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CONTENTS.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE POPULAR CONCEPTION OF THE SCIENTIFIC MAN AT THE PRESENT DAY.[1]

WE are so accustomed to hear reports on the progress of science that we have almost ceased to ask ourselves what we mean by progress. What is or is not progress depends of course on the point of view. Some are so far ahead of the majority that they can not see how much progress is made by those behind them; others are so far in the rear that they can not distinguish what is going on ahead of them. We must also admit that there are different directions in which progress may be made. You have all seen the agile crab and been surprised to find how rapidly he gets over the ground, although he never seems to go ahead, but to scramble off sideways. The crab, perhaps, wonders why men are so stupid as to try to move straight forward. It is a popular belief, but, not being a zoologist, I am not prepared to vouch for its correctness, that the squid progresses backward, discharging a large amount of ink. One might perhaps ask: Is the progress of science sometimes like that of the crab, rapid but not straight forward, or, like the squid, may not the emission of a large amount of printer's ink really conceal a backward movement? So far as the accumulation of facts is concerned, there is a steady onward progress in science and it is only in the unwise or premature theorizing on known or supposed facts that science

[1] Address of the president of the American Association for the Advancement of Science, New Orleans meeting, 1905.

strikes a side track or even progresses backward.

As far as botany is concerned the progress during the past year has not been startlingly rapid, but it has been in the direction of an accumulation of facts rather than in the formulation of new theories and the enunciation of general principles, very important if true, but unfortunately not always true, as time shows. If there have been no remarkable discoveries in botany during the past year, on the other hand it may be said that few of the steps which have been taken will need to be retraced hereafter. What strikes one most in a survey of the botany of the present day is, I think, the fact that it is becoming more and more difficult to say just what is and what is not botany. Formerly all botanists were cast in pretty much the same mold and, as a science, botany was sharply limited except, perhaps, in the direction of zoology. One could pass for a very good botanist, although quite ignorant even of the rudiments of other branches of science. Now we often see in botanical journals papers which might almost as well have appeared in physical or chemical journals and in many cases one is not at liberty to form a final opinion as to the value of a paper purporting to be botanical until physicists or chemists, or perhaps both, have also expressed their opinions in regard to it. In short, the hard and fast lines which formerly shut botanists up in a world of their own have been broken down and botany has become an inseparable part of a broader science. This enlargement of the botanical horizon resulting from the gradual shading off of the confines of botany into the domain of other sciences not only tends to make it more attractive to botanists themselves, but also serves to add dignity to botany in the eyes of those who are not themselves botanists. Young botanists with a modern training may be permitted to feel confidence in entering on so broad a field, but those who are no longer young and whose training was that of the old school, no matter how much they may sympathize with modern conditions, can not help feeling distrustful of their ability to judge critically of work done in so many new directions and by so many diverse methods. Botany has, in fact, become so broad a science compared with what it was not many years ago that no one man can be expected to be in position to judge critically of work done except in certain branches of the subject. Consequently there have been formed a number of societies each devoted to a special department of botany and, if one wishes to know what is going on in botany, one is forced to attend the sessions of the societies affiliated with the association as well as those of our botanical section. It is to the presiding officers of those societies and of the botanical section that one must look for anything like adequate presentations of the present state of botany. The views of one man are not sufficient, but he who would acquire a broad view must listen to the representatives of different branches. It seemed better, therefore, that, departing from the practise of my predecessors, I should not attempt what can be done better by others, and I have selected for my subject not the present condition of botany, but another topic which ought to interest us all, viz., the scientific man, what he is believed by the public to be and what he really is. Do not, however, suppose that I am about to regale you with personalities concerning my contemporaries. I wish merely to call your attention to the estimate which the public place on scientific men as a body and to consider the question whether they really understand the aims and needs of persons like ourselves.

You must have noticed in reading the magazines and papers that a change has

recently come over the public in their attitude towards us. They believe that they have really discovered what we are, they recognize that we are more respectable than they used to suppose and the question has been asked more than once: What shall we, the public, do to help scientific men? That that question should be correctly answered is certainly of extreme importance to us. It is, therefore, worth our while to consider the recent change in the attitude of the public toward us, the question how far that attitude is correct from our point of view and how far their ideas of what should be done for us correspond with what we really desire and need.

First, what do they think of us? The lights, or the supposed lights of science, have always been objects of interest to the world. The mass of scientific men have, on the other hand, counted for little. The public have always needed some idols to worship and in their indiscriminate collection of gods there have always been a few taken from the scientific world. Their wonderful achievements have been magnified beyond all recognition, their precocious sayings have been recorded and their opinions on theology, music, politics and many other subjects about which they knew nothing in particular have been paraded before us. Once in a while when the flashlight of the caricaturist has been thrown upon them, they have been shown to have some human weaknesses and the learned professor who is supposed to be discussing evolution or the vortex theory with his neighbor at some fashionable reception has been represented as really only making remarks about the ladies present while imbibing fluids which it is said retard rather than aid the metamorphosis of brain tissue. Those who were not so fortunate as to be counted among the lights of science were passed over as having perhaps an academic importance, but of no account in the real world, being both impractical and impecunious. The question, what is the good of science, was supposed to be unanswerable and it seemed to follow as a corollary that a man who spent his time on things which were good for nothing must himself be good for nothing.

All that has changed and the traditional scientific man has disappeared almost as completely as the traditional Yankee of the stage. The change came gradually but the proof that it had come was brought before us suddenly. In 1902 there was called in New York a meeting of those who were designated by the picturesque expression, captains of industry. To that meeting representatives of science were invited, not as lions to be stared at, but to sit with the leaders of the industrial and commercial world as representatives of science, and not only of applied science, but of pure science. As the captains of industry were supposed to be men of force in organizing and to have a keen insight into men and things, we had a right to feel that science was honored, perhaps not more than ever before, but for a reason for which it had not been honored before in this country. The fact that since that date the reputation of some of the captains of industry has suffered an eclipse, does not alter the fact that to be considered a captain of industry was, in the eyes of the public, enviable. The conception of a scientific man as a captain of industry means simply the acknowledgment that science has a practical relation to the world and that fortunately the public have advanced far enough to see, although perhaps somewhat dimly, that pure science sooner or later develops into applied science. The leaders of science are to be placed in the class of organizers, managers of a sort of scientific trust. This is science up to date and the public are right when they regard science as an organization. But they are only partly right.

There is a good deal more than that in science and, although good managers and directors are necessary, it is true that the power of organizing and the power of investigating are two different things and often exist in inverse ratio to each other, and it is the latter which is at the basis of science. An organizer is of no use until there is something to organize and the materials on which the organizer in science must work are not made by machinery, but by the brains of individual workers, and it is important that they should be placed under the most favorable conditions for work. If hitherto there has been perhaps too little organization, there is a danger that in the future there may be too much. In a mill many men are doing the same kind of work, but in science one man should not duplicate the work of another. The object of organization in the one case is to secure uniformity of product; in the other to encourage diversity of work.

You have seen the statement in print that there are not enough workers in science and it has been claimed that the rewards are so inadequate that many young men can not afford to enter on a scientific career. It has been proposed to remedy that difficulty, and we not infrequently hear that something should be done by the public. So far nothing very definite has been proposed. It has been suggested that scientific men should be better paid. Against that we have absolutely nothing to say, but we are waiting a little impatiently to learn how they are to be paid. The captains of industrial establishments make large fortunes and it seems to be a principle of economy that in the management of other people's money a pretty large proportion finds its way into the pockets of the managers. Others who probably recognize the obstacles in the way of arranging that scientific men shall be better paid would solve the difficulty by having a limited number of great prizes to be awarded at intervals.

It is certainly pleasant to know that the public would like to do something for us, for with the intention may come later the fulfillment. But it may be well to look into the matter a little more closely. In the first place, assuming that more men ought to go into science, it is by no means certain that, were the remuneration much greater, the right kind of men would go into the field. It would be an easy matter, if the pecuniary rewards were great enough, to induce any number of men to go into science, but a man in search of money is not ever likely to do the best work in science. Unless a man has a love of science for its own sake, apart from the money he is to make out of it, he must be classed as a business man and not a scientific man. A more important point to ascertain is how many men with a strong desire to study science and with good ability have been obliged to abandon its pursuit and gain their living in some other way. There are certainly some, but I am unable to form a definite idea as to the number. There are undoubtedly a good many men in the field struggling under difficulties which keep them from doing the best work of which they are capable. Before attempting to draw more men into the field it would be better to provide properly for those already in it.

Little need be said on the subject of a limited number of great prizes. So far, we are in the dark as to what the prizes are to be. We can not, of course, adopt the plan established in some countries and bestow on a few favored sons of science titles of nobility or knighthood. This method of rewarding merit has something to be said in its favor. It costs the bestower nothing and pleases the recipient. A chemist with a decoration round his neck is, of course, distinguished at once from

other chemists. A physicist in knee-breeches and an embroidered coat is imposing and, if a cocked hat under his arm be added, quite irresistible. But all this glory is not for us in this country—as yet. Nor can we expect that the coveted title of Geheimrath will be bestowed by our government. The great prizes must necessarily be in the form of money, either as pensions or gifts. To have any real value a pension must be something of which both the amount and the date on which one may count with certainty on receiving it are fixed years in advance. To expect a pension, which some one else may receive, is hardly a consolation. If money is to be given outright how much is necessary to be considered a great prize? When we consider that even incompetent presidents of insurance companies consider their services cheap at a hundred thousand a year, one wonders what sum would be considered a proper reward for years of valuable work done by competent scientific men during the best years of their lives. Even at the best, the most that could be given to scientific men would be a mere pittance compared with what the other captains receive. It is unnecessary to try to answer the question, even if modesty did not forbid, for the principle of bestowing a few large prizes with the expectation of benefiting science is a delusion and it is to be hoped that no benevolent person will make the mistake of establishing one or more great prizes. What is wanted is not the possibility of sometimes receiving a large sum, but the certainty that the amount received annually will be sufficient to enable one to live and work without discomfort in the present and without anxiety for the future.

The ways in which the public may aid scientific men are directly by endowments for paying salaries and indirectly by providing properly equipped laboratories and other necessary equipment, and especially for paying for the services of assistants. Both forms of help are necessary, for a man capable of managing and getting the greatest amount of good work out of a well-equipped establishment deserves more than a meager salary. On the other hand, those with what appears to be a respectable salary may have to spend a good part of it to make good the deficiencies in their equipment. In deciding whether a man is well paid or not it is necessary to ask not only what salary he receives, but what are the means of work provided for him. It is not my intention here to call attention to the special ways in which scientific establishments would be benefited by gifts from the public nor to discuss the question what is a proper salary for a scientific man. The latter depends upon too many complicated conditions and can not be separated from the more general question of what those in equally important positions in other walks of life are paid. The question of proper equipment, including the question of assistants, has already been brought before the public on a good many occasions and in a good many ways, and a good deal has been given in recent years, although by no means enough.

If, as it appears, the public have reached a better conception of the position of the scientific man in this country and of his pecuniary needs, it may be added that he has the right to hope that he can appeal to the public not only for pecuniary but for moral support, for, in many cases, the public are the final arbiters where differences arise and unfavorable conditions often disappear quickly as soon as it is felt that one side or the other is backed by public opinion. It may, therefore, be well to state somewhat explicitly some of the conditions which are unfavorable to the progress of science in this country or which tend to retard it. Here it is not so much a question of money as of a just appreciation of

the true position of scientific men in their relation to those for whom their work is undertaken. That work, using a rough classification, may be considered under three heads: that done in technical and commercial concerns, that done for the government and that done in universities, including under that general term all colleges, scientific schools and similar institutions which have a permanent endowment of some kind.

In chemical, electrical and mechanical engineering works and other essentially commercial undertakings the scientific man is occupied mainly with routine duties and the number of persons employed in this kind of work is large and will be much larger in the future. The ratio of demand and supply in this case must always regulate the salaries paid and, as scientific experts are a necessity in these lines of business, the pay ought to be expected to be comparatively as good as in other branches of business. Occasionally, as we have seen recently in the case of electrical engineering, the supply may become suddenly greater than the demand in the lower grades of work, but these things soon regulate themselves. Hitherto the value of biological work in connection with waterworks and other hygienic establishments has not been as fully appreciated as it should be and the openings for specialists in biology have not been very numerous. There has been, however, a change for the better in this particular field. It is not, however, with the case of those whose work is what may be called routine work that we are concerned here, but we must ask why it is that, in those occupations which are primarily money-making, Americans have been so reluctant to employ original investigators for the purpose of developing their business. For a good many years the great value of original research in connection with manufacturing concerns has been fully recognized in some European countries. The Carlsberg laboratory at Copenhagen is a brilliant example of how much scientific work by experts of reputation can aid a practical industry, and we all know how the employment of experts to investigate special questions has helped the Germans to coin money in chemical industries. We shall have to admit that in certain respects we are more stupid than some other nations. I have heard of an important firm engaged in the manufacture of chemicals who could not be persuaded to employ a competent chemical investigator, not a mere analyst, to develop their business, because they felt unable to pay the princely salary of $1,500 a year. This is the same kind of stupidity which seeks to secure foreign trade by sending out agents who are unable to speak a word of the language of the country to which they are sent. If our business men are too stupid to take advantage of the help afforded by science, although informed as to what is done by their foreign competitors, we shall not be called on to shed many tears over their ultimate failure in the competition for business.

The relations of the national government to science and to scientific men are most important, but unfortunately very perplexing on account of the numerous complicated conditions which have to be considered. Although the government is concerned only incidentally with science, it has in its service more scientific men than any other institution. I have said that the government is only incidentally concerned with science, believing that the object of government is to take charge of the work of administration entrusted to it by the constitution and acts of congress. Varied as this work may be, it does not include everything. For instance, the education of the country is fortunately not entrusted to the national government and the busi-

ness of education belongs to the states and the people in general. The theory that any department or departments of the government are to serve as universities for the scientific training of young men is, it seems to me, false. The government may properly give information to the public on certain questions and, in this sense, it may be regarded as educational, but these questions arise in connection with definite special problems which necessarily affect the whole country, such as the subject of epidemic diseases of animals and plants and their prevention, questions concerning the preservation of forests, of irrigation and similar subjects which from their nature are of immediate national importance. This view, however, is not accepted by many, perhaps a majority of scientific men connected with the government. There is something in the air of Washington which seems to make it inevitable that those in the government employ should believe that it is the business of the government to undertake or control all scientific work. In some cases this belief has been carried so far that attempts of the states or universities to carry on explorations or special investigations have been regarded as an encroachment on the field belonging by right to the government, and no sooner has some university or private person sent out a party of explorers than a rival party has been sent out from Washington. There is a tendency to forget that there are several millions of people in the United States not connected with the government and that large sums are furnished by institutions and private individuals for the study of scientific questions which can perfectly well be investigated without supervision from Washington. It has been said that the government has at its disposal more money than any state or institution, and therefore it is better able to do all kinds of scientific work. This conclusion does not necessarily follow from the premises, for the questions arise: Is the money voted by Congress as likely to be spent as economically as the amounts available in institutions not under government control, and, in general, is the concentration of scientific work under the government as advantageous for the development of science in this country as a proper distribution of the work among a number of independent institutions? Outside Washington there is a belief that, in accomplishing scientific work, a given amount appropriated by a university or other endowed institution will go farther than the same amount obtained by vote of Congress. In its fiscal arrangements the government treats the appropriations for scientific purposes as a part of a general budget, and the annual appropriations which become available in July lapse unless spent before the following July. Suppose then it is estimated that a given scientific investigation will require a certain amount of money. If that amount is voted it must be spent before the end of the fiscal year, and there is no doubt that it will be spent in some way or other. But, unfortunately, scientific investigations usually require a good deal of time and often very much more time than was anticipated. As a result, there must be additional grants, and to obtain them there is a great temptation to show that something has been done by printing reports of unfinished work. Outside the government departments grants made for a special investigation do not lapse at the end of the fiscal year and such investigations can, therefore, be planned more intelligently and carried out at a less expenditure of money. Also, in the matter of printing, the expense under the government is very great, owing to the large editions which are necessary. In the case of the better scientific works with numerous plates the great size of the edition, which

must be larger than required to supply copies to those really competent to appreciate the work, implies a pecuniary waste. But there is still the important consideration that in attempting to extend the work in too many directions, acting on the theory that the government should do all kinds of scientific work, the point is soon reached where no department and no bureau can be expected to do the work well, and what might be done well suffers by being weighted with what can not be done well. We have seen bureaus which, after acting for some years on the theory that any question theoretical or practical which could possibly be construed as having any relation to its work should be undertaken, finally break down under the weight of the impossible task and at last settle down to their legitimate, special, practical work. If one glances over the large mass of scientific publications of the different departments one can hardly fail to recognize that the most valuable are those which treat of special questions in applied science which have been conducted with a view to furnish information on subjects coming within the legitimate limits of investigation by the government, since the material to be studied can be better obtained by the government than by state or private institutions. The publications on pure science or on subjects not having a practical bearing are certainly no better, if, as is sometimes the case, they are as good as similar publications from other sources. Briefly, it seems to me that it would be no worse for the government and better for the science of the country in general if the scientific work done by the government were not spread over so wide a field. It will be said that the universities are also ambitious and attempt to do more than they can do well, which is perfectly true, but that is no reason why the government should make the same mistake.

The consideration of the attractions offered by scientific work under the government and the relations of the scientific corps to their superior officers is rather a delicate matter, for, while one may be allowed to speak of the advantages, as soon as one ventures to hint that there may be disadvantages he is likely to be told that he does not understand the situation. We can only say that, if the scientific employees of the government are perfectly satisfied with their positions and regard them as ideal, they are decidedly more fortunate than their fellow scientists in other places. What attracts men to Washington is not primarily the salaries, except in the case of young men just beginning their scientific careers, although in general salaries are not so small as has sometimes been supposed. Nor does the fact that the few, like the heads of bureaus, who receive large salaries are overwhelmed with administrative work prove that they are worse off than the better paid professors in universities where, until recently, with the higher salaries went more lecturing and more committee work. In the universities, however, this state of things is gradually improving, but it is difficult to see how it can change in the government departments. The salary which the average man can expect is small and, if held to strict accountability for his time by the department in which he may be, he can not add to it by outside work or, if he does, he may be called upon suddenly to explain. The attractions are the freedom from lectures and class work, although this is to some extent counterbalanced by a large amount of official correspondence, and the possibility of having clerical and mechanical assistants to aid him in his work. A still greater attraction probably is the fact that one will at not infrequent intervals be sent, at government expense, on a mission of some kind to different parts of the country or abroad, an arrange-

ment which relieves the monotony of routine work and enables one to see more or less of the world. In some universities the professors are allowed a year's absence once in seven years, but they are then generally on half-pay and have to provide for their own traveling expenses out of a reduced income.

There is supposed to be a certain glamour attached to government positions in all countries, but, as far as scientific men are concerned, those in government employ have, like others, to depend for their reputation on their merits rather than on their positions. Even in the case of Germany, where it is generally supposed that official positions are more highly esteemed than in this country, to be a professor in one of the leading universities is a distinction as great as to be a government official, that is, in the capacity of a scientific worker. There is a certain class of men who would always find Washington more congenial than any other place. To them the interviewing of members of Congress and other officials is a pleasure. To them the newspaper correspondent is always welcome. Although they may have great scientific and administrative ability which enables them to accomplish a great deal of good work, they are so constituted by nature that they never can be quite contented unless they have the opportunity of mixing in the stir and bustle of the world and of being heard of men and seen of women. This class of men is a small one and, I am inclined to believe, is growing smaller. It does not include the great majority of those whose work is of the most value to the government. This large majority prefer conditions which allow them to work in peace and quiet, and security of tenure in office without the feeling that sooner or later there may be an overturning of some kind is what they desire most in addition to adequate salaries. This possibility of some unexpected change in policy is the great disturbing feature in Washington, and that such changes must occur sooner or later is inevitable because the atmosphere of Washington must always be political. This does not mean that the scientific men employed by the government need concern themselves with politics. In the past that may have been the case, but there is no reason to suppose that at the present day a botanist would have to be a Republican botanist or an entomologist a Democratic entomologist to be sure of his position. Nevertheless, politics must always be a disturbing element because the scientific workers must be assigned to some bureau of some department, and the secretaries, the heads of the departments, are always politicians and always will be. I do not intend to use the word in its degraded sense, although it might be going too far to use the word statesmen as applied to all secretaries. At any rate all will admit that they can hardly be expected to be scientific men or to have, except in very rare cases, any real knowledge of scientific subjects. They are appointed because they represent some political interest and change with the party and generally with the administration, so that their service is short. One secretary succeeds another at short intervals and the policy of one may not be the policy of another. One may believe that there can not be too much scientific work; another that science unless sordidly practical is worthless. The policy of launching out on scientific work of all kinds without regard to expense, on the ground that our country is rich and that there is no need of counting the dollars and cents, is sure to be followed by indiscriminate retrenchment. In any case a secretary is obliged to look out for his own interests in relation to his party and in political crises no one can tell what may be done. Suppose that the presidents of all universities were

changed once in four years and that the new presidents had power to change the policies of their predecessors at once. One could easily imagine that scientific work would suffer.

The permanency of tenure in the government is supposed to be secured by the civil-service regulations and these regulations have undoubtedly improved the condition and raised the quality of government employees, but, so far as securing trained scientific men is concerned, the system, however well it may work in the case of clerks and low-grade positions, is not one which is so well adapted to the cases of positions requiring special scientific training. The recommendations of those under whom a man has studied or for whom he has worked would appear to be of more value than successful answers to a number of more or less stereotyped questions. The system, while it may keep out a very poor man, does not necessarily secure a very good man, unless, in some way unknown to us, the difficulties of a rigid system are softened by a beneficent interpretation of the rules. The civil service system, although acting somewhat to the disadvantage of a scientific man so far as entering the service is concerned, is on the other hand undoubtedly a protection to him during his service.

A recent executive order, however, seems to us to be a most unfortunate step backward, and, whatever may be said, must inevitably cause a feeling of insecurity. From the somewhat vague accounts given in the papers at the time of its promulgation one would perhaps not have been warranted in forming an opinion concerning the precise object which it was designed to accomplish, but the explanation of the order given in the president's recent message is, of course, authoritative. It is as follows:

> Heads of executive departments and members of the commission have called my attention to the fact that the rule requiring a filing of charges and three days' notice before an employee could be separated from the service for inefficiency has served no good purpose whatever, because that is not a matter upon which a hearing of the employee found to be inefficient can be of any value, and in practice the rule providing for such notice and hearing has merely resulted in keeping in a certain number of incompetents, because of the reluctance of heads of departments and bureau chiefs to go through this required procedure. Experience has shown that this rule is wholly ineffective to save any man, if a superior for improper reasons wishes to remove him, and is mischievous because it sometimes serves to keep in the service incompetent men not guilty of specific wrongdoing. Having these facts in view, the rule has been amended by providing that where the inefficiency or incapacity comes within the personal knowledge of the head of a department the removal may be made without notice, the reasons therefor being filed and made a record of the department. The absolute right of removal rests where it always has rested, with the head of a department; any limitation of this absolute right results in grave injury to the public service.

The justice of the last sentence is beyond question. There is, however, another absolute, moral right which is not mentioned in this connection, viz., the right of a person accused to be heard in his own behalf by the one in whom the power of removal is vested. The expression inefficiency or incapacity coming within the personal knowledge of the head of the department, taken in connection with the previous statement that experience has shown that the rule requiring three days' notice is wholly ineffective to save any man, if a superior, for improper reasons, wishes to remove him, suggests several unpleasant possibilities. In the first place one regrets hearing that it is not only possible that persons might be removed for improper reasons, but especially that experience has already shown that the previous rule was powerless to prevent such removals. Stated baldly, experience has shown that persons have been removed for improper reasons since the establishment of the rule. By whom, one

would like to ask? By the heads of departments in whom is vested the absolute power of removal? The expression, personal knowledge of the heads of departments must, in the case of scientific employees, be taken to mean indirect rather than direct knowledge, since they are not themselves scientific men and must practically obtain their knowledge of one scientific subordinate from other subordinates, and this is an additional reason why, when it is a question of removing a scientific man, he should be allowed to state his case to the head of the department and, if he is charged with misdemeanors of any kind, be informed by whom the charges have been made. It is evident that the new order has caused some criticism, since what was said in the message was not merely explanatory, but also in the nature of a defense. It is sincerely to be hoped that this order, embodying as it does a principle which may in practise cause injustice, may be revoked and something more specific and less sweeping be substituted for it. It is useless to say that there is no danger that the rule will be applied except in cases where the incompetency or indiscretion is quite plain. So long as it exists, knowing the weaknesses of human nature, there is always a danger that it may be applied in a way to cause injustice.

Turning to the universities and other similar endowed institutions we also find very perplexing conditions, but they have been discussed so frequently in print that the public is tolerably well informed in regard to them. If in the government departments the political atmosphere prevents the highest development of scientific life, in the universities the air is chilled, as far as scientific men are concerned, by the widely spread heresy that too much athletics is a good thing for a university. So long as a coach receives a higher salary than any professor, one is warranted in asking whether learning is too cheap or athletics too dear. Certainly on pay day professors would be glad to be classed as coaches. Is the craze for spectacular athletics ever going to pass away? Apparently not, for athletic contests, theatrical and similar non-academic diversions, are naturally more interesting than learning of any kind to a by no means small proportion of those who form the body of students. It is certainly a weak point in our universities that there have to be taken into account two different classes of men; those whose primary object is study and those whose interests are mainly or exclusively athletic and social. It will be said that the line between the two is not a sharp one, but in the interest of learning it seems to me best that a line should be drawn, even if it has to be somewhat arbitrary. One should avoid, in general, making distinctions without differences, but, on the other hand, it should not be forgotten that in some cases the moral effect of making a distinction is to bring out the fact that there is a real difference. It would certainly be advantageous for scientific men, using the word in its broad sense, if the public could be given to understand clearly that in the universities a real distinction is made between the genuine student and the student *pro forma*. They would probably feel that the money they give is well spent if spent on the genuine student, while on the other hand they might be sceptical about the good of spending money on those who do not care to study more than they are forced to do to keep in college. To have it suspected that the universities are of a sort of Jekyl-Hyde nature, at one time all athletics, at another all study, would obscure their true position. It is of great importance that the standard by which the value of a professor is estimated should not be the size of his classes and the number of his lectures. This method of estimating

their value used to be universal and, although the more enlightened part of the public have ceased to regard the number of students and lectures as the most important thing, the old way of estimating values is still far too prevalent. At the present day, the real distinction of a university depends more on the amount and quality of the higher work than on the amount of instruction of a low grade. It was supposed, a few years ago, that the universities and colleges would gradually differentiate themselves into classes; the better endowed into institutions where the higher studies would be made prominent, while those with only a moderate endowment would confine their work to the instruction of undergraduates. But it is not likely that this will be the result. The advent of the multi-millionaire makes it possible that at any time some very rich man may leave his millions to one of the poorly endowed colleges. Since any college may succeed in capturing the millions, there is a new inducement for colleges to live beyond their means rather than limit themselves to what they can do well with the money they actually have. In the universities, as in the government departments, there is a disposition to branch out in too many directions and to believe that one university must try to do everything that other universities are trying to do. Sooner or later there must be some limitation to what any given university can expect to do; otherwise, since the amount of money which even the best endowed universities can expect will never be sufficient for them to do everything, some, if not many, of the branches of science must be kept on a starvation basis. The governing bodies of universities are altogether too much inclined to ask themselves the question, Is there not some new subject which can be introduced? without stopping to consider the more fundamental question whether the subjects already included in the curriculum are properly provided for.

Briefly, the main difficulties to be met with in the universities are, first, as we have seen, the organic connection of a studious and a non-studious body which would be remedied were it possible to draw the line between work of a low grade and the higher studies and place those in charge of the latter in an independent position. Two other difficulties are the excessive demand on the time and energy of the professors by lectures and class work and, in many cases, the insufficiency of the salaries. In a way, the two are phases of the same difficulty. If there were plenty of money both would disappear. Since so large a portion of the income of most universities is derived from students' fees, there is a tendency to pay the larger salaries to those having the larger classes or, at least, those with large classes feel aggrieved that the fees should be spent largely on those in charge of the higher studies in which there must always be a few students. There is, it seems to me, no better way of aiding universities than by endowing chairs in the departments of higher studies in which there can never be many students and where the amount obtained from fees is hardly worth considering.

Perhaps the most important question affecting the future not only of science in the limited sense, but of learning of all kinds in this country, is that of the proper relation of the faculties of the universities to the trustees. That the question has come into prominence at the present time is due to the fact that, since in business the tendency is toward a greater concentration of power in a few hands, so, if we regard education as a business, the control of all educational questions should be in the hands of a few trustees. In the universities, however, there is the purely financial question of the management of the funds and the

question of education considered from the intellectual side, and the two questions are not only essentially different in their nature, but also the training necessary for a business man is not the same as that necessary for one who is to be an educator and a scholar. To the trustees belongs the management of the finances and it would be preposterous to entrust purely business matters to a numerous body like the faculty even were they not unfitted for such work by their lack of proper training. To the faculty belong the practical work of education and the advancement of learning. The difficulty at the present time is that when it comes to the question of the general educational policy to be pursued, there is an increasing tendency on the part of trustees to assume that that is their business and not that of the faculty. Practically the board which controls the expenditure of money can, if it wishes, shape the policy without regard to the opinion of others. Whether it is better for education and learning that they should do so is another matter. Probably a large portion of the educated public are of the opinion that the faculty are better qualified than the trustees to decide educational questions both theoretical and practical, and they would certainly agree in thinking that no educational policy should be adopted without the concurrence of the faculty. It would surely be a misfortune should the public endorse the opinion said to have been expressed recently by a trustee that the faculty are merely the employees of the trustees and that their opinion is of no consequence even in cases which seriously affect their work and their future. Furthermore, the farce of asking the opinion of a faculty when there was never the slightest idea of following it does not add to the dignity of either trustees or faculty nor does it tend to bring about the harmony of action necessary to success. The expression, only an employee, however, may not be quite so contemptuous as it at first seems, for, after all, the trustees themselves are only employees. They are not managing their own money on their own account, but are simply employed to carry out the intentions of those who have given their money to found and carry on different institutions of learning and they are responsible to the public for the way they perform their duties. They may not be paid in money, but they are paid in the honor of holding positions which are justly highly prized. Unless the public feel that they are administering their trusts wisely and in accordance with the intentions of those who have given the money, they will sooner or later cease to supply more funds and there is always need of more money.

It seems to me that the antagonism between the trustees and the faculty is really less marked than many suppose and, if the opinions of the faculty are at times apparently disregarded, it may be in part, at least, because the trustees find it difficult to ascertain just what the collective opinion of the faculty is. In the larger universities the faculties are so large that, when meeting in a body, their discussions are apt to be very prolonged and not always to the point. It ought to be possible to contrive some way in which the views of both boards could be presented in a definite, practical way. In one of our universities, I understand, there is a joint board composed of some trustees and some members of the faculty, known as the committee on education, before which are brought questions in which both boards are intimately concerned, and the recommendations of this committee, it is said, have always, so far as known, been adopted by the trustees. The faculty members of such a board should of course be selected by the faculty itself and serve only for fixed intervals, in order that they may really rep-

resent the views of the majority of the faculty at any given time.

If in discussing the position of scientific men in this country I have given greater prominence to the conditions which tend to retard progress than to those which favor it, it is because I believe that the first step toward the removal of obstacles is to state clearly what those obstacles are. It is not improbable that some evils will disappear as soon as it is generally recognized that they are evils. We have seen that the public are more interested than they were in the welfare of scientific men, and the better they understand existing conditions, the better for us. If they now believe that organization and concentration are necessary in science, as in business, they should also understand that organization has its dangers as well as its advantages. While accepting the prevailing idea of the necessity of organization, we must, at the same time, insist that the future of science requires that a proper balance be maintained between general organization and individual independence. Furthermore, the organization needed in science does not consist in having scientific work placed under the control of purely business men but of scientific men who have a capacity for administration, and such men can be found. Purely financial matters must be entrusted to non-scientific business men, but science itself is something different from business in the ordinary sense. Even when placed in charge of scientific men, it is important to avoid carrying the organization of science so far as to repress individual effort and bring about a sort of bureaucracy which resents unfavorable criticism and requires all work to conform to a fixed narrow standard. Science should be a republic in which, with the approval of the majority of workers, the more capable become the rulers. Science should be well organized, but it should never become, in a purely business sense, a trust.

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THE PROBLEM OF THE METALLIFEROUS VEINS.[1]

The rush of the gold-seekers to California in 1849, and the quickly following one to Australia in 1851, were notable migrations in search of the yellow metal, but they were not the first in the history of our race. There is, indeed, no reason to suppose that, in the past, mining excitements were limited even to the historical period; on the contrary, the legends of the golden fleece, and of the golden apples of the Hesperides, probably describe in poetic garb two of the early expeditions, and long before either we can well imagine primitive man hurrying to new diggings in order to enlarge his scanty stock of metals. Among the influences which have led to the exploration and settlement of new lands, the desire to find and acquire gold and silver has been one of the most important, and as a means of introducing thousands of vigorous settlers, of their own volition, into uninhabited or uncivilized regions there is no agent which compares with it. In this connection it may be also remarked that there is no more interesting chapter in the history of civilization, than that which concerns itself with the use of the metals and with the development of methods for their extraction from their ores. Primitive man was naturally limited to those which he found in the native state. They are but few, viz., gold in wide but sparse distribution in gravels; copper in occasional masses along the outcrops of veins, in which far the greater part of the metal is combined with oxygen or sulphur, copper again, in porous rocks, as in the altogether exceptional case

[1] Presidential address before the New York Academy of Sciences, December 18, 1905.