SCIENCE

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*ANNUAL DISCUSSION BEFORE THE AMERICAN SOCIETY OF NATURALISTS.**

THE ATTITUDE OF THE STATE TOWARD SCIENTIFIC INVESTIGATION.

A FAIR criterion of intelligence in the government of a country is afforded by an examination of its annual budget. There is first the provision for a certain number of expenditures which are purely conservative, because the State must maintain itself, it must defend itself, it must support a large class of office holders who are more or less useful. Without knowing the figures it is safe to say that the budget of Russia is chiefly of this order. These expenditures may be wisely and honestly made, but they largely go to waste; they are either immediately productive or altogether non-productive. On the other hand, there are expenditures in the nature of investments, looking to the future and characterizing the most far-sighted statesmanship. Conspicuous among these are the funds invested in education and science.

Said Helmholtz in 1862†: "In fact men of science form, as it were, an organized army, laboring on behalf of the whole nation, and generally under its direction and

* Given at the Baltimore Meeting, 1900.

† 'On the Relation of Natural Science to General Science' (Heidelberg, 1862), 'Popular Lectures on Scientific Subjects' by H. Helmholtz. New York, D. Appleton & Co. 1873. Pp. 28–30.

at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprise, to increase wealth, to adorn life, to improve political and social relations and to further the moral development of individual citizens. After the immediate practical results of their work we forbear to inquire; that we leave to the uninstructed. We are convinced that whatever contributes to the knowledge of the forces of nature or the powers of the human mind is worth cherishing, and may, in its own due time, bear practical fruit, very often where we should least have expected it." Helmholtz in this most influential essay enforces his point by citing Galvani and Galileo and continues: "Whoever, in the pursuit of science, seeks after immediate practical utility may generally rest assured that he will seek in vain. All that science can achieve is a perfect knowledge and a perfect understanding of the action of natural and moral forces. * * * At the same time we must acknowledge that the value of scientific discoveries is now far more fully recognized than formerly by public opinion, and that instances of the authors of great advances in science starving in obscurity have become rarer and rarer. On the contrary, the government and peoples of Europe have, as a rule, admitted it to be their duty to recompense distinguished achievements in science by appropriate appointments or special rewards."

Upon the general contention of Helmholtz as to the ultimate practical importance of pure scientific work, Dr. Galloway will speak from the standpoint of botany and Dr. Howard from the standpoint of applied entomology.

Of European countries Germany places in its budget the largest productive investments of this kind; France is not far behind, England is perhaps fourth and affords a conspicuous example of blindness and fatuity in the matter of unproductive investment; she has, it is true, established textile schools, but has not sufficiently supported technical schools; the cost of a single battleship would establish four splendidly equipped technical schools; England secures the ship and postpones the construction of the schools. All this is through no fault of her prophets of science, who have been as persistent as Jeremiah in foretelling the consequences which are sure to follow.

Yet England gave Darwin his schooling upon the *Beagle;* Huxley secured his upon the *Rattlesnake.* As a sea-faring nation marine zoology appeals to her imagination, and the single notable departure from her short-sighted policy in the encouragement of pure science is the magnificent service she has rendered in the *Challenger* expedition. Our own Dana was trained upon the Wilkes expedition; the French Government equipped the *Talisman*; the German government is supporting the highly successful cruise of the *Valdivia* and its publications under Chun; the U. S. Government has a permanent exploring vessel in the *Albatross.*

In this rivalry of foresightedness the German and French governments have been our keenest competitors both on sea and land, and have probably surpassed us in the recognition of the ultimate economy of pure research. In Germany, quite apart from the extension of the technical school system which to-day is placing her in the lead of all the manufacturing states of Europe, one recalls the annual grant to the Naples Zoological Station. Her most admirable recent action is the subvention of Professor Abbe for his investigations upon optics. Abbe's work was not in the nature of invention, but of research and discovery in the highest sense resulting in the production of an illuminating stage, apochromatic and achromatic immersion lenses, which have fairly revolutionized biology. What we owe to these lenses in a theoretical sense could not be stated in a single

volume and the economic value is equally immeasurable.

The distinctive feature of pure science is that it is not remunerative; the practical rewards and returns are not the immediate objects in view. On the other hand, the work of Tyndall and Pasteur on fermentation, pursued in the first instance for its own sake, has come to have an economic importance which is simply incalculable.

American legislators have lent a willing ear to the advice of wise men. What we now enjoy we owe mainly to the counsels of Joseph Henry, Spencer F. Baird and G. Brown Goode. And I may call attention here to a thought which will be expanded presently, namely, that the secret of the success of these men is to be found in their enthusiasm, unselfishness and lofty scientific and personal character. When we consider the liberal appropriations made year after year for the United States Geological Survey, the nobly equipped station at Wood's Holl, the purely scientific work which is now being supported by many States and municipalities, there is abundant cause for congratulation; but lest we think of ourselves more highly than we ought to think, let us recall the contrast between our lavish liberality in certain appropriations and our lack of enlightenment in certain details of legislation. The student steps in line with the farmer to support the manufacturer; he is encouraged to work, he is denied the tools. In regard to the importation of models, microscopes and other scientific instruments the tariff is a tax which bears most heavily upon research. By the tariff on lithographic plates Congress places a Chinese wall around publications of the first class in all branches of natural history. America is a most unfavorable center of scientific publication so far as illustrations are concerned. Professor Sedgwick will perhaps have something to say upon these subjects.

In these matters the American Society of Naturalists has expressed and will continue to express its urgent desire for reforms which will come about through public enlightenment.

The main object of this discussion, however, is not merely a reiteration of opinions which we all share, but a symposium in regard to some of the new directions in which we must apply our energies in order to secure ultimately the best results.

In the last analysis we are *advocating public taxation* for the purposes of research. Having considered the parental relation of the State to the investigator—what are the filial relations of the investigator to the State. Granting that we have carried the outer works by demonstrating the wisdom of taxation, felicitating ourselves upon the fact that we have an enlightened public opinion behind us, there now remains the honorable obligation on our part of administering these funds to the very best service of the State, and it is to this obligation I wish to especially direct your attention. There are two directions in which it is possible that we have not as yet fulfilled our duty.

I believe with Huxley that good science rests upon good morals and that good morals rest upon those principles which are best enunciated for plain people in the ten commandments. In the special field of work under discussion, it seems to me that in return for the confidence of the State, specialists are under the binding obligation to administer public funds in the most scrupulous manner. I have in mind instances where the confidence of the State has been betrayed and where results damaging to the general cause of science have inevitably followed. Extravagance in the use of words and parsimony in the use of ideas; the lavish illustration of papers of little scientific and of less literary value; the reckless expenditure of public funds for instruments, apparatus,

and general equipment that anticipate imaginary rather than real needs; the diversion of these funds to purposes for which they were never intended; the surreptitious introduction of material not mentioned in the original purpose of an appropriation; in short, the obtaining of money under false pretenses; these are immoralities which retard the development and jeopardize the existence of the grand system which our state and national governments have so wisely instituted.

A second consideration is the importance of cooperation between nation, state, and university in education and organization for research. A conspicuous example of the splendid results which may flow from such cooperation is found in the present administration of the United States Geological Survey. We see the Government cooperating with the states and with the universities and public museums to produce a uniform investigation of the geology and paleontology of the entire area of the United States. Of this Professor Clark is far better qualified to speak than I am.

In the foundation of the United States Fish Commission Station at Wood's Holl, Spencer F. Baird, one of the most large-minded men this country has produced, formed a similar conception of the advantages of cooperation in biology, which alone justifies the erection of an enduring monument to his memory. While the execution of his purpose may be described as having ebbed and flowed like the tides, strong under some administrations, such as Goode's, and not even as yet fully attained, we have in the last few years seen an approach to the fulfilment of Baird's ideal, and it remains for the United States Fish Commissioner and his staff, and the Director and Trustees of the Marine Biological Laboratory at Wood's Holl, to consider a plan of cooperation which will effectively combine the intellectual and material forces of these two institutions in the future. No private institution can compete with the material resources of the government; no government institution can flourish without availing itself of the intellectual resources of the university. The cooperative advantages which the Marine Biological Laboratory should enjoy as the premier institution of its kind in this country should be extended to other laboratories along the coast. The difficulties in the way of bringing about such cooperation are more apparent than real, in fact, I am one of those who have firm faith that the ideal is also the practical and that we shall see Baird's plans fulfiled in the case of biology, even as Hayden's plans have been fulfiled in the case of geology.

If the larger scientific interests of the country are one, and if the Utopian state is one in which there is a sympathetic nervous system connecting state and university work, it is obvious that our colleges and universities should consider more carefully than they have done the preparation of men especially for state work. Educators have perhaps had too exclusively in mind the medical school, the teaching profession, and too little the direct service of the state. This is a feature of the general subject which will be especially spoken of by Dr. Howard who is well qualified by his knowledge to discuss present conditions in state and college and the present needs of government science.

College and university men of science, and state and government men of science, naturally acquire certain individual characteristics; they have their strong points and their weak points, and it is of advantage to American science at large that these two classes of men in all departments of science, in physics, chemistry, geology, botany, zoology, should abrade their angles by coming into frequent contact; because contact not only removes prejudices, but it increases mutual respect and admiration,

until an entire unity of purpose and action is consummated which completes the scientific structure of the nation.

HENRY FAIRFIELD OSBORN.
COLUMBIA UNIVERSITY.

THE attitude of the state toward scientific investigation is less a question of inherent right than of expediency. Political economy assigns no sharp limitations to the functions of government and whether or not any particular interest should receive the fostering care of the state depends upon circumstances. That scientific research is a subject of government concern is becoming recognized more fully every year. A well-known English educator in discussing the endowment of research by the state says: 'that liberal and scientific culture, intelligence, and the whole domain of mind, is a national interest, as much as agriculture, commerce, banking or water-supply.'

Granting all this, and I am sure no one here maintains any other view, we are confronted with the fact that the state cannot support, or even subsidize, *every* national interest. Which should receive government support must finally be determined by expediency—by whether in the long run the state is to be benefited by the aid extended.

Agriculture, commerce and banking, for example, can be maintained by private enterprise and can be made largely or wholly self-supporting. Their prosecution can be left therefore largely to the individual, with such incidental protection as may be required in the particular case. Scientific investigation is not and cannot hope to be self-supporting in most instances. This I believe to be the determining factor. Admitting the material value of scientific investigation to the state, it becomes necessary for the state to see that its interests are secured.

It may perhaps be desirable to examine for a moment the reason why scientific investigation is not and can not be self-supporting. This may be found in the fact that the great majority of scientific researches have no immediate commercial value and as commodities can not find a speedy or, in most instances probably, even a prospective market. We all know of many investigations, begun without thought of pecuniary advantage, that have ultimately produced practical results of the greatest importance. Instances might be cited of investigations, the value of which were not apparent until a generation or more had passed, as, for example, paleontological researches which have laid the foundation for the correlation of deposits of great economic value. The support of such investigations must, as Professor Osborn has shown, be looked upon as investments for the state which no far-sighted statesman will ignore.

I have found, although my own experience has been limited to be sure, that the average legislator, who is considering honestly the interests of the state, is not without appreciation of the far-reaching value of scientific work, if convinced that the investigations proposed will be honestly conducted. The legislator, surrounded, as he too frequently is, by evidences of political jobbery of every sort, is very keen in detecting what is false and untrue. He may be over-suspicious in some instances and may even suggest that you have some ax to grind in the measure which you bring forward, but if he is honest in purpose his support in the end is not difficult to obtain. I have always gone on the principle that the legislator whose support I was seeking was a public-spirited and intelligent citizen who was capable of judging of the true merits of the subject under consideration. I have never claimed for the investigation proposed that it would in every instance bring an immediate financial return, but rather that the work laid the foundation for subsequent re-

searches, the material value of which could not be estimated. In stating the objects of the Maryland Geological Survey in the opening chapter of the first volume of its reports I said: "The fact must be borne in mind that much preliminary and fundamental work has to be done, the utility of which is not at once apparent to the uninitiated. The publication of such material, rendered necessary as a basis for future investigation, is often liable to misinterpretation, but yet may be of far more lasting value to the State than some superficial statement that is intended to meet a supposed practical need." I believe it is not difficult for the scientific man, with a subject of real merit, to secure the confidence and support of any body of legislators, if he approaches them with honesty of purpose, and with his plan sufficiently matured for them to see its real significance.

We find that ever since the establishment of universities and seminaries widely over Europe in the fourteenth and fifteenth centuries, the civilized countries of the world have recognized in one form or another the relation of the state to scientific investigation. Not only the great nations of the world but oftentimes the small and relatively poor countries like Belgium and Switzerland, as well as the smallest of our own commonwealths, have frequently provided liberally for the support of scientific research. This has been accomplished through the publicly endowed educational institutions, through the public museums and through the special bureaus of the government. The dependence of these various public organizations, as well as the privately endowed institutions upon one another in scientific investigation, has been already pointed out by Professor Osborn, and I shall presently refer to a concrete instance of this in my own work.

Too frequently scientific investigation has held a subordinate place in both the publicly and privately endowed institutions, their chief functions being either educational or commercial. The purpose of the schools and universities is primarily in most instances the instructing of youth in the already acquired results of scientific research rather than the fostering of investigation for itself, although the latter as a secondary consideration often holds a prominent place in the larger institutions of learning. The museums and scientific bureaus are like our great universities centers of research, without the exactions of teaching, where continuous investigation can be pursued under most favorable conditions, although here again either educational or commercial considerations for the most part ostensibly control. That this is not always the case either in our own country or abroad is cause for congratulation, and the support of research directly for itself without other, and oftentimes false, claims is becoming yearly a more fully recognized fact.

It is interesting for us who are Americans to know that the claims of science received recognition at the very inception of our government, for we find that George Washington in his first message to Congress stated: "Nor am I less persuaded that you will agree with me in opinion that there is nothing more deserving your patronage than the promotion of science and literature. Knowledge in every country is the surest basis of public happiness. In one in which the measures of government receive their impressions so immediately from the sense of the community as ours it is proportionally essential." How well that early advice has been carried out by the statesmen of later days under the wise counsels of Henry, Baird, Goode and their successors, Professor Osborn has already shown.

That much can be accomplished through cooperation between our national bureaus and the State and university institutions, I

have had occasion to know in the conduct of the State Geological Survey of Maryland, the resources of several of the national bureaus, as well as the State and university institutions being at my disposal in the advancement of the work. Any single one of these agencies, if alone employed, could not readily have accomplished the same results. This is shown by the scope of the work which the local scientific bureau in most of our smaller States must necessarily embrace. Its investigations cannot be as fully differentiated as is possible in the case of the national bureaus, except by largely increased expenditure, seldom provided even by our richest States, and whether the organization is known as a geological survey or by some other name, it must naturally deal with the whole realm of the physical features of the commonwealth. It need not, however, encroach upon the functions of other departments of the government and more particularly of its nearest associates, the more strictly agricultural institutions, but should, by the classification and mapping of the soils which depend primarily on geological criteria, afford the foundation for agricultural work. But in this as well as in the topographic, hydrographic, magnetic, climatic and forestry work, the relations of all of which to geology are more or less intimate, the aid of the national bureaus is essential, while the State bureau can be the medium by which the results may be presented to the local communities in a manner that would be difficult if not impossible for any institution of the central government. Each has a well-defined field of action and instead of conflicting can be of material advantage to the other.

The same is true of the university and in even larger degree, for here are trained the specialists, who either in State or in national work can add much to the effectiveness of both, while the opportunities afforded by the latter for wider experience react on the university in many ways. The advantages offered the university instructor and student by cooperation in government explorations and surveys are only part of the increased opportunities which can result from this relationship. The various bureaus and divisions of the U. S. Department of Agriculture, the U. S. Geological Survey and the U. S. Coast and Geodetic Survey are all manifesting a broad spirit of helpfulness that is being met by the state and university institutions. The possibilities of an extension of this cooperation between nation, state and university promise well for the widening of the bounds of scientific investigation in this country. It is indeed a hopeful sign when we see the scientific men of the nation, whatever their affiliations, working together with mutual interest and respect. May it presage the dawn of a still brighter day in American science.

WM. BULLOCK CLARK.
JOHNS HOPKINS UNIVERSITY.

THE State and scientific research cover an enormous field—as broad as scientific research and as broad as government possibilities. The men who have spoken and are still to speak are specialists. They can speak theoretically of other matters, but more authoritatively of their own field. I am a specialist and shall therefore limit myself to 'the State and zoology.' By 'the State' I shall refer only to the general government.

In opening this discussion, Professor Osborn indicated two points upon which he expected me to speak. The one was the ultimate practical importance of pure scientific work from the standpoint of applied entomology, and the other was the preparation of men by our colleges and universities especially for State work. In regard to the first topic, the case is so self-evident as to require little elaboration. It is upon work in pure science that the entire superstruc-

ture of economic entomology has been built, and workers in applied science are constantly making use of the results of the labors of workers in pure science. The practical outcome, however, of the labors of the workers in pure science is indirect, while the practical outcome of those who work in the economic applications of science is direct. In any emergency the direct method is the one which is immediately productive of practical results. The study of economic entomology is a study of facts which will enable us to meet one great and widely extended emergency. It must be conducted by the direct method, and the reason why this country stands in advance of the rest of the world in this application of science is because we are a practical people and have adopted the direct method. There can be no doubt, however, that it is necessary for the most successful economic worker to have had a sound training in pure science.

This leads us naturally to the second point—the preparation of men by universities especially for State work. The first training should be, as just stated, a broad one in pure science, but the practical applications should follow with as rigid a course of instruction as can be given. University teachers should make a study of the markets for the brains and training of their students. They should study the conditions of those markets and their needs. This is self-evident. But where is there a college professor who has made a careful study of the practical scientific needs of the Government? Some years ago the President of Vassar College visited in Washington during the Easter vacation. He spent his days visiting the scientific branches of the Government service. He spent his evenings at the Cosmos Club talking with the heads of those bureaus. He went home and arranged a course of lectures on the scientific work of the Government to be delivered for the most part by the men actually at the head of these branches of work. His aim was simply one of broad education, and I doubt whether he had any practical point in mind for the future of his students beyond the acquisition of general knowledge, but you will readily see that this idea might be used in a most practical way.

Men in charge of university departments of scientific work should keep closely in touch with the Government work along similar lines. They should be encouraged to do this by the Government. Government should employ their services wherever they can be of use, and such cases are numerous. They themselves should be able, with the intimate knowledge acquired by official association or by close investigation of Government work, to lay out lines of study which will fit their students to take a hand in Government work. In many cases, of course, this cannot be thoroughly done in university laboratories at the present time. Very few college graduates can pass the special examinations for certain scientific positions under the Government without training which they have secured outside of the colleges. A study of such conditions will show just how this is to be done, and universities will find it to their advantage to increase their facilities for instruction in such directions, and certainly it will be to the advantage of the Government scientific work. This is by no means a new idea. Several practical college men have been asking this question of men in charge of Government bureaus and only recently the newly elected President of the Massachusetts Institute of Technology, who went there direct from a Government bureau, sent out a circular letter asking Government officials how he can best train men in Boston for other branches of Government scientific work than that of which he was in charge.

What does government do for zoology,

and what ought it to do? If it does not do as it ought, why does it not do so?

Aside from the meager sums which the State experiment stations supported by the Government allot to animal industry and to economic entomology, the zoological activities of this Government center at Washington. There are three institutions which do zoological work for the government. The Smithsonian Institution, with its National Museum and National Zoological Park branches, is the only one of the three which cares for pure zoological science. The U. S. Department of Agriculture, with its Bureau of Animal Industry, its Biological Survey, and its entomological service, is wholly economic in the aims of its zoological scientific work. The third of these institutions, the U. S. Commission of Fish and Fisheries, was also established by the Government for a purely economic purpose.

It is not my intention to dwell at any length upon the relative merits of economic and pure scientific work. I have a strong conviction that humanity gains far more from scientific work undertaken with an economic aim than from the labors of the other class of scientific men, and I believe it to be a most unfortunate condition of affairs that hundreds of the men, best fitted by brains and training to attack the many economic problems which are fairly crying for solution, are delving away in their search for truths and principles which when found have only a remote bearing, if any at all, upon the sum total of human happiness. I was once filled with the resounding majesty of the phrase 'science for science's sake,' but now, while I admit the grandeur of the idea, I have come to parallel it and its opposite in my mind with the contrast between abstract and practical Christianity—both beautiful, but one for gods and the other for men.

Now what is Government doing for these three scientific institutions at Washington?

The Smithsonian Institution receives each year $246,540, for the National Museum, and $75,000, for the National Zoological Park. The National Museum employs 33 scientific men, and the National Zoological Park, 2. All are pitifully underpaid. The amounts spent on purchase of collections have been extremely small. Neither the Museum nor the Park has a responsible head in the proper sense of the term. The Secretary of the Smithsonian Institution supervises the work of both branches and alone asks Congress for their appropriations. The personnel of the scientific force of the Museum is admirable in quality but absurdly insufficient in quantity. Not a scientific man on the force has the proper facilities for work. The collections are large but they are one-sided and there is little money to supply the deficiency. Underpaid, with few facilities, grievously dissatisfied with conditions, nothing but the rare enthusiasm which scientific work inspires keeps these able men at their labors. The National Museum needs a new building planned for all time to come. It needs now an annual appropriation of double the present size. As soon as the beginning of a new building is made it will need an appropriation of ten times its present size. Think of what the words *United States National Museum* should mean and then think how the present institution fits the name! Government has not given a proper amount of money and Government shows faint signs of ever giving it. Why? Because Congress has not been made to see the importance of the subject; because Congress has not been asked for the money with sufficient force and with sufficient argument. The Board of Regents of the Smithsonian Institution might make this request and back it with all the weight of the illustrious names of the men who compose that body. The Secretary of the Smithsonian Institution

might make this request and urge it strenuously and incessantly and with an ability which few other men possess. The scientific men of the country might urge it. Organizations of many different characters might petition Congress for it. But the men who best know the truth about the present conditions, the scientific employees of the National Museum, may say no word.

The National Zoological Park is naturally by no means as important an institution as the National Museum, since it is concerned with but one branch of science, but it falls as far short of what it should be as does the National Museum, and for the same reasons. Double the means and a force of zoologists are its important needs. This institution should naturally be a branch of the National Museum, but the National Museum as it should be and as it will be is too great a branch of Government to be controlled by the Smithsonian Institution. It should have its independent organization; it should have its responsible director who will spend his winter days laboring with Congress for appropriations and his nights planning broad lines of development. The Smithsonian Institution has done a great and good work, but it should not be given control of great national institutions like the ideal national museum. Infinitely better would it be were the Smithsonian Institution attached to the National Museum as one of its component parts. The Smithsonian has played its rôle with the Museum. It officiated at its birth and nursed it through its childhood; but the youth is now cramped. It must grow. It must burst the Smithsonian cage and stretch out its own appealing hands directly to Congress.

The U. S. Department of Agriculture is the first of the Government bureaus which does economic zoological work. Here as in the National Museum the men are underpaid, but the facilities for work are vastly better. Government appreciates more readily work which promises immediate economic results and hence money for such work is more easily gained. Scientific men in the Department of Agriculture refuse positions offered elsewhere at higher salaries, on account of these better facilities. Good research work and initiative in investigation are encouraged. Nothing could be more ideally perfect than the relation between the present head of the Department of Agriculture and his scientific corps. Four years ago he announced his policy in this regard in conversation with one of his scientific chiefs in the following words: "I am here to facilitate your work, not to dictate to you. Make your plans, conduct your investigations, and I will help you with all my strength, but I shall hold you responsible for results." Scientific men should honor James Wilson for the introduction of this novel principle in the administration of a Government scientific bureau. The good, sound, progressive scientific work now being done by his corps is everywhere commended, and I am proud to be connected with such an organization. New laboratory buildings are needed here, but there is no fear that they will not come in the immediate future.

The U. S. Commission of Fish and Fisheries deals with a single aspect of zoology and with a single industry. Just why scientific men are chosen as the administrative heads of the U. S. Geological Survey and the U. S. Coast and Geodetic Survey and not, since the days of Baird, for the Fish Commission is one of the mysteries of Government. Nearly four years ago this Society did the creditable thing in passing resolutions and sending them to Washington in the hands of Professor Osborn, protesting against the appointment of any other than a scientific man as the director of this important branch of applied scientific work. The present incumbent of the

office is a good official and no personal objections are to be raised against him. The principle, however, is not a good one, and the next appointee to this office should be a man who combines scientific attainments with administrative ability. The old popular idea of a scientific man—that he lacks what is called 'common sense,' that he is impractical—is an unfortunate estimate gained from unappreciative observation of workers in pure science, but it no longer holds. Henry, Agassiz, Baird—all men of affairs, now gone, did much to change this popular estimate, and the host of brilliant men who have succeeded them—men of high scientific rank, who control the destinies and shape the policies of great institutions, and who turn out work of great and important practical value, have demonstrated beyond the slightest doubt that scientific men are the broadest men of affairs, that they are practical men, and that they are fit to be leaders not only in thought but in action.

It is doubtful whether any government in existence does as much for the encouragement and development of science as does our own. This has repaid her a thousand fold, and the sound judgment of the American people and their patriotic pride in national attainment will effect a steady increase in governmental support of scientific work in spite of temporary checks. With scientific men, however, must come the initiative. They must point out the needs and the ways and means by which these needs must be supplied. This fact is the justification of this discussion.

L. O. HOWARD.

U. S. DEPARTMENT OF AGRICULTURE.

Is it not true that the attitude of the State toward science and scientific research is at all times greatly influenced by the shaping of public sentiment through the work of scientific men themselves? This is a practical age, and in America especially the tendency is more and more to give a practical trend to almost every line of research. We find, therefore, as a matter of fact, that there is a general lack of interest in, and support of, matters having to do with pure science alone, while on the other hand all questions having practical application, and even those in which the practical end is remote are received with commendable liberality. Taking the field of botany, for example, it would be difficult, if not impracticable, to secure support for the preparation and publication of purely floristic monographs, unless it could be pretty clearly shown that such a project had some practical end in view.

In so far, therefore, as the attitude of the State toward all work of this nature is concerned, there is a great deal of conservatism to be overcome, and this conservatism is especially pronounced where pure science is brought strongly to the front. The reason for this is not far to seek, for its roots lie imbedded in the selfishness of human nature, which, acting through organization in the shape of government, sees, or thinks it sees, in the aggressiveness of science a menace to existing institutions in some form or other. While science in its nature is aggressive, the men who do most to advance it often lack aggressiveness, and for this reason the far-reaching effect of science as an educational factor at the present time is not fully understood or appreciated.

This brings me more particularly to the main question I wish to raise in this discussion, namely, what should be the attitude of the scientific man toward the cause he represents. I am strongly of the opinion that he owes it to himself and to his work to put forth every legitimate effort to advance the interests of the cause. He should of course keep constantly before him the fact that to bring honor and credit to the

work he must recognize the duties of life which Professor Osborn has already pointed out. This will not allow him, however, to sit calmly down and wait for the material things of the world to come to him. The men who have it in their power to aid him are too busy to go out of their way to render help unless that help is sought. There exists a mistaken idea that because one is engaged in or may be directing scientific work he is the one to be sought. We see this idea shaping the policy followed in some of our important institutions, as already pointed out by Dr. Howard, and as a result they are being outstripped in every way by others which have a better appreciation of what is necessary to influence public sentiment. After all, the public and those who represent the public look at this matter in its true light, for they have been educated to expect those who are responsible for important lines of work to make their needs plainly understood.

With the distinctly utilitarian sentiment toward science, as pointed out, the question arises as to what stand should be taken by those charged with the guidance of the work with respect to shaping a general policy which will meet the demand for practical ends, and at the same time advance the cause of science to the fullest extent. Extremes must be avoided, for if the tendency is too strong toward pure science, opportunities will be lost through lack of support, and if toward ultra-utilitarianism, science itself will he endangered through the development of false views, erroneous statements and lack of judgment—rocks and reefs that must by all means be avoided. There is always a medium ground, however, where science and practice can each be made to help the other and each be the stronger for the support thus gained. This is the stand, I may say, that is now taken by those charged with most of the work conducted under the auspices of the Government, and which, during the past fifteen years at least, has resulted in a rapid development of all work along broad and safe lines. Most of the departments of the Government, wherein scientific work is carried on, owe their existence to a demand for greater knowledge on problems concerning the interests and welfare of the people. In the early days of this work too much attention was given to a mere diffusion of knowledge without regard to its source, and as a result of this original research did not receive the attention it deserved. In later years, however, the importance of research is becoming more and more appreciated, and as a result the work has increased in strength and now commands the respect it deserves. It is unnecessary to dwell upon any specific work now being done by the Government, as the object of this discussion, as I understand it, is more to deal with general matters, and certain of the details have already been given by Dr. Howard. I will conclude what I have to say with just one statement, namely, that the future attitude of the State toward scientific research will in large measure depend on our own efforts individually and collectively. Let us therefore go forth with a determination to advance the cause of science in every way and to stand firmly for the great principles of truth it represents.

B. T. Galloway.
U. S. Department of Agriculture.

In considering the attitude of the State toward scientific investigation it may be well to remember that with us the State is the people, ours being a government of the people, by the people, for the people. What then is and what should be the attitude of the people toward scientific investigation? Probably very much the same as their attitude toward education, and concerning this there can be no question. From the very beginning our people made careful provision for education by the establishment of public

schools. They have asked, and answered emphatically in the affirmative, the question: Does education pay; and I believe that they are asking and answering the other question, Does scientific investigation pay, very much in the same fashion. The golden stream of benefactions which has now for many years been flowing in upon educational establishments proves that the people firmly believe that education pays. They believe in education.

I have been very much interested to hear the quotation from the 'Message of Washington' urging upon our people the importance of promoting scientific investigation and research. I believe that the American people are, in increasing numbers, large-minded enough to look through and beyond the nearer every-day phenomena and to realize that the promotion of discovery, no less than the promotion of learning, pays in every sense of the word. They perceive that it pays in the highest sense, in the enrichment of intellect and the cultivation of faculty. They perceive also that it pays in the utilitarian sense, in that it gives leadership among the nations of the earth in the applications of science which always follow hard upon the heels of discovery. Professor Osborn has done well to point out that those nations which support research most liberally are those which are taking the lead in the industrial world to-day.

I remember a saying of General Walker's, that he firmly believed that we should outgrow the necessity of protection, and we are beginning to-day to witness the fulfilment of his prediction. The enormous development of our export trade, based upon our scientific and economic system of manufactures, arts and industries, marks that over-growth of the merely home market and local protection which General Walker was far-sighted enough to foresee. I believe that, if once the people realize what a burden and a hindrance is inflicted upon scientific research, and thereby upon educational and industrial progress, by the tariff upon microscopes, dissecting instruments, models, diagrams and other apparatus of research and instruction, that tariff will melt away like dew before the sun.

And so it is also, I believe, with the relations between pure and applied science. The barrier between them is fading away, because they are constantly drawing nearer together and over-growing one another. Pure science has given to applied science the fundamental elements of truth, perfection, knowledge and skill. Applied science, on the other hand, has developed so prodigiously as to react favorably upon pure science, furnishing for it rich sustenance and fertile soil in which it may flourish. An hour might well be spent in pointing out not only the aid which pure science has given to applied science, but reciprocally the enormous development of pure science and scientific investigation wrought by applied science. It is one of the marvels of the day that many highly organized and differentiated industries, and even many of the coarser arts, find their narrow but sufficient basis of profit in the employment of the results of latest and most advanced researches in pure science.

Our age has been called by one of the speakers who has preceded me, a practical age, and so it is; but it is an age which has discovered in science the Promethean fire. The highest and truest utilitarianism of to-day is a generous cultivation of scientific investigation, not indeed for its own sake, but for the sake of the results which are sure to follow from it. As to the pursuit of science for its own sake, Professor Osborn has, it seems to me, used a happy illustration in referring to the scientific investigations of the Government as an investment rather than an immediate outlay for current expenses. As to pure science pursued strictly for its own sake, I think we may

rather describe it as an investment from which we still expect ultimately some return. Science for its own sake is, after all, much like investment for its own sake; which has never been made, I fancy, even by the least practical of philanthropists.

For illustration of public appreciation of scientific research as a necessity for practical results, I may give an example. When in 1886 the newly organized State Board of Health of Massachusetts attacked scientifically the problem of protection of the purity of inland waters, they reported to the people of that State that in order to do the work required by the Legislature it would be necessary to inaugurate and prosecute special and novel investigations, and for this and other purposes they asked for an appropriation of $30,000. This sum was immediately and cheerfully granted by the people for this purpose and has ever since been continued, annually, with the result that the Massachusetts experiments are referred to with commendation and advantage by bacteriologists and engineers all over the world. Again, when it became clear that antitoxin for diphtheria had become a public necessity and its proper preparation a public duty, the same State Board of Health secured the services of one of the most distinguished bacteriologists in the country, Professor Theobald Smith, and requested him not only to prepare antitoxin for the citizens of the State, but also to investigate the best methods of its preparation and preservation, besides other cognate and novel but pressing problems in the field of pure science. Here also the most thorough-going utilitarianism has proved to be scientific investigation pushed to its utmost limits.

Just here also the State, by and for the people, might well do much more than is yet done. As a nation we have hitherto played but an insignificant part in those scientific inquiries which underlie the medical and sanitary arts. As a nation we cannot claim any of the credit for originating the germ theory, or antiseptic surgery, or for laying the foundations of modern bacteriology, or for the discovery of antitoxins or for elucidating the ætiology of malaria, or for inventing the agglutination test for typhoid fever. We may be excused for our inertness previous to 1870, because until then the civil war or its sequelæ claimed all our energies; but from comparative inactivity in these matters since that time—excepting in one honorable division of the government service, the agricultural,—we have no good excuse to offer. If we are to hold our proper place among the nations in the prosecution of medical and sanitary inquiry the State or the States must lend their powerful aid, or else private enterprise or the universities must do far more than they have yet done in this direction.

In this connection, and especially on this platform, it will not be out of place for me to refer to the intense satisfaction which all lovers of good government and of the intelligent and scientific administration of public affairs feel, that Dr. Gilman, the founder of purely university education in America, and the president of this University, which has done so much for the cause of scientific investigation, has consented to accept the presidency of the National Civil Service Reform Association; for I believe that the introduction of more science and more scientific investigation into the civil service means the development and extension of a rational system of government based upon merit, rather than partisanship or spoils. Here Harvey, the father of physiology, raised the true standard for us when he exclaimed: 'I avow myself the partisan of truth alone.'

I cannot close without expressing my cordial assent to another point made by Professor Osborn and my belief in its extreme importance, viz., the reciprocal duty which the scientific worker owes to the State.

Who can forget the famous and stinging characterization of that tutor in Magdalen College whom Gibbon's caustic pen has embalmed in eternal disgrace, one Dr. ———, of whom Gibbon said, 'he well remembered that he had a salary to receive, and he only forgot that he had a duty to perform.' I have always been sorry that Dr. ——— was a teacher and glad that he was not a scientific man. President Hadley, I think, struck the right note when he cautioned young men not to ask themselves 'How much can we get out of college?' but rather, 'How much of ourselves can we put into it?' Science, like religion, demands of her votaries lofty sacrifices and personal devotion, and if they are public servants their debt to her is always not less but more.

WM. T. SEDGWICK.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

THE ALBANY MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

I.

THE thirteenth annual meeting of the Geological Society of America was held in Albany on December 27, 28 and 29, 1900. The fellows were called to order by the retiring President, Dr. George M. Dawson, Director of the Geological Survey of Canada, at 10 A.M. on Thursday, in the chapel of the Albany Academy. A very gratifying number of members was present and during the sessions from 50 to 60 were in attendance. All felt the significance of meeting in the city where stratigraphical geology received its greatest single impetus in America and where the classification of most of the Paleozoic was chiefly worked out. Memories of James Hall were in all minds and frequent reference was made to the late venerable State Geologist, first President of the Society.

At the opening meeting brief addresses of welcome were made by Dr. F. J. H. Merrill, State Geologist, and by Dr. J. M. Clarke, State Paleontologist. The Council then presented its written report, which showed the Society to be in a very flourishing condition. During the year one fellow, Mr. Franklin Platt, has died. The present enrolment is 248, and the financial condition is gratifying. The following officers were declared elected:

President, Charles D. Walcott, Washington, D. C.; *First Vice-President*, N. H. Winchell, Minneapolis, Minn.; *Second Vice-President*, S. F. Emmons, Washington, D. C.; *Secretary*, H. L. Fairchild, Rochester, N. Y.; *Treasurer*, I. C. White, Morgantown, W. Va.; *Editor*, J. Stanley Brown, Washington, D. C.; *Librarian*, H. P. Cushing, Cleveland, O.; *Councillors:* Samuel Calvin, Iowa City, Ia.; A. P. Coleman, Toronto, Can.

A memorial of Franklin Platt, prepared by Persifor Frazer was then read by W. M. Davis, and at its conclusion the reading of scientific papers was immediately taken up.

Experimental Work on the Flow of Rocks recently carried out at the MacGill University, Montreal: FRANK D. ADAMS.

This paper gave the results of an investigation in which the effects of very heavy pressure on rocks were studied with a view to ascertaining how the gigantic movements which geologists observe in the strata of the earth's crust have taken place.

Marble was the rock on which most of the work was carried out, but harder rocks such as granite are now being studied as well. Small columns of marble an inch in diameter and an inch and one-half high were carefully turned, polished and then very accurately fitted into heavy wrought iron tubes constructed on the plan of heavy ordnance, by wrapping strips of wrought iron around a core of soft iron and welding the whole together. The core of iron was then bored out and the marble substituted for it. Heavy steel pistons were fitted into each end of the tube, and the rock was thus submitted to very high pressures, often for several months continuously, in espe-