SCIENCE

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THE RELATION OF THE ACADEMY TO THE STATE AND TO THE PEOPLE OF THE STATE[1]

WE are celebrating the twenty-fifth anniversary of an institution whose existence is unknown to the great majority of the people of Ohio. Yet it has enjoyed a prosperous life of a quarter of a century during which it has held many meetings in different parts of the state. At these meetings important results of original research on the part of its members were presented, many of which have been published by the academy and in various scientific journals, thus becoming a part of the great store of learning which the world is accumulating.

The academy can not be fairly charged with undue exaltation of its own merit or importance in the past and, as an incorporated institution of the state it has a right to think that some consideration should now be given to the relations which it might and should sustain to that state and to the people of the state.

As a preface to such consideration it seems desirable to refer to the views of a few persons who would naturally be among its most active supporters did they not believe that under present conditions there is no good reason for the existence of such a society as the Ohio Academy of Science, contending that other organizations of a similar character, mostly national in their scope, offer as good or better facilities for the accomplishment of the principal ends the academy has in view. There is enough ground for such a contention to justify a reply.

Of the many remarkable social evolutions

[1] Address at the celebration of the twenty-fifth anniversary of the Ohio Academy of Science.

that have marked the last quarter of a century none is more curious and interesting than the marvelous increase in the number of societies or groups of people associated together for some special purpose other than what is generally known as "business." It seems to be an accepted theory that if any thing is to be done or ought to be done it is only necessary to form an organization of those who think it ought to be done, after which it is often assumed that in some mysterious way the thing will do itself. There is no part of the country however remote or difficult of access that has not been penetrated by and permeated with this malady, and clubs, associations, circles, etc., have been formed in bewildering numbers and perplexing confusion as to origin and *raison d'être*. Persons cynically inclined have attributed this to the fact that each organization requires a president and other officers and that the universal desire for place-holding is thus gratified. While there is doubtless more truth in this explanation than we would care to acknowledge, the phenomenon is largely the outcome of the modern drift towards specialization in all spheres of human activity. Indeed it is more than a drift; it is a veritable flood-tide and many organizations of recent creation are examples of specialization gone mad.

Scientific men have not escaped this epidemic and during the past twenty years their segregation into groups each of which confines its activities in study and research to a special and often a very narrow field, has gone on with alarming rapidity. Alarming because while there can be no question that science has been and will continue to be greatly advanced by specialization it can not be denied that the man of science has suffered and will continue to suffer from the same cause. Burrowing in a trench, necessary as that operation often is, if persisted in to the exclusion of other occupations, deprives the burrower of that breadth of view and general acquaintance with the topography of the surrounding country which is necessary to the understanding, direction or control of larger operations. It will be admitted that up to the present time the epoch-making generalizations in science have originated with men, who, though profound students of some great subdivision of human knowledge, have not been given to acute specialization. Although we may not expect another Bacon to rise and declare, "I have taken all knowledge to be my province," it is safe to predict that if we are to have in the future discoveries of a magnitude comparable with that of the Copernican theory of the universe, the law of gravitation, the doctrine of evolution or the conservation of energy, they will come from men whose learning is comprehensive rather than intensive. Indeed the same rule must hold in more restricted fields of research. One who devotes himself exclusively to the study of "the abdominal parasites of the white ant" is not likely to evolve from it a new and important biological principle; nor is it probable that an intensive study of conjugate systems of space curves or years devoted to a revision of the atomic weights of the rare metals would carry one far on the way towards an explanation of the nature and cause of gravitational attraction. I would much regret to be understood as deprecating or disparaging specialization in science. It is of the highest importance even in its narrowest phase for through it the phenomena of nature are revealed. But finding how one phenomenon is related to another; the logical grouping of results of observation and experiment and the derivation therefrom of general principles and laws will always call for intellectual powers of a distinctly higher order.

I conclude, therefore, that an organization like the Ohio Academy is of prime importance to science in Ohio because it is essential to the proper and complete development of the man of science. By mingling with those whose explorations of the mysteries of nature are directed along lines diverging greatly from his own he is better prepared to estimate correctly the comparative and the absolute value of his own work. He has also an opportunity to familiarize himself with methods and instruments of research used in other departments of science which he can often summon to his own service with great profit.

In our own National Academy of Sciences there is no division of members into sections in sessions for the presentation and discussion of scientific papers. Communications of the most diverse character are presented before the entire body and this course is highly commended in a recent volume by Dr. George E. Hale, which is a study of the academies of all nations and their relation to the progress of human knowledge.

Unfortunately the history of scientific organizations in this country during the past quarter of a century shows a strong movement in a direction contrary to that which I have suggested as desirable. Forty years ago the American Association for the Advancement of Science was divided into two sections, one of which included those members who were most interested in the so-called "exact sciences," mathematics, astronomy, physics and chemistry, while the other was made up of students of the "natural history sciences." During the week or ten days of its annual meeting there were daily morning sessions in which both sections participated and there were frequent evening meetings at which addresses and lectures were given by eminent scholars representing both grand divisions of science, each chosen for his skill in presenting his subject in such a way that it was intelligible and interesting to members who were on the other side of the dividing line. In this way the mathematician or physicist might always have a fairly correct knowledge of the more important developments or the larger generalizations in biology or geology. The doctrine of evolution, which came first from that side, was quickly appreciated by students of exact science to which it has since been profitably applied. They, in their turn, gave to the naturalists the great principle of the conservation of energy, of which great use has been made in the study of life in its various forms. The psychological effect of the mingling of these two rather diverse elements of the scientific body was also of great value, and there is not the slightest doubt that both were greatly benefited.

In this bi-partite classification of its membership the association had followed the example of its English forerunner in a practise which the latter still maintains. In the American Association the disintegration began about thirty years ago and at present it is divided into twelve sections.

In addition to this specialization within the largest scientific body of the country, during the past twenty years an astonishingly large number of other scientific societies have come into existence, each of which is specially devoted to a particular department or, more often, to a subdivision of a particular department of science. Indeed the pressing need of the hour is the organization of a Society for the Prevention of the Organization of Other Societies.

Perhaps the most deplorable consequence of this minute subdivision in the ranks of scientific men is that, because of habitual isolation from all not familiar with its technical vocabulary little or no effort is made by one group to translate the

results of original research into a language intelligible to any or all of the others. In spite of the sensational vaporizing about scientific men and scientific discoveries that abounds in the Sunday newspapers and fills the pages of popular magazines, it is absolutely true that at the present day there are almost no attempts to popularize science, that is by men who know what they are talking about. A great journal which for half a century was devoted to the exposition of the results of scientific investigation in the vernacular common to educated men has recently been compelled to suspend further publication for lack of support. It seems to be a case in which both producer and consumer have disappeared.

The Ohio Academy of Science is organized in such a way as to afford, it is hoped, an effective check upon this unfortunate tendency. In its sectional meetings opportunity is offered for the discussion of results of research of the most specialized character, while in its general sessions the more important of such results, when finally accepted, may be presented in a manner intelligible and interesting to all. As an illustration of the latter possibility I may be allowed to refer to the great pleasure and profit with which, as one whose intellectual horizon has always been regretfully restricted, I listened at the last meeting of the academy to a most able, interesting and instructive summary of work done in the suppression of the foot and mouth disease.

I think it fortunate that the academy is never likely to be very great in numbers. Let us hope that there will always be at least one institution whose excellence is not to be measured by a numerical standard.

The American Association for the Advancement of Science with its ten thousand members, its twelve sections and its twenty-three affiliated societies, all meeting at one time and place, is an aggregation of parts not very closely related. It no longer affords, as in the early years of its existence, a great opportunity for that commingling in social and scientific intercourse which counted for so much in both pleasure and profit for its members. The smaller, specialized national societies take its place in large measure in this respect, but these fail in one most important particular. In them a man mingles with his kind; it is mingling with the other kind that he often most needs.

Finally, the Ohio Academy, being a state institution, should appeal to all residents of the state who are interested in the advancement of science or the promotion of scientific discovery. The geographic compactness of the state and the network of transportation lines by which it is covered makes it easy for all to attend its meetings, wherever they may be held, while the national societies are usually in session at such distant points that the burden of expense and time makes them impossible for many.

The academy, therefore should be accepted as a very desirable, indeed necessary adjunct to the scientific activities of the state and it is entitled to the loyal support of all residents of the state, especially of those who are actually engaged in scientific work.

Let us now consider its relation to the state under which it enjoys a corporate existence. In answer to the question "What has the state done for the academy?" a single sentence will suffice. A quarter of a century ago the state gave the academy its charter, in payment for which it received the sum of five dollars; about two years ago when the academy desired to correct a slight and hitherto undetected error in its name as recorded in the charter the state graciously allowed one word to be

stricken out, receiving for the stroke another payment of five dollars. That is all. It is not known that the state has in any other way recognized the existence of the academy.

In nearly all enlightened countries there is an organized body of scientific men, existing under a charter which gives it at least a quasi-official standing and the scientific knowledge or technical skill of its members is assumed to be at the service of the government whenever in legislative, administrative or judicial proceedings scientific problems are encountered. In England there is the Royal Society; in France the Academie Française; in Italy the Reale Accademia dei Lincei—the "Royal Academy of the Lynx"—of which Galileo and Colonna were early members, and in the United States we have the National Academy of Sciences, which, though not yet utilized by the national government as completely as would be desirable, has furnished the material on which some of the most important and far-reaching legislation of Congress rests. By the terms of its charter the government may call upon the academy to "investigate, examine, experiment and report upon any subject of science or art." The actual expense of such service is to be paid by the government, but members receive no compensation. In some states of the union in which there are chartered academies of science a similar relation exists and state governments have greatly benefited thereby, but in Ohio the state government has never yet asked its academy to "investigate, examine and report" upon any subject of science or art. This apparent lack of appreciation of the merits of the academy and the possibilities of its usefulness must be attributed to an indifference or ignorance on the part of state officials for which the members themselves may be largely responsible. Believing that it has thus far failed in this, one of its most important functions, I shall dwell a little on what I conceive should be its proper relation to the state in this respect.

I would have the academy act, through its properly constituted committees, as the adviser and counsellor of the state in all matters relating to science or the arts. The necessity for such advice and counsel is becoming more and more evident every year because the sciences and the arts are every year playing a more and more important part in all things affecting the well being of both the state and the people of the state. Eager to secure the benefits of applied science, state and municipal governments as well as private individuals have been guilty of wasteful extravagance in their unreasoning haste to do good to themselves before they know what really is good. During the past few years we have expended many millions of dollars in the building of what we hope will prove to be good roads. Bad grades, lack of drainage, collapsed foundations and crumbling bricks already show that in many instances we shall be grievously disappointed. That the greater part of the enormous loss resulting from such failures might have been avoided is apparent to any one possessing even a slight knowledge of the principles of highway construction.

Several years ago laws were enacted affecting the sanitation of our dwellings and public buildings, fixing in great detail the methods by which connection shall be made with public water supply, sewers, etc. These were supposed to be in the interest of the individual as well as that of the community at large, as a protection against the spread of disease, and the importance of many of them can not be denied. But within a few years it has been proved that many of the restrictions put upon us by our boards of health are quite useless and

unreasonable. We now know that sewer gas is not poisonous and that much of the cost of a system of so-called "sanitary" plumbing may be avoided, as is already done in countries where legislation follows information in such matters. As our sanitary legislation is much of it largely in the interests of a trade union it is rigidly enforced and the unnecessary burden upon the people is by no means light.

Much the same may be said of our laws and regulations relating to the ventilation of school and other buildings. They add greatly to the cost of construction and maintenance but they are far from being in accord with the more recent results of scientific investigation.

The people of Ohio pay, annually, many millions of dollars for a commodity for the measure of which, as it passes from producer to consumer, the state has made no provision whatever. The assumed honesty of the producer is the consumer's only protection.

Many other examples of wastefulness and burdensome legislation and administration might be cited, but these alone, resulting in a single year in a loss many times enough to endow an academy of science in perpetuity, should be convincing evidence that there is great need of wise counsel whenever laws relating to the applications of scientific discovery are under consideration by a legislative body whose members must of necessity be largely ignorant of the basic principles involved.

It will probably be suggested that the state already has at its command a body of scientific and technical advisers in the several faculties of the state universities and that these, being already in its employ, can more appropriately be called upon for service. But there are numerous other institutions of learning, in the faculties of which are to be found men of high scientific attainments and great technical knowledge and skill, men who are recognized by the members of the State University faculties as their peers in every respect, and the state should be glad to be able to avail itself of their accomplishments. Besides these, with whom science or technology is a profession, there will always be other citizens of Ohio (and may their tribe increase) who, though not connected with any educational institution, are lovers of learning and successfully engaged in research in some department of science. Their knowledge and experience may also be made available through the academy, of which they are almost certain to be members. Aside from the fact that the academy will constitute a much larger group than the faculties of the state universities from which expert counsellors may be chosen there can be no doubt that its advice would always have a higher value on account of its independence of action and freedom from political control or legislative influence. Even college professors are not wholly exempt from the weaknesses of human nature and conditions might arise in which it would go hard with them to oppose in report or recommendation a strong movement of the majority of a body of men to whom they must look for appropriations necessary to their continued existence. Instances in which such influence was successfully exerted would be, of course, extremely rare, but suspicion of its presence might be much less so.

There is a weakness in the third of the three great divisions of our governmental system which has long been deplored by all thoughtful people, to the cure of which a state academy of sciences might make a large contribution.

I refer to the use, or rather the abuse of expert testimony in courts of law. Such testimony is generally summoned in trials in which questions arise involving some de-

partment of science or some one of the technical arts. It must be frankly admitted that the scientific expert himself is responsible, more than any one else, for the humiliating fact that courts and juries often have little respect for him and little confidence in the evidence which he furnishes. This unfortunate and unnatural condition is the result of a system which is a disgrace to all who are responsible for it. The scientific expert has allowed himself to become an advocate. All of his tests, experiments and investigations are made to bolster up a particular theory. Phenomena or results of experiments that tend to discredit this theory are excluded from his testimony unless brought out by the skillful questioning of the attorney on the other side, who has been coached by another expert whose tests, experiments and investigations have been made for the purpose of breaking down this particular theory or establishing a different one. Often both of these men know the real truth of the controversy and if locked up in a research laboratory or isolated from outside influence would come to substantial agreement as to every important fact bearing upon it, for two trained observers can never differ long as to the phenomena present in any investigation.

But they have discredited themselves and the great body of scientific men whom they temporarily represent by selling their services as advocates rather than as experts skilled in ascertaining facts.

It has long been recognized that the remedy for this evil lies in the selection of expert witnesses by the court. Attorneys on both sides should be allowed to suggest questions to the court for the experts to answer if the court considers them proper but never to examine or cross-examine the witness directly. The compensation of the witness should be fixed by the court and paid by the state. The court would often find the academy the best source of information regarding the qualifications of experts and would gladly transfer to it the responsibility of making a selection, precisely as some years ago the officers of our national government charged with the administration of the internal revenue laws shifted the responsibility in an important case to the National Academy of Sciences and adopted the recommendations of its committee.

During the past few years there has been much talk (and not much besides talk) about the importance of conserving our national resources, state and national. I need hardly say that the membership of the academy includes men who have studied these resources for many years; who are better informed regarding them than any or all others. Whenever the state shall seriously undertake legislation to secure their conservation it will be a reckless administration that does not apply to them for advice and counsel.

At the risk of being charged with grossly exaggerating the merits of my fellow academicians and others of their kind I venture to refer to one other function of our complex social and industrial life for which I have long thought to be especially well fitted, those men who are thoroughly trained in scientific methods and who have shown their capacity for the original investigation and solution of difficult scientific problems. I mean for service as arbitrators, especially in those cases in which both sides declare there is nothing to arbitrate, each believing, often with perfect sincerity, that his own position is absolutely right and the other absolutely wrong.

Arbitration, in theory the best method of settling disputes, in practise has more often failed than not. It could hardly

be otherwise under the prevailing system. The ordinary procedure is for each side to choose a representative, generally a lawyer, who is pledged to do his best as an advocate, not as a judge. These two after much difficulty, and sometimes by the tossing of a coin, select a third who is often secretly known to favor one side or the other and thus the case is won before it is begun. In the more favorable case of the third arbitrator being open minded and anxious for a correct decision, the points in dispute are confused and obscured by the pleadings of his legal colleagues whose trade is "to make the worse appear the better reason."

In their place put men who have had much training and long experience in discriminating between appearances and realities, whose life work is the ascertainment of facts, the discovery and announcement of truth regardless of consequences, and arbitration would no longer mean a mere temporary expedient or an illogical and unsatisfactory compromise.

Much of the history of modern civilization might be summoned in support of my contention that training and discipline in the methods of scientific investigation may be depended upon above all other processes to give men power to distinguish between the true and the false; to analyze and reconcile confusing and contradictory evidence, and to extract therefrom whatever of truth it may conceal. For such men are guided by the sentiment that inspired Galileo when, in speaking of the Copernican system of the universe and other scientific doctrines which the Pope had condemned he had the courage to say:

> while there can be no doubt that his holiness has absolute power either to admit or condemn, *it is not in the power of any creature to make them to be true or false otherwise than in their own nature and in fact they are.*

Omitting further consideration of the many ways in which the academy might serve the state, and ignoring entirely the intrinsic value of contributions to science which its existence might make possible, I must refer briefly to the reciprocal obligation of the state to the academy.

In the beginning the question was asked, "What has the state done for the academy?" and the answer was, "nothing." My answer to the question what *should* the state do for the academy is almost as brief. It is, "not much." Its usefulness to the state will depend largely on its being free from state control or departmental influence. At the same time their mutual relations should be close enough to justify the state in calling upon it at any time for services of the kind I have indicated. The provision in the charter of our National Academy already quoted seems to be quite satisfactory. In return for services which in time will become both numerous and valuable the state should do two things for the academy. It should undertake the publication of its annual reports, including monographs, memoirs and other contributions to its proceedings which are judged to be of sufficient interest and importance to the people of the state. This is already the practise of several states in which academies of science flourish and it is done by the national government for the National Academy. It should also provide a suitable building in which the regular meetings of the academy could be held, where its archives and collections could be stored and where its special committees could hold their meetings and prepare their reports. This is certainly a modest demand if the members of the academy pledge themselves in return to give to the state without cost, in the form of advice and counsel, the full benefit of their scientific training and technical skill.

During the past few years in public and private speech, in books, newspapers and magazines the word "efficiency" has been heard and seen almost *ad nauseam*. The better the horse the more we are inclined to ride it to death, but that phase of the meaning of this word which implies making full and economic use of all our varied resources must in the end enjoy a useful survival. From the awful calamity which has fallen upon the world in the form of a general European war there are many lessons to be learned, not the least important of which is to discover the origin and cause of the marvellous efficiency of the military forces of one of the great nations involved, or rather, of the people of that nation, or still more accurately, of the nation as a whole, which has displayed a capacity for the immediate and complete utilization of every available resource, animate and inanimate, that has commanded the admiration of even its most bitter foes.

For one of the principal sources of this efficiency we have not far to look.

In 1893, when every nation of the world was collecting the best examples of its material resources and industrial products for exhibition at the great World's Fair held at Chicago in celebration of the four hundredth anniversary of the discovery of America, an old man in Berlin was commanded to present himself at the Royal Palace for an interview with the Emperor of Germany. To him spoke the Kaiser, saying:

> We are sending to America the finest products of our factories, our mills, our fields and our mines; some of our choicest works of art will be there, but above all of these Germany is most proud of the men she produces. You are the best we have and you must go to represent us.[1]

[1] This is no imaginary interview. I have given as nearly as possible the exact words used by Baroness von Helmholtz in telling me of it afterwards.

The man thus addressed was not a field marshal of the German army, or an admiral of her navy, her most famous diplomat or her richest iron-master. He was Herman Ludwig Ferdinand von Helmholtz, Germany's greatest natural philosopher, at once the most versatile and profound scholar of the nineteenth century.

The incident is well worthy of our attention as a striking illustration of the value which is set upon men of science and their work by the German Empire. During the past fifty years no other nation has so encouraged scientific research and by no other nation have scientific discoveries been so readily accepted and so quickly utilized. In all legislation upon economic questions the man of science has had paramount influence, and in that greatest of all economies, the prevention of unnecessary waste and the getting out of every material thing the last drop of usefulness, the Germans, from prince to peasant, have no rival.[2] The administration of her municipal governments is a model for the rest of the world, because the advice of the scholar has been sought at every turn. All of her foremost industrial enterprises have had their beginning in the laboratory. In many important lines she has controlled the markets of the world, not on account of her su-

[2] A personal experience, amusing but instructive, may be worth relating. While living in one of the largest cities in Germany I ordered a suit of clothes from a good shop on one of the principal streets. On the first trial of the coat I failed to find the small "change" or ticket pocket usually on the right side. When I called attention to its absence the tailor showed me that it had been put in on the *inside* of the larger pocket below, explaining that if he put it where it is usually placed by American or English workmen it would be *impossible to have the coat turned,* as the cut in the cloth would then show on the left side! And when I expressed my preference for the usual location he remarked, "Nearly every gentleman in Germany has his coat turned once."

perior business or commercial intelligence but because of the knowledge and technical skill of her chemists.

Whatever we may think of the outcome it can not be denied that it is *applied science* that has enabled the German Empire to suddenly convert itself into a huge engine of destruction, all parts of which seem to have been so delicately adjusted to each other that the awful strain to which the whole is now subjected is distributed among the several members in exact proportion to their ability to bear. Other nations are learning this lesson in the hard school of experience and they are paying tuition in blood and treasure.

Fortunately for us it may be learned by observation as well as by experiment.

T. C. Mendenhall

November 9, 1915

HISTORICAL SKETCH OF THE OHIO ACADEMY OF SCIENCE

Twenty-five years ago the first decisive steps were taken looking toward the organization of an Ohio Academy of Science. At the annual meeting of the Biological Club of the State University held November 3, 1891, the retiring president made a short address in which he said substantially: There is need of one institution in Ohio to the organization of which our club should direct its combined energy and influence. This is a state academy of science. If local clubs and societies of science are beneficial, the reasons that make them so apply with greater force to a state organization. Who can estimate the inspiration, the stimulus to research and investigation, that such an institution would provoke? In a great agricultural state like Ohio, a deep, abiding and constantly growing interest will ever be taken in the sciences of geology, botany and chemistry, for these constitute the very foundation, the body and bones, of any rational basis of practical knowledge regarding soils and the various crops that grow thereon. But our State Academy would not be confined to the sciences that relate so directly to soils and crops. All branches of biology, as well as physics, chemistry, mathematics, anthropology, meteorology, economics, sociology, etc., everything that contributes to the sum total of scientific knowledge, should find a place. The initial steps toward the founding of such an academy should be taken by this club, and to-night. This can be done by the appointment of a committee, which should energetically push the matter by preparing a program for a meeting, and issuing a call to all interested, to assist in the organization. In pursuance with this declaration the club appointed a committee consisting of D. S. Kellicott, W. A. Kellerman and the speaker to take such measures as in their judgment were deemed best to carry into effect the wishes of the Biological Club.

The committee soon secured the promise of hearty cooperation from many of the most prominent scientists in Ohio, and issued a call for a meeting to be held in Columbus, December 31, 1891.

The meeting took place at the date named, and appointed a committee on organization consisting of W. A. Kellerman, of the Ohio State University; E. W. Claypole, of Buchtel College; and Henry Snyder, of Miami University.

While the committee just named were preparing a constitution and by-laws, papers were read by Dr. A. M. Bleilie, E. E. Bogue, J. M. Bradford, H. E. Chapin, H. J. Detmers, W. A. Kellerman, D. S. Kellicott, H. A. Weber, W. C. Warner and A. A. Wright.

After the adoption of a brief but comprehensive constitution and a few simple by-laws, the organization was completed by the election of the following officers to serve the