where they are taught. *Fourthly,* a decrease in the influence and prestige of those independent scientific bodies which play so large a part in the social and intellectual activities of the scientific community and provide the cross-connections between groups which might otherwise be isolated. *Fifthly,* the danger that he who pays the piper may call the tune, and that research may be required to be devoted primarily to objects which the politician, or the civil servant, regard for the moment as of national importance; or even—as in Germany and the Soviet Union —to bolstering up theories which the official philosophy of the state prescribes.

To avoid all these troubles, the independence and integrity of science must be carefully preserved; in the universities, in the learned societies, in the various associations or institutions devoted to the advancement of knowledge. Whenever state support is given, a buffer should be interposed, similar to that provided by the University Grants Committee between the universities and the treasury. In our existing research councils (Department of Scientific and Industrial Research, Medical Research Council and Agricultural Research Council), working with government funds, the buffer is already provided by the fact that the members of the councils are chiefly independent scientific men. The same safeguard exists at present with much of our state-aided research: we must carefully watch that the strength of this safeguard is fully maintained, that it does not become a formality, and that the principle is consciously extended wherever possible as the financial burden of scientific research and development is taken over (as is bound to happen more and more) by the state.

In many of the departments of government, however, notably those of the defense services, scientific research is undertaken on a grand scale, which can not be controlled directly by outside independent bodies. In these establishments particularly, the danger of stagnation and complacency exists. They are devoted to specific service purposes, often, of necessity, secret: and the condition of secrecy prevents them, in ordinary times, from attracting many of the ablest and brightest minds, who prefer the freer atmosphere of the universities, the possibility of discussing and publishing their results, and the recognition of their colleagues resulting therefrom. Consequently, in war, those who direct these establishments are often people who have arrived at their positions by seniority and long service, during which they have been largely isolated from the ideas and criticism of current scientific thought: it has been difficult for them not to become officials rather than working scientists. When an emergency occurs, as at present, numbers of able men come in, but to posts in which they can exert relatively little influence, and their ability and imagination may for long be imperfectly used. This indeed is inevitable under the present system, for they have at first no experience of service conditions and needs. After a year or two, perhaps, longer than necessary, these able people find their proper level, but not until much damage has been done by lack of imagination and energy in the posts they might have filled before.

To avoid this trouble—and it is a very real one—two main principles may be applied. *Firstly,* to introduce into each department or organization some kind of scientific advisory council, similar to that which on the whole works so well now in the Ministry of Supply. This council should consist partly of independent scientific men chosen for their special knowledge on the one hand, for their wide contact with the scientific community on the other: and partly of official scientific people representing not only the department or organization itself, but a variety of other departments, so that a good cross-section of official knowledge and experience is available. And *secondly,* in ordinary times to arrange for regular interchange of personnel between the government research establishments and organizations, and the universities and other independent institutions in which research is carried on.

I know that this second proposal will shock some of

those who have lived in the traditional secrecy of service science; but it is right all the same. Why should not a chemist or mathematician from Woolwich, a physicist from Signal School, an engineer from the Royal Aircraft Establishment, go back as a lecturer or professor to a university, or to the research staff in a commercial laboratory; just as a physiologist from the National Institution for Medical Research or an aeronautical engineer at the National Physical Laboratory or a zoologist at the Marine Biological Laboratory at Plymouth may do? And why should not the research workers in government laboratories be just as regular attendants at the meetings of scientific societies as those in other institutions? I sometimes thought, before the war, how good it would be to take a mission, harmonium and all, to one of the most important—and the most dead-alive—of these places and try to stir up a little general scientific enthusiasm.

It is difficult to get over vested interest and tradition in these things. As regards the first desideratum, that of an idependent scientific advisory council with the framework of a government organization, from a department where it does not exist already we are apt to get the reply from the political head or the permanent secretary, "When we want scientific advice we can always go to Sir X.Y.," not realizing that Sir X. has sat in an office for years and that, anyhow, he can not be knowledgeable on everything. Or we are told that the department has an excellent scientific organization of its own, which has, in fact, gone on without any expert criticism for many years, saved indeed from criticism by its well-preserved secrecy. Or it is said, "When we want scientific help we can turn to the D.S.I.R., the M.R.C. or the A.R.C., as the case may be." Those excellent bodies can in fact do much, but they can not do more for other departments than answer specific questions. A large part of scientific work lies in formulating the questions to be asked, and that can not be done except by people who are in close personal touch with the actual needs. A family doctor, in fact, is wanted, to watch over the scientific health of the department; to call in a consultant alone at intervals is little use; the family doctor must be available to realize the need and to understand the situation of the patient—*then* the consultant's advice is valuable. The three research councils are to be regarded as consultants, excellent and essential ones; but they do not make it unnecessary to have independent advice within a department.

As regards the second desideratum, that of a free interchange of personnel, backwards and forwards between government establishments and the universities and other outside scientific institutions, the first need is for a common pension scheme. All scientific workers, whether in the universities, or in commercial laboratories, or in government employment, should come under the Federated Superannuation System for Universities (F.S.S.U.) as do those employed by the three Research Councils (D.S.I.R., M.R.C., A.R.C.). Then the departments should insist on sending their people away at intervals, to carry on research elsewhere and to refresh their souls in institutions outside. Conversely, the departments should invite outside scientists (naturally under proper safeguards of secrecy when necessary) to work for corresponding periods in their establishments. The advantage of this second step would be that the importance and interest of the problems which are being tackled in government establishments would be more commonly realized, and better men would be inclined to take part in their solution. In the defense services a reserve of officers and other ranks is an essential part of an efficient organization for war: in the scientific services similarly, a reserve of research workers for the case of emergency of any kind, would seem to be equally essential. I am not thinking only of war; other emergencies occur requiring the sudden application of scientific knowledge and method. It would be simple and not very expensive to build up such a reserve of scientific talent, available for service when needed and in so doing to introduce a new spirit and a new outlook into government scientific establishments.

One great advantage of working in the scientific establishments either of the government or of a large company or corporation, is the fact that equipment is not limited below the minimum that is necessary for efficiency. In most of the free institutions, money for research is notoriously short. One of the great needs of research is better financial support, and in the relative poverty of charitable people and bodies to which I fear we must look forward for some time, this support will have to come from the state. One hears proposals made, for example, for a national research council to be set up to administer grants for research. In considering such proposals we should be wise to remember three principles:

(*a*) that a powerful buffer is required to prevent the state from interfering with the integrity and independence of research, and to save research from being over-planned and directed by officials sitting in government offices;

(*b*) that it is often better to ask existing and experienced agencies, which we know to work, to undertake new jobs, in spite perhaps of apparent imperfections in their organization, rather than to allow our young revolutionaries to scrap the old and set up new schemes, cleaner on paper but untried;

(c) that the chief value of research grants will often be to young and comparatively unknown people, so that as far as possible devolution of allocation should be adopted, and the responsibility left to the university or other institution in which they work and where they are known.

For my part, as regards research in the universities, I should feel inclined, if a government fund of, say, one million pounds were available for scientific research, to ask the University Grants Committee to allocate it to different universities as they do the larger sum of two and a quarter million pounds of the Treasury grant. Each university would then deal with the disposal of the sum allotted to it, in much the same way as the Royal Society does with the Government Grant for Scientific Investigations; and as in the last few years the University of London has already done with a substantial fund which it has put aside for this very purpose from its own resources. It is true that, of the Treasury Grant of two and a quarter million allotted by the University Grants Committee, a considerable part goes ultimately to research; or at least to maintaining the people and the institutions by whom and in which research is done. I know, however, from long experience, both personally and by helping to administer the Royal Society grant, the great advantage to the individual and to the institution where he works, of the possibility of obtaining a grant, possibly large, more often small, for a specific research project; to be expended by the young research worker (or the older one) at his discretion and not merely by the department. What the University of London has made a start in doing in this way, following on the example of the Government Grant for Scientific Investigation, administered by the Royal Society, can be done by other bodies; but money will be required. In the days of straitened circumstances which we can not but foresee ahead, it must come from the state if scientific investigation is to be kept up—as it must be; and the natural body to allocate it to its different claimants among the universities would be the University Grants Committee. In this way we could avoid creating new and untried machinery.

For research in industry, in medicine and in agriculture (apart from their overlap with university institutions) the machinery for similar grants exists already in the three Research Councils: with extended financial provision from the Treasury if necessary. In industry at least part of the sum required should be subscribed by the industry itself as it is at present with the Research Associations devoted to various subjects and working in cooperation with the D.S.I.R. The personal grants given at present by the D.S.I.R. for researches "of particular timeliness and promise" are of great value and could with advantage be extended.

I have tried to cover a large field in a very short time, and have been forced to deal for the most part with principles rather than details. I have omitted all reference to the pay and status of scientific people; the people themselves and the conditions vary widely, and for some men too much security just as well as too little may diminish their usefulness and initiative. I have not referred to the question of grants for students training for research, or of provision for weeding out those who show no scientific capacity; nor have I even mentioned scientific education, which would require a lecture to itself. And, lastly, I have not ventured to discuss how the scientific resources of the nation at war could be better utilized. That might involve not only the usual items of criticism and the usual items of defense which we have all heard, but also—if properly undertaken—an exposure of facts which must at present be kept secret and of difficulties due to the personal peculiarities of individuals. Unfortunately, when science comes, as it must come in war, into direct touch with action, it finds itself thwarted by intrigue, upset by unscrupulous exploitation of social and political connections, surrounded by personal ambitions and jealousies. These provide no small part of the difficulty in the way of utilizing our great scientific resources to the full. Blessed are they who remain innocently in their laboratories and grumble: for it is a thankless task to try to get things right.

One last word. In recent years a number of brilliant revolutionaries, filled with political zeal but without experience of affairs, have won great fame and applause by showing how science is going to change the face of society. The public is inclined to place these gentlemen on the same intellectual pedestal as Einstein, supposing that their science is as great as their chatter. The more responsible members of the scientific community are a little frightened by these activities—not because they grudge their colleagues their easy fame—but because the impression is put about that scientists as a whole claim to be allowed to dominate policy; and so, resistance is aroused to their more modest suggestion that they ought to be consulted. If these remarks should reach the ears of those on whom the task of formulating public policy falls, they can be reassured. The majority of scientific men are quite reasonable and have no grandiose ideas. We know our own limitations—as we are well aware of yours. All we ask is that we should be considered as equals in a common task—not merely as superior technicians paid to dish up the magic which you order.