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SCIENCE, AND ITS CHANGING SOCIAL ENVIRONMENT¹

By Professor P. W. BRIDGMAN

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THE first part of this address dealt with recent work of the author in extending the pressure range attainable in the laboratory. The subject has been similarly treated in the third volume of *Science in Progress*, published by the Society of Sigma Xi.

And now I will turn from these technical matters, with which I have been personally concerned, to matters of more immediate and vital interest to all of us. In the present world struggle physics has come to occupy a position in the very front line. A large part of the body of physicists has been asked to divert its activities from accustomed channels, and all of us who have been able have rejoiced that the opportunity has been offered and that we can be of service. Because

of the obvious importance of the service that physics is rendering, many physicists are anticipating, after the war, a permanent increase of the appreciation of the public for physics, and a great increase in the attractiveness of physics as a profession for our abler young men.

There are, however, other aspects of this rosy future to which I wish to direct your attention. Because of the heavy social impact of the products and techniques resulting from scientific investigation, there is a growing tendency in many quarters to maintain that science, and this of course includes physics, is the servant of society and that all scientific activities should be under complete supervision and control by society or the state. This point of view is finding advocates among scientists themselves. It seems to be growing in favor in some quarters in this country,

¹ Part of the retiring presidential address to the American Physical Society, given at Columbia University, January 23, 1943.

but not yet to the same extent as in Russia, where it is widely accepted, judging by various mass proclamations of Russian scientists published in our press, or in England, where there is an aggressive and articulate group with a similar attitude—the book by Bernal entitled “The Social Function of Science” comes to mind. Indicative of the feeling in some quarters in this country, there is an article in a recent number of the *Popular Science Monthly* which is an extreme example of this point of view. I believe that there is a probability that after the war this feeling will be intensified in proportion to the very success that physicists may have in helping to win the war.

Closely connected with the thesis that scientific activity is a social function is the growing impulse to hold the scientist personally responsible for all the consequences of his discoveries. In all this there is a good deal with which one may sympathize, but I believe that nevertheless an unqualified and unreserved acceptance of the current popular views about the social position of science will result in a false placing of emphasis which in the long run will be harmful both to scientists in their profession, including physicists, and to society as a whole.

The issue is confused by the looseness with which the word “science” is used. Popular usage lumps under the single word “science” all the technological activities of engineering and industrial development, together with those of so-called “pure science.” It would clarify matters to reserve the word science for “pure” science. Because a single word is used, there is an impulse to assess a blanket responsibility and to set up blanket controls. Superposed on the confusion arising from verbal looseness there is another less innocent factor. It seems to me that there is often just plain resentment that changes in accustomed routine are so often the outcome of investigations in pure science. Large numbers of the genus homo do not like to be shaken out of an accustomed routine. It is this resentment more than anything else which I believe leads to fastening of “responsibility” on pure scientists. In extreme cases this has even led to the demand for a compulsory moratorium on all scientific investigation.

I think there has been a tendency for scientists in general and physicists in particular to acquiesce too meekly in the implication of social responsibility for their discoveries. The conjuring up of “responsibility” is often only the device of a lazy man to get some one else to do for him something of vital concern to him which he should be doing himself, and scientists in their naiveté have not seen this.

Let us imagine what acceptance of the thesis of responsibility would involve. Perhaps the most fundamental of all the conditions for success in scientific

discovery is complete freedom. If the scientist were required to make only those discoveries which could not wilfully be perverted to harmful uses, he would almost certainly feel himself so restricted that he would make no discoveries at all. Furthermore, it is impossible for a physicist or any one else limited by human fallibility to foresee all the consequences of a discovery, much less, to balance all the good consequences against all the bad consequences. Responsibility does not exist when there is no mechanism by which the responsibility can be determined. Neither is there any mechanism by which the physicist can control such consequences of his discoveries as he can foresee. It is society as a whole that is in a position to provide the mechanism of control rather than the individual discoverer, so that it is therefore the responsibility of society to see that discoveries in pure science are properly exploited, not the responsibility of the discoverer. When a physicist makes a new discovery and imparts it to society, he is presenting society with an opportunity, and this opportunity implies responsibility on the part of society.

Society already has available a mechanism of at least partial control in a control of patents and production. Whether an entirely adequate control could be exercised in a framework of a society broken up into separate nationalities as at present may not be easy to decide; certainly the decision and the resultant action is out of the province of the individual scientist.

What is it that makes the “pure” physicist go when he is on the trail of some new idea in his laboratory? The answer is, of course, complex, but I believe that through all the multifariousness runs one simple guiding thread, the craving for understanding. To the extent that the guiding motif of an enterprise is the craving for understanding, to that extent the enterprise may be said to be purely scientific, as distinguished from technological, or utilitarian, or artistic, or political, or what not. The craving for understanding reaches its greatest poignancy only in a few cases, but all of us who are engaged in pure research have it to a certain extent, and it is the vital part of what makes us go. It is not a matter to be argued about, as to whether such a craving has economic or other justification; it is only to be accepted as a fundamental fact about human beings that some of them have developed to a high degree the passion for understanding and a delight in the corresponding activities, just as others have a strongly developed sense of beauty or of conduct. If society is ever going to become anything more than a vicious merry-go-round of circular activity, if ever there are ends in themselves or goods in themselves, then surely the gratification of the craving for understanding is one of them.

To those who have a passion for understanding

society will not be a satisfactory place unless it affords opportunity for the acquiring of understanding, so that to the extent to which the function of society is to make life satisfactory for its members, and it seems to me that this is pretty nearly the whole function of society, one of its responsibilities is the making and providing of adequate scientific opportunity. Society is the servant of science even more and in a more fundamental sense than is science the servant of society. Any control which society exerts over science and invention must be subject to this condition.

Physicists are, I think, even if they give intellectual assent, inclined to be too diffident to insist on all the implications of this conclusion. Many of us find it uncongenial to thrust ourselves forward and to insist on the service owed us by society, particularly at the present. We have a feeling that we should not confuse the issue of winning the war by insisting on matters of obvious personal concern at a time when the very existence of the society to which we are accustomed is threatened. I would urge that on the contrary now is the time more than ever to insist that society must conform to the pattern of service to science. What are we fighting for anyway? After we have scavenged the world of the blight of totalitarianism, what are our long-range objectives? Have we nothing eventually in view more admirable than the abolition of want and the securing of comfort for everyone, ends which at present bulk so large in our programs? Will we be permanently satisfied with these, or will something more be necessary to give dignity and worth to human activity?

In urging the claims of science and scientists on society we may fortify ourselves by reflecting that we are not urging society to give without return. The exercise of the mind and the acquiring of understanding is after all not an ignoble human activity. In more idealistic phraseology it is sometimes described as the pursuit of truth. One might even argue that it is the one human activity which distinguishes us most from the brutes; certainly it is the one in which there is the greatest room for future development and in which we have most failed up to now to realize our full potentialities. In the long run society is a better place for every one when there is intellectual freedom and encouragement and flourishing activity in pure science. It does not put much of a strain on other social mechanisms to have scientific activity going on, nor are we an obtrusive class. We work hard and like it; the pursuit of personal comfort or even happiness is not a particularly compelling motive with us; there is a certain disinterested impersonality in our striving which has on occasion been commended. We do not ask for much in comparison with what we give: freedom and leisure to do our work and decent security for the future. Many of us already have been more

or less fortunate in these respects, and some of us already have been living under conditions which approach the millennium according to our simple standards. But it seems to me that the prospect is becoming less bright. Not many people like to use their minds, and there is always some spontaneous hostility of those who do not like to think toward those who do. For years before the war there were signs of a growing anti-intellectual sentiment, which I believe is now becoming visibly intensified with the passions and emotions always associated with war. It seems to me that scientists are curiously obtuse as to the social conditions which make possible their existence as a class. It is by no means a certainty that society will so evolve that the individual will be allowed to engage in independent intellectual activity. The danger of such an evolution increases with the growing command by society of techniques assuring a satisfactory degree of common ease and comfort. Society may well come to feel that the scientist has not enough more to give it in the way of material benefits to justify keeping him. If society is ever going to become a place in which intellectual activity is encouraged and intellectual ability prized, those of us who like to think have got to fight for it. If we do not take action in our own behalf, no one else will do it for us. And we must do it now because social institutions are changing so rapidly that after the war it may be too late. Judging by the one criterion of greatest significance in this country, economic position, there is no doubt that the changes now taking place are leading to a worsening of the position of those who like to think as contrasted with those who do not. When we contemplate all the pressure groups insistent only on their own advantage, we need not be diffident in striving for an even greater recognition than in the past of the social importance of intellectual activity, and of the importance of stimulating such ability by commensurate rewards.

A distorted conception of democracy is forming under stress of the war, a conception which urges the equal right of every one to share the goods of society irrespective of what he gives back to society. The conception of democracy which was implicit in the old fashion "American ideal" seems to me more admirable. According to this conception democracy meant equal opportunity for ability, no matter how humble its origin, to rise to its natural level. So far as capitalism was discussed at all, it was justified, at least in theory and in spite of its defects, because it incidentally provided a machinery by which special service received special reward. It was not considered that a society was either ignoble or undemocratic that gave special reward for special service. Nor was the individual who consented to receive special reward for special service considered to have debased himself. It was felt

that society need not grudge to act to its own advantage because it was also for the advantage of the individual; society did not resent the individual of exceptional abilities but took pride in him. It seems to me that a certain crabbed and ungenerous spirit of envy and resentment against unusual ability is growing; this is underlined by recent events. To me there is something dead wrong with a social philosophy that attempts to set *any* upper limit to the value of the contribution which a man of unusual ability can make to his society, particularly in time of war. In the name of democracy our ideals are becoming less democratic. A partial explanation is doubtless to be found in industrial and capitalistic abuses. But an explanation does not constitute a justification.

We, who are perhaps more vitally concerned than any other group, have thus far failed to take steps to ensure that the economically altered society of the future shall retain those essential features that once inspired our democratic vision. Our conviction has not been strong enough that a society is a good society in which intellectual ability is prized and rewarded. We are passively accepting a change in the economic system by which the relative position of all intellectual workers, including the scientist, is being definitely debased, and in which assurances and commitments made by society in the past are being needlessly scrapped. This applies with particular force to the private universities and to the workers in them. We are not fighting against these things ourselves, and we in the universities are not insisting that our university and educational administrators fight for them for us.

What are we going to do about it? In the first place, we are not going on strike, but those of us who are in the position will continue to work as hard as we can to develop all the devices in the power of our ingenuity or to make what other special contributions

we can to destroy totalitarianism and all that it implies. Neither, I think, will scientists attempt to organize themselves into a pressure group to try to mold society to their pattern. Even if it were not ludicrous for so small a minority to think of making such an attempt, we would find such an attempt distasteful at a time when so many of our young men are being called on to make extreme sacrifices. And even if not distasteful, who could find time to devote to such an attempt when we are all so busy with immediate things? But it would be stupid not to take time to at least see what the situation is, and once having seen it, it will be possible to do many things incidentally without slackening in our other efforts. Merely by letting it be known that we are aware of the situation we may accomplish something. From the long range point of view our job is primarily one of education. We should avail ourselves of every opportunity and even go out of our way to make opportunity to let our conviction be known that a society is in the long run the best society in which those who have the ability are given every opportunity and inducement to practice the pursuit of truth and of understanding. We must hold up intellectual power and accomplishment to the admiration and emulation of our young and stimulate their pleasure in intellectual activity. Our educational programs must be revised if necessary to give this emphasis. We must teach our young a social philosophy which recognizes that society is a means and not an end, and we must give them a technique by which they can discover those ends which they can accept with intellectual integrity as making society worth while. If we do not do these things, we are in danger of finding when this struggle is over that we have been fighting for a lifeless husk; if we do them we will be playing our part in molding a public opinion which will create the society of our vision.

DIGITALIS AND SOME OF ITS DERIVATIVES. II

By Dr. HARRY GOLD

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(Continued from page 129)

One of the results of these studies was to show that a similar number of units determined on the frog (U.S.P. XI units) produced widely different effects, while the degree of effect paralleled the number of units determined on the cat. The frog, therefore, appears not to be a suitable animal for the standardization of digitalis preparations that are to be used in man. When the frog and the cat method give different answers in a comparison of specimens of digitalis, that obtained with the cat method is more nearly applicable to humans.

The cat method has now been adopted as the official

method of assay in the Twelfth Revision of the U. S. Pharmacopeia. It is to be expected that in the future the potency of digitalis preparations of commerce will be more uniform.

There are certain objections to the cat method as well, since the technique involves intravenous injection, and in that way it fails to distinguish between absorbable and non-absorbable material. This is a matter of some importance, since digitalis is most commonly administered orally in man.

There is abundant reason for the belief that the potency of a specimen of digitalis or a glycoside which is to be used in man should be assayed directly on man.