features, but also acquainted with the electrical people of New York, with its factories, its places of business, and its methods of business? These men would become available in a day, and could be at once set to work in carrying out the details of a vast and complicated system. Their work need not be confined to that purely electrical in character, because every electrical engineer is by training and of necessity a mechanician, and every sort of apparatus would be readily understood by him, and a very slight training would make him master of it.

Those members volunteering for naval work would be equally useful. The ordnance officer at the Navy Yard would constantly find himself overwhelmed with a mass of work which he would be utterly unable to carry out without the assistance of some such corps as this. And for the reason that electrical engineers are of necessity mechanicians, a great deal of technical work could be intrusted to them, such as the arrangement and fitting of gun-carriages, the storage of ammunition, the assembling of guns, etc. Their more immediate and obvious field, however, would be in the installation and fitting of electric lights, motors, telegraphs, telephones, and other electrical appliances, on board the vessels of war constantly called into requisition. In the matter of fitting out merchant steamships their usefulness would be at once apparent. The number of regular officers would be found utterly out of proportion to the number of ships, and the whole navy would undergo an expansion. Only a very few regular officers could be assigned to each vessel; so that the majority of the officers would have to be volunteers, as was the case in our civil war. During the first part of the war, the command of the different vessels would naturally be intrusted to regular officers, leaving the other positions to be filled by volunteers. Now, as the commander of a ship is head of all the departments of a ship, he cannot give much personal attention to one especial department. Therefore the general arrangement and fitting-out of all vessels, both regular war-ships and merchant steamships, would have to be largely intrusted to volunteers in all that relates to the electric and ordnance equipments. Now, as the work of fitting out ships with electric and ordnance equipments calls for technical knowledge and experience of a high character, it is obvious that a corps of well-trained technical men, such as is here suggested, would be more than useful: it would be necessary.

A further field for the employment of such a corps in time of war is suggested by the fact that the genius of our people tends towards constant invention and improvement of all sorts of machinery and apparatus; and our history has shown that every war has brought into being many inventions in weapons of defence and offence. Can it be doubted, then, that any future war would produce more such inventions? And in view of the great progress of electrical science since the last war, and considering the great number of electricians in New York, can it be doubted that many of these inventions would be electrical in character? Under the stimulus of a national peril, and with the resources of New York at command, it is certain that important and novel warlike applications of electricity would at once spring into being. And while our regular forces of both army and navy were employed on their specific duties, what more natural than that some new Ericsson should arise, and some new Monitor or other craft startle the nations of the world? Therefore, besides the obvious uses to which such a corps as this might be placed, there are other uses, no less important, of inventing, constructing, and using weapons of defence, the nature of which we cannot as yet even faintly conceive. And as few heroes of our late war go down to history with more glory than has Ericsson, so perhaps our next war may produce some electrician, now unknown, whose fame will outlive the ages.

It would seem as if such a corps as this could be formed under existing laws, and that there would be no difficulty in enlisting members. The attractions of the Naval Reserve and of the National Guard seem sufficient to induce a large membership in the different regiments; and there is no reason why membership in an electric regiment should not be equally desirable and confer equal distinction. The qualifications for entrance as regards education and intelligence would be greater than those for any other regiment or battalion. Its military and naval usefulness would be acknowledged, and its position in all respects would be one of dignity. The larger the membership, the better; provided, of course, that due care be observed in excluding undesirable persons. The whole electrical influence of New York and of the country would be at its back, with all its millions of dollars, and its men of world-wide fame; and there is no reason why it should not acquire a national influence.

The course of instruction could be readily carried out, embracing the naval and military applications of the purely technical science with which the members are already familiar, instruction being given by regular navy and army officers detailed for the purpose. This instruction would naturally embrace the construction and care of apparatus. It being presupposed that there are different ranks in this corps, the system of instruction will naturally differ with the different ranks. With the higher ranks, it would naturally embrace the theory and practice of gunnery, navigation, including compasses, and seamanship. Steam-engineering would probably not need to be taught, it being assumed that the members require very little instruction in that branch. For the lower ranks, the scheme of instruction need not include much more than the handling and care of the different apparatus. On the outbreak of war, the members volunteering for the different services could be subjected to certain examinations, and their rank determined by the proficiency exhibited. As to the details of organization, uniform, etc., these need not be entered into here, as they can obviously be settled at any future time. My only purpose now is to propose to you a plan for meeting an emergency which may some day arise.

I would hazard the suggestion that this corps should at first comprise about two hundred and fifty members, and that it should be officered, uniformed, and drilled as are the other corps of the National Guard. I would even advocate infantry drill as a means of instilling thoroughly the military idea. Occasional runs in the torpedo-boat "Cushing," and frequent trips out to sea for target practice in some of the modern war-ships, would be essential; and while there would be considerable work, there would also be many compensating social and other advantages.

I venture all these suggestions with much diffidence, but earnestly hope that you will think them worthy of earnest consideration. My only excuse for broaching the general plan is that it has been in my mind for some years, that it has been commended by every man to whom I have spoken about it, and that I have been urged to bring it to the attention of the electricians of New York.

THE RELATIONS OF MEN OF SCIENCE TO THE GENERAL PUBLIC.[1]

JUST fifty years have passed since a small body of enthusiastic students of geology and natural history organized themselves into an association which was, for the first time in the history of this country, not local in its membership or in its purpose. As the Association of American Geologists and Naturalists, it was intended to include any and all persons, from any and all parts of the country, who were actively engaged in the promotion of natural-history studies, and who were willing to re-enforce and strengthen each other by this union. So gratifying was the success of this undertaking, that, after a few years of increasing prosperity under its first name, the association wisely determined to widen the field of its operations by resolving itself into the American Association for the Advancement of Science, thus assuming to be in title what it had really been in fact from the beginning of its existence. One of the articles of its first constitution, adopted at its first meeting, provided that it should be the duty of its president to present an address at a general session following that over which he presided. The

[1] Address delivered at the Indianapolis meeting of the American Association, August, 1890, by its retiring president, Professor T. C. Mendenhall.

performance of this duty cannot, therefore, be easily avoided by one who has been honored by his fellow-members in being called upon to preside over the deliberations of this association; nor can it be lightly disposed of, when one realizes the importance of the occasion, and recalls the long list of his distinguished predecessors, each of whom in his turn has brought to this hour at least a small measure of the work of a lifetime devoted to the interests of science.

The occasion is one which offers an opportunity and imposes an obligation. The opportunity is in many ways unique, and the obligation is correspondingly great. In the delivery of this address, the retiring president usually finds himself in the presence of a goodly number of intelligent people, representatives of the general public, who, knowing something of the results of scientific investigation, have little idea of its methods, and whose interest in our proceedings, while entirely cordial and friendly, is often born of curiosity rather than a full appreciation of their value and importance. Mingled with them are the members and fellows of the association, who have come to the annual gathering laden with the products of many fields which they have industriously cultivated during the year, each ready to submit his contribution to the inspection and criticism of his comrades, and all hoping to add in some degree to the sum-total of human knowledge.

The united presence of these two classes intensifies the interest which naturally attaches to an occasion like this, and not unnaturally suggests that a brief consideration of the relations which do exist, and which should exist, between them may afford a profitable occupation for us this evening.

In the beginning it may be truthfully affirmed that no other single agency has done as much to establish these relations on a proper basis as the American Association for the Advancement of Science. In the first article of its constitution the objects of the association are defined as follows: "By periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of the United States, to give a stronger and more general impulse and a more systematic direction to scientific research in our country, and to procure for the labors of scientific men increased facilities and a wider usefulness." So perfectly do these words embody the spirit of the association, that, when more than thirty years later the constitution was thoroughly revised, none better could be found to give it expression. That it has been successful in promoting intercourse between those who are cultivating science in different parts of the United States, may be proved by the testimony of thousands who have come to know each other through attendance at its meetings. In a country whose geographical limits are so extensive as ours, and whose scientific men are so widely scattered, it is difficult to overestimate its value in this particular.

In giving a stronger and more general impulse and a more systematic direction to scientific research in our country, it has been singularly fortunate. Its meetings have been the means of disseminating proper methods of investigation and study throughout the land. Hundreds of young students, enthusiastic but often not well trained, have found themselves welcome (sometimes to their own astonishment), and by its influence and encouragement have been moulded and guided in the utilization of their endowments, occasionally exceptional, to the end that they have finally won a fame and renown which must always be treasured by the association as among its richest possessions. Wherever its migratory meetings have been held, the pulse of intelligence has been quickened, local institutions have been encouraged and strengthened, or created where they did not before exist, and men of science have been brought into closer relations with an intelligent public.

But it is in relation to the last of the three great objects to accomplish which the association was organized,—namely, "to procure for the labors of scientific men increased facilities and a wider usefulness,"—that it has been, on the whole, less successful. It is true that when we look at the history of science in America during the past fifty years; when we see at every point evidences of public appreciation, or at least appropriation of scientific discovery; and, most of all, when we observe the enlargement of older institutions of learning to make room for instruction in science, and the generous donations to found new technical and scientific schools, together with an occasional endowment of research, pure and simple,—in view of all these, I say, we are almost constrained to believe that scientific men have only to ask, that their facilities may be increased, and that their labors could hardly have a wider usefulness.

Unfortunately this pleasing picture is not a true reflection of the actual condition of things. The attentive observer cannot fail to discover that the relation between men of science and the general public is not what it should be in the best interests of either or both. In assemblages of the former it is common to hear complaints of a lack of appreciation and proper support on the part of the latter, from whom, in turn, occasionally comes an expression of indifference, now and then tinctured with contempt for men who devote their lives and energies to study and research, the results of which cannot always be readily converted into real estate or other forms of taxable property. It cannot be denied that the man of science is at some disadvantage as compared with his neighbor, the successful lawyer or physician, when it comes to that distribution of confidence with responsibility which usually exists in any well-ordered community, although the latter may possess but a fraction of the intellectual power and sound judgment which he can command. To his credit it may be said that he is usually considered to be a harmless creature, and to render him assistance and encouragement is generally regarded as a virtue. The fact of his knowing much about things which do not greatly concern the general public is accepted as proof that he knows little of matters which seriously affect the public welfare.

It is true that when the public is driven to extremities it sometimes voluntarily calls upon the man of science, and in this emergency it is often unpleasantly confronted with the fact that it does not know where to find him. The scientific dilettante, or, worse, the charlatan, is often much nearer the public than the genuine man of science; and the inability to discriminate sometimes results in disaster in which both science and the public suffer.

In venturing to suggest some possible remedies for this condition of things, it will be logical, if not important, to roughly define the two classes under consideration,—the

scientific and the non-scientific. One is the great majority, the general public, including in the United States over sixty millions of people in all conditions, cultured and uncultured, educated and uneducated, but in average intelligence, we are proud to say, superior to the people of any other nation in the world. Out of these it is not easy to sift, by definition, the small minority properly known as men of science. Only a rough approximation may be reached by an examination of the membership of scientific societies.

The American Association for the Advancement of Science includes in its membership about two thousand persons. It is well known, however, that many of these are not actually engaged in scientific pursuits, either professionally or otherwise: indeed, it is one of the important functions of the society to gather into its fold as many of this class as possible. The fellowship of the association is limited, however, by its constitution, to such members as are professionally engaged in science, or have by their labors aided in advancing science. They number about seven hundred, but in this case it is equally well known that the list falls far short of including all Americans who by their labors in science are justly entitled to a place in any roll of scientific men. On the whole, it would not, perhaps, be a gross exaggeration to say that not more than one in fifty thousand of our population could be properly placed upon the list, even with a liberal interpretation of terms.

In this estimate it is not intended, of course, to include that large class of active workers whose energies are devoted to the advancement of applied science. Although their methods are often the result of scientific training, and while the solution of their problems requires much knowledge of science, the real advancement of science at their hands is rather incidental than otherwise. In certain particulars they may be likened to the class known as "middle-men" in commercial transactions,—the connecting link between producer and consumer. It is in no way to their discredit that they usually excel both of these in vigilance and circumspection and in their quick perception of utility. By them the discoveries of science are prepared for and placed upon the market, and it is difficult to overestimate their usefulness in this capacity. It is true that the lion's share of the profit in the transaction is generally theirs, and that they are often negligent in the matter of giving the philosopher the credit to which he is entitled; but for the latter, at least, it is believed that the philosopher is himself often responsible.

If this statement of the relative numbers of the scientific and the non-scientific is reasonably correct, the scientific man may at least congratulate himself on wielding an influence in affairs vastly greater than the census alone would justify; and this fact encourages the belief, that, if there is any thing "out of joint" in his relations with the general public, the remedy is in his own hands. Let our first inquiry be, then, in what particulars does he fail in the full discharge of his duties as a man of science, and especially as an exponent of science among his fellows?

Without attempting to arrange the answers which suggest themselves in logical order, or, indeed, to select those of the first importance, I submit, to begin with, his inability or unwillingness, common but by no means universal, to present the results of his labors in a form intelligible to intelligent people. When inability, it is a misfortune, often the outgrowth, however, of negligence or indifference; when unwillingness, it becomes at least an offence, and one not indicative of the true scientific spirit. Unfortunately we are not yet entirely out of the shadow of the middle ages, when learning was a mystery to all except a select few, or of the centuries a little later, when a scientific treatise must be entombed in a dead language or a scientific discovery embalmed in a cipher.

Many scientific men of excellent reputation are to-day guilty of the crime of unnecessary and often premeditated and deliberately planned mystification: in fact, almost by common consent, this fault is overlooked in men of distinguished ability, if, indeed, it does not add a lustre to the brilliancy of their attainments. It is usually regarded as a high compliment to say of A, that, when he read his paper in the mathematical section, no one present was able to understand what it was about; or of B and his book, that there are only three men in the world who can read it. We greatly though silently admire A and B; while C, the unknown, who has not yet won a reputation, and who ventures to discuss something which we do understand (after his clear and logical presentation of the subject), must go content with the patronizing admonition that there is really nothing new about this, and that, if he will consult the pages of a certain journal of a few years ago, he will find the same idea,—not developed, it is true, but hinted at, and put aside for future consideration,—or that he will find that Newton or Darwin declared what is essentially the same principle many years before. No one can deny that there is great reason and good judgment displayed in all this, but the ordinary layman is likely to inquire whether it is distributed and apportioned with nice discrimination; and it is the standpoint of the layman which we are occupying at the present moment.

All will admit that there are many men whose power in original thinking and profound research is far greater than their facility of expression, just as, on the other hand, there are many more men whose linguistic fluency is unembarrassed by intellectual activity; and representatives of both classes may be found among those usually counted as men of science. It is with the first only that we are concerned at the present moment, and it is sufficient to remark that their fault is relatively unimportant and easily overlooked. Among them is often found that highly prized but imperfectly defined individual known as the "genius," for whose existence we are always thankful, even though his interpretation is difficult and laborious.

Concerning those who, although able, are unwilling to take the trouble to write for their readers or speak for their hearers, a somewhat more extended comment may be desirable. It is always difficult to make a just analysis of motives, but there can be little doubt that some of these are influenced by a desire to imitate the rare genius whose intellectual advances are so rapid and so powerful as to forbid all efforts to secure a clear and simple presentation of results. The king is lame, and the courtier must limp. With others there is a strange and unwholesome prejudice against making science intelligible for fear that science may become popular. It is forgotten that clear and accurate thinking is generally accompanied by the power of clear, con-

cise, and accurate expression, and that as a matter of fact the two are almost inseparable. The apparent success before the people of the dilettante and the charlatan, has resulted, in the case of many good and able men, in a positive aversion to popular approval. It should never be forgotten that the judgment and taste of the public in matters relating to science are just as susceptible of cultivation as in music and the fine arts, and that scientific men owe it to themselves to see that opportunity for this culture is not withheld. A just appreciation by the people of real merit in art has resulted in the production of great painters, sculptors, musicians, and composers, and there is every reason to believe that the best interests of science would be fostered by similar treatment. Even the great masters in science, then, can well afford to do what is in their power to popularize their work and that of their colleagues, so that, through closer relations with a more appreciative public, their opportunities may be enlarged and their numbers increased.

Another error into which the man of science is liable to fall is that of assuming superior wisdom as regards subjects outside of his own specialty. It may seem a little hard to accuse him of this, but nevertheless it is a mistake into which he is easily and often unconsciously led. That this is the day of specialization and specialists, every student of science learns at the very threshold of his career; but that one man can be expected to be good authority on not more than one or two subjects, is not so generally understood by the public. It thus frequently happens that the man of science is consulted on all matters of a scientific nature; and he is induced to give opinions on subjects only remotely, if at all, related to that branch of science in which he is justly recognized as an authority. Although going well for a time, these opinions often prove to be erroneous in the end, resulting in a diminution of that confidence which the public is, on the whole, inclined to place in the dictum of science.

Examples of this condition of things are by no means wanting, and they are not confined, as might at first be assumed, to the lower ranks of science. A distinguished botanist is consulted and advises concerning the location of the natural gas field, a mathematician advises a company in which he is a stockholder in regard to the best locality for boring for oil, and a celebrated biologist examines and makes public report upon a much-talked-of invention in which the principles of physics and engineering are alone involved.

In these and many other instances which might be related, the motives of those concerned, at least on one side of the transaction, cannot be questioned, but certainly their judgment is open to criticism; and the outcome of it all is, that the confidence of the people in scientific methods and results is weakened. Fifty years ago or a hundred years ago there was good reason for much of this sort of thing. Specialization was neither as possible nor as necessary as now. The sparseness of the population of the country, the absence of centres of learning and scientific research, the obstacles in the way of easy and rapid communication between different parts of the country,—all these and other circumstances contributed to the possibility of a Franklin, who wrote, and wrote well, upon nearly all subjects of human thought; whose advice was sought and given in matters relating to all departments of science, literature, and art. Combining in an extraordinary degree the power of profound research with a singularly simple and clear style in composition, together with a modesty which is nearly always characteristic of the genuine student of nature, he wisely ventured further than most men would dare to-day, in the range of topics concerning which he spoke with authority.

But at the present time and under existing conditions there is little excuse for unsupported assumption of knowledge by men of science, and, fortunately, the danger of humiliating exposure is correspondingly great. The specialist is everywhere within easy reach, and the expression of opinions concerning things of which one knows but little is equally prejudicial to the interests of science and society.

The scientific man should also be at least reasonably free from egotism in matters relating to his own specialty, and particularly in reference to his own authority and attainments therein. In controversy he has the advantage over most disputants, in that he can usually call to his support an unerring and incontrovertible witness. A well-conducted experiment or an exhaustive investigation, carried out with scrupulous honesty, deservedly carries great weight; but it must not be forgotten that it does not, in a very great degree, depend upon the personality of him who directs the experiment or plans the investigation. One must not confound himself and his work, to the extent of assuming that upon him ought to be bestowed the praise and admiration to which his work is, perhaps, justly entitled. This blunder is analogous to that of the mechanic in whom the first symptom of insanity appeared as a conviction that he was as strong as the engine which he had built, evidence of which he unpleasantly thrust upon any who might deny the truth of his assertion. "By your works shall ye be judged," may be especially affirmed of men of science not only as regards the judgment of the public, but particularly that of their colleagues and fellow-workers. Least of all should title, degree, membership in learned societies, or the possession of medals or other awards of distinction and honor, be paraded unduly, or offered by himself, in evidence of his own fitness. In general, these are honorable rewards, which are justly prized by scientific men; but some of them have been so indiscriminately bestowed, and in some instances falsely assumed, that the general public, not yet properly educated in this direction, does not attach great value to them as an index of real scientific merit. Where real merit actually exists, nothing is usually gained, and much is likely to be lost by boastful announcements of high standing or of accumulated honor. A distinguished man of science, at the end of a controversy into which he had been called as such, complained that he had not been recognized as a fellow of the Royal Society. "You gave us no reason to suspect your membership," quietly but severely replied a man of the world.

As another element of weakness in the scientific man, I venture to suggest that he is often less of a utilitarian than he should be. This is a sin, if it be such, which seems especially attached to those who, unconsciously or otherwise, are imitators of men of science of the highest type. The latter are so entirely absorbed in profound investigation, and their horizon is necessarily so limited by the very nature of

the operations in which they are engaged, that they are altogether unlikely to consider questions of utility; nor, indeed, is it desirable that they should. The evolution of processes and methods by means of which the complex existence of the present day is maintained is largely the result of specialization or the division of labor. In such a scheme there is room for those who never demand more of a fact than that it be a fact, of truth that it be truth. But even among scientific men the number of such is small, and as a class they can never be very closely in touch with the people.

Strong to imitate, even in those characteristics which are akin to weakness, many persons of lesser note affect a contempt for the useful and the practical which does not tend to exalt the scientific man in the opinion of the public. Even the great leaders in science have been misrepresented in this matter. Because they wisely determined in many instances to leave to others the task of developing the practical applications of their discoveries, it has often been represented that they held such applications as unworthy a true man of science. As illustrating the injustice of such an opinion, one may cite the case of the most brilliant philosopher of his time, Michael Faraday, who, in the matter of his connection with the Trinity House alone, gave many of the best years of his life to the service of his fellowmen. The intensely "practical" nature of this service is shown by the fact that it included the ventilation of lighthouses, the arrangement of their lightning-conductors, reports upon various propositions regarding lights, the examination of their optical apparatus, and testing samples of cotton, oils, and paints. A precisely similar illustration is to be found in the life of our own great physicist, Joseph Henry, who sacrificed a career as a scientific man, already of exceptional brilliancy, yet promising a future of still greater splendor, for a life of unselfish usefulness to science and to his countrymen as secretary of the Smithsonian Institution, as a member of the Lighthouse Board, and in other capacities for which he was especially fitted by nature as well as by his scientific training.

There is an unfortunate, and perhaps a growing, tendency among scientific men to despise the useful and the practical in science; and it finds expression in the by no means uncommon feeling of offended dignity when an innocent layman asks what is the use of some new discovery.

[Continued on p. 232.]

NOTES AND NEWS.

AN important experiment has been made in the province of the Don Cossacks, Russia, by M. Sherebzov. He collected the water from rain and the melting of the snows into two pools, holding together about 1,872,000,000 cubic feet, and distributed it among the fields in spring and summer. These pools supplied sufficient water to irrigate more than 2,290 acres, but were unable to contain all the water which flowed towards them; and therefore two new pools have been made, and the irrigated area enlarged to 2,960 acres. In consequence of this irrigation, says *The Scottish Geographical Magazine*, the wheat-crop has increased from about 9½ to 15½ bushels per acre; and the profits of the undertaking have been, according to M. Sherebzov, 30 per cent.

— Nothing in the wonderful history of photographic progress, which has been so strikingly rapid during the past few years, has been of greater importance than the development of what may be called, for want of a better term, "the photo-mechanical processes," which are so largely superseding wood engraving, steel engraving, and other pictorial methods. This subject is of great interest to the whole public, but particularly to all persons in any way interested in the production or use of pictorial illustrations: such as artists; authors; publishers of books, magazines, and newspapers; printers; and manufacturers whose products require illustration. For the past few years these processes have multiplied in number, have improved greatly in their results, and are every day assuming greater importance in both artistic and economical directions; yet it is a remarkable fact that in no exhibition have they been brought together for comparison and study. Beginning Nov. 3, 1890, the New York Camera Club will give an exhibition in its rooms, 314 Fifth Avenue, of the work of the various establishments producing all classes of such plates.

— Attention was drawn some months ago by *Engineering* to the very interesting experiments of Messrs. Mach and Salcher, who succeeded in photographing bullets in their flight. These experiments have been repeated with larger weapons, and the results previously obtained fully confirmed. To obtain a photograph, the camera is arranged at one side of the line of fire; and, as the shot passes a fixed point, it causes the discharge of a Leyden jar, the light from which is sufficient to allow of a photograph being taken. No results of any importance are obtained, according to *Engineering* of Oct. 3, till the velocity of the shot exceeds that of sound. But at higher speeds than this the photographs show that a wave of compression precedes the bullet in its flight. The shape of this wave is an hyperboloid of revolution with the apex of the hyperbola some little distance in front of the shell. Behind the shot a conical wave is formed, the angle of which is less, the greater the velocity of the shot. If the semi-vertical angle of this cone is a, the velocity of the shot is said to be

$$\frac{\text{velocity of sound in air}}{\sin a}.$$

— The greatest enemy to the plum is the insect commonly known as the plum curculio. This is the cause of the wormy fruit that so often falls from the trees. Various remedies have been tried for this pest, and for several years trials have been made at the Ohio Experiment Station of the method of killing the insects by spraying with a very dilute mixture of Paris-green and water. The experiments were again repeated this season by the station entomologist, Dr. C. M. Weed, with good results. An orchard of 900 bearing trees in Ottawa County, O., right in the heart of a great fruit growing region, was selected for the experiment. In the north half of it the method of catching the curculios by jarring on a sort of inverted umbrella mounted on wheels was employed, while the south half was sprayed four times with pure Paris-green mixed with water, in the proportion of four ounces to fifty gallons of water. The first application was made May 8, just after the blossoms had fallen from the late-blooming varieties. There was a heavy rain the same night, and it rained almost continuously until May 15, when there was a short cessation. The second spraying was done on that day. The third spraying was made May 26; and the fourth and last, June 2. On the jarred portion of the orchard a great many curculios were caught, showing that they were present in numbers. A careful examination of both parts of the orchard was made on June 3. Between one and two per cent of the fruit on the sprayed trees had been stung, while about three per cent of the plums on the jarred trees were injured. No damage to the trees was then perceptible. Early in July the orchard was again examined. Some of the sprayed trees showed that the foliage had been damaged by the spraying, but the injury was not very serious. Not over three per cent of sprayed fruit was stung at that time, while about four per cent of that on the jarred trees was injured. But on both the fruit was so thick that artificial thinning was necessary to prevent overbearing. A large crop of fruit was ripened on both parts of the orchard, and, so far as could be judged from the experiment, the practicability of preventing the injuries of the plum curculio by spraying was demonstrated. This process is very much less laborious and costly than jarring; and, if future experience is as successful as this season's work, plum-growing will become much easier.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

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THE RELATIONS OF MEN OF SCIENCE TO THE GENERAL PUBLIC.

[Continued from p. 231.]

Referring to the theoretically extremely interesting spar prism of Bertrand, which under certain conditions may be used to detect traces of polarization of light, a recent writer remarks, "But for this application, the prism would possess, in the eyes of the true votary of science, the inestimable value of being of no practical utility whatever."

Much is said, everywhere and at all times, about the pursuit of science for the sake of science; and on every hand it is sought to convey the impression that one who has any other object in view in interrogating Nature than the mere pleasure of listening to her replies, is unworthy of a high place among men of science. So old, so universally accepted, so orthodox, is this proposition, that it is with much hesitation that its truth is questioned in this presence. In so far as it means that one cannot do any thing well unless it is done *con amore;* that pecuniary reward alone will never develop genius; that no great philosopher, or poet, or artist, will ever be other than unselfishly devoted to and in love with his work,—just so far it is true, although it does not, as is often assumed, furnish a motive of the highest order. It is a trite saying, but perhaps it cannot be too often repeated, that he who lives and labors in the interest of his fellows, that their lives may be brightened, that their burdens may be lessened, is, above all others, worthy of the highest praise. By this standard the value of a discovery must at last be fixed; bearing in mind, of course, that the physical comfort of man is not alone to be considered. Judged by this standard, the work of Newton, of Watt, of Franklin, Rumford, Faraday, Henry, and a host of others, is truly great. There should be, and there usually is, no controversy as to relative merit between the discoverer of a gem and the artist who polishes and sets it. In science the genius of the former is unquestionably rarer and of a higher order; but his work will always be incomplete, and in a great degree useless, until supplemented by that of the latter.

Another demand which the public may justly make upon the man of science is that his interest in public affairs should not be less than that of other men. Through his failure in this particular, science has long suffered, and is suffering in an increasing degree. This criticism is especially applicable in this country, where in theory every man is supposed to bear his share of the public burden, and to take his part in the performance of public duties. Unfortunately, the attitude of the scientific man is too often one of criticism and complaint concerning matters in the disposition of which he persistently declines to interfere. It cannot be denied, I think, that men well trained in the logic and methods of scientific research ought to be exceptionally well equipped for the performance of certain public duties constantly arising out of local, state, or national legislation; yet the impression is well-nigh universal that the scientific man has no genius for "affairs." Indeed, it has been more than once affirmed that he is utterly devoid of administrative or executive ability, and even that he cannot be trusted with the direction of operations which are almost wholly scientific in their nature. That there are many examples which seem to justify this belief is too true, but that there are other instances in which administrative and scientific ability have been combined is also true. Little search is required to reveal cases in which men of science have so ignored all ordinary rules and maxims of business procedure as to merit severe criticism, in which, unfortunately, the public does not discriminate between the individual and the class which he represents. It seems astonishing that one who is capable of successfully planning and executing an elaborate research, in which all contingencies are provided for, the unexpected anticipated, and all weak points guarded and protected, may utterly break down in the management of some much less complicated business affair, such as the erection of a laboratory or the planning of an expedition; and I am unwilling to believe that such failures are due to any thing other than culpable negligence on the part of the individual.

It is generally recognized, that, aside from all questions of a partisan political nature, this country is to-day confronted by several problems of the utmost importance to its welfare, to the proper solution of which the highest intellectual powers of the nation should be given. The computation of the trajectory of a planet is a far easier task than forecasting the true policy of a great republic, but those

qualities of the human intellect which have made the first possible should not be allowed to remain idle while an intelligent public is striving to attain the last. That men of science have not, thus far, made their full contribution to the solution of some of these great problems, is due to the fact that many have exhibited an inexcusable apathy towards every thing relating to the public welfare, while others have not approached the subject with that breadth of preparation in the close study of human affairs which is necessary to establish the authenticity of their equations of condition. As already intimated, we do not seem to be getting on in this direction. Our own early history and the history of other nations are full of examples of eminent scientific men who were no less distinguished as publicists and statesmen. The name of Franklin is imperishable alike in the history of science and of politics. On many questions relating to exact science, the Adamses spoke with confidence. Thomas Jefferson was a philosopher, and, on assuming the duties of the highest office in the gift of the people, counted his opportunities for association with men of science as one of its chiefest rewards. Other illustrations might be selected from the pages of the history of our own country; while in Europe, where science has been longer cultivated and under more favorable conditions, they are much more common. This is notably so in France, whose roll of scientific men who have distinguished themselves and their country during the past century, includes many names prominent alike for the importance of their performance in her various crises of peace and war. The present president of the French Republic, himself an engineer, bears a name made famous in the history of science by the rich contributions of his ancestors, one of whom voted for the execution of Louis XVI., and was a member of the Committee of Public Safety. It would be difficult to overestimate the value to science, as well as to the public, of the presence in the halls of legislation of even a very small number of men who might stand as exponents of the methods of science and as competent authorities on the results of their application. Our national Congress, especially, is almost constantly dealing with questions of great moment to the people, which can only be thoroughly understood and wisely dealt with by scientific men; and the presence of one or two such in each branch of that body would be of decided advantage to the whole country. In the nature of things, opportunities for such representation will be rare; but when they occur, they must not be suffered to escape.

Finally, if the conclusions reached in the foregoing should be thought wise, and should any young man at the threshold of his scientific career determine to be guided by them in establishing his relations with the general public, he will find splendid examples among the distinguished leaders of all departments of science. Should he desire to present the results of his labors in such a way that they may be understood by intelligent people, he may imitate Franklin, whose literary style, as to simplicity and clearness, commanded the highest praise from literary men; or Faraday, who was able to give expression to the most involved conceptions in simple English; or Tyndall, the appearance of whose "Heat considered as a Mode of Motion" was an epoch in the history of physical science, in its relation to an intelligent constituency, without which it cannot thrive. He will learn that there is no discredit in "popularizing" science; that popularizing what is not science is the thing that is to be shunned and prevented. The arrogance of genius is not less disagreeable than that of riches, although it is less common.

Should he wish to cultivate modesty in estimating his own attainments, he need only follow Newton, Darwin, and, in fact, the whole list of distinguished men of science down to the present time, with a few rare and unexplainable exceptions, the existence of which serves, like a whistling buoy, to point out what should be avoided.

Should he aspire to be of some use to the world and to leave it better because of his life, he will be encouraged by the fact, already considered, that in the long-run those discoveries are most highly esteemed, and justly so, which are the most potent in their influence upon civilization and society by ameliorating the condition of the people, or by enlarging their opportunities, and that all really great men of science have not lost sight of this fact; that "science for the sake of science" does not represent the highest ideal, nor can the "almighty dollar" ever be bartered for the "Divine Afflatus."

All of these questions will serve to enlarge his interest in public affairs, because he will come to recognize that he is himself but a part of the public. He will remember the delight of Faraday, when near the end of his life he saw a huge dynamo illuminating the tower of a lighthouse. That which he had given to the world as an infant, in his splendid discovery of induction, had, through the fostering care of others, grown to a brilliant manhood; and he experienced exquisite pleasure in the reflection that it might be the means of saving the lives of his fellowmen. The ideal of duty which ought to be present in the mind of every man of science may well be higher than that growing out of mere selfish pleasure in the acquisition and possession of knowledge.

Perhaps it is hardly becoming in me, at this time and in some sense representing this large body of scientific men, to make even a simple remark in criticism of the general public, the party of the second part in the question which we have considered to-night. I venture to suggest, however, that, whenever the public is disposed to consider its obligations to Science and her votaries, there are some things which must not be forgotten,—things so important and so numerous, indeed, that many volumes would be inadequate to their enumeration. Prove this by comparing the world *with* science, with the world *without* science. Take as an illustration that which less than two hundred years ago was but a spark—a faint spark—exhibited on rare occasions by the scientific man of that time. With this spark, thanks to science, the whole world is now aflame. Time and space are practically annihilated; night is turned into day; social life is almost revolutionized; and scores of things which only a few years ago would have been pronounced impossible, are being accomplished daily. Many millions of dollars of capital and many thousands of men are engaged in the development of this agent, so purely a creation of science that the Supreme Court of the land has already decided that it has no material existence. Surely science, which has brought us all these blessings, together with thousands besides, is worthy of every care and consideration at the hands of a generous and appreciative public.