before those who are using it have had a fair chance. But we who are on the outside know little of the plans of those who are inside. All signs indicate that they are making an earnest effort to solve an exceedingly difficult problem, and all who have the opportunity should do everything in their power to aid them.

In the changes which have been brought about in the condition of science in this country since 1848, it is safe to say that this association has either directly or indirectly played a leading part. It is certain that for the labors of scientific men increased facilities and a wider usefulness have been procured.

IRA REMSEN.

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*THE TWENTIETH CENTURY BOTANY.**

AT previous meetings of this and kindred societies the retrospective field in botany has been pretty thoroughly covered. It would seem a fitting time, therefore, to take a glance into the future and endeavor to see what there is for botany and botanical science in the years immediately before us. It is realized that an endeavor to set forth the lines along which botany will develop is a risky thing, and no doubt fifty years hence the views I may express at this time will cause only a smile in the light of actual developments. Notwithstanding this fact, I am willing to essay somewhat the rôle of a prophet, not so much with the idea that I expect all of my prophecies to be realized, but rather in recognition of a principle that to wish a thing or to desire a thing is at least a point gained in the full realization of the wish or desire. What I have to say, therefore, will be rather in the nature of an expression as to what I desire to see brought about in a field of work which to me seems fast opening to great possibilities. If an expression of these desires and the vitalizing of the thoughts which inspire them by placing them before you serve but to put in motion some of the forces which will act for the betterment of botany, my object shall have been fulfilled.

Before taking up specifically the more important lines along which botany seems likely to develop, and before considering some of the demands which may be made upon botany in the twentieth century, I should like briefly to call attention to what may be termed the present attitude of the state toward the work, for about this question hinge some points which are of vital importance to the future expansion and growth of botany as a whole. By the attitude of the state I of course mean the attitude of the people, for, in this country at least, the state is the people. It requires no argument to prove that the attitude of the state toward botany is rapidly changing. Even those of the younger generation realize that within their time the feeling of the people toward botany as a science and botany applied has changed greatly for the good of the work. I believe this is due to the fact that the utilitarian side of botany has been kept largely in the foreground, and the people have come to know and understand that a substantial encouragement of the work means a direct benefit to many important interests. When botany and botanical work were confined largely to the collecting and mounting of plants, the building up of herbariums and, perhaps, the working out of obscure laboratory problems, public sentiment could not be aroused in its behalf. Every time we have reached into new fields with the object of broadening the work and benefiting the people, the people have responded and given us most generous aid.

As an object lesson in this field I may call attention to the rapid growth of botany and botanical work in the Department of Agriculture at Washington. Fifteen years

* Address of the past-president, Botanical Society of America, St. Louis meeting, 1903.

ago the total amount expended for work of this kind did not reach $25,000 annually. The present year the honorable secretary's estimates for the work will aggregate about $400,000; and if the allied lines of investigation in which botany and botanical science play an important part are considered, the funds devoted to the work will exceed half a million dollars. This amount, it must be borne in mind, is an annual expenditure and practically represents an endowment on a three-per-cent. basis of over fifteen million dollars. This is for investigations and experiments alone, as purely educational subjects are considered only in an indirect way. That the people, or the state, are not averse to responding to the needs of botany from the educational point of view is manifested in the remarkable development of the work in a number of our important universities and in the growth of educational institutions, a type of which is found in the New York Botanical Garden. Here, through the energy of a corps of earnest workers, the educational value of botany has been recognized and generous support has been secured for the development of gardens, museums and laboratories. These results, however, I imagine, would not have been attained without appealing to the utilitarian ends in view. The practical value of such an institution to the community and to the country has been presented in the proper way, and the necessary support was forthcoming.

The argument, therefore, in all this is that for the future development of botany and botanical work we must make up our minds to two important things; first, the presentation of our wants to those upon whom we must depend for support, in such a way that the ultimate practical value of what we desire to do will be seen; second, the thorough discharge of our duties to the end of showing that the trust imposed on us has been fully and honestly respected. I may be preaching an heretical doctrine and be criticized on the ground that science has nothing to do with such material things and will take care of itself if kept pure and undefiled. This may be true, but I have long since reached the opinion that the doctrine of science for science's sake may be beautiful in theory, but faulty in practice. Some one has said that pure science and science applied are like abstract and practical Christianity, both beautiful, but one is for gods and the other for men.

It is men that we are to deal with in the future—keen, practical, analytical men, and they want and should know the why and the wherefore of what they are asked to support. It is recognized that there are but few men who have the gift of presenting what is frequently an abstruse problem in such a way as to gain material support. There ought to be more such men, and as the needs of the work develop, doubtless there will be more. From the tendency of the times the fact becomes evident that more and more the pursuit of science must be looked upon in a business-like way. Therefore, future aid for this work, be it in botanical or other lines, must come by going after it in the proper manner. In other words, the scientific man can not afford to wrap about himself a mantle of false dignity and assume that because his work is scientific he is debarred from seeking aid where aid is needed. What we shall expect to see, therefore, in the future is a manifestation of that spirit of progress which recognizes that science must seek its own interests and not wait to be sought.

Science, and I mean, of course, in the main, botanical science, can not and will not suffer by this attitude. I do not mean that the spirit of commercialism, of barter and trade, will enter into the matter. This is an extreme which will be avoided, as well as that other which comes with it, the idea that the responsible head of scientific work

must stand on a pinnacle and say, 'I am a scientist; this is enough; walk up and lay at my feet your tributes in order that you may receive my beneficent smiles.' I am not overdrawing this picture, for this very day there are institutions founded and conducted for the advancement of science where this attitude is maintained. The result is that men with the love of their work at heart who are forced to work under these conditions find themselves handicapped on every side by a sort of immaculateness, perhaps beautiful in theory, but of no practical value in the every-day affairs of life. Under this system work is carried to a certain point, and then, when a little effort would make it complete, the dignity—and I use this word with a question mark—of science looms up, and the needed support must give way to that. Fortunately, botany has not suffered so much from this attitude as some of the kindred sciences, but her cause has been delayed by it in certain cases and is being delayed even to-day.

I repeat, therefore, that the twentieth century shall see this spirit disappear, and in its place shall come one which is fully progressive, recognizing that to be a scientist is to be a man of affairs, a man gifted with that most uncommon of all things—common sense. It will be recognized that 'true science is an invention, the invention of a tool, which will enable man to become more vital, more effective, more adequate in the world in which he finds himself.' This is especially true of botanical science, which in the future must necessarily spread into many walks of life.

It is evident from what has been said that botanists themselves will have much to do with shaping the future attitude of the state toward the work in question. Expediency in all cases will govern the action of the state, and the fact that the botany of the future will more and more become closely identified with utilitarian projects will make the state dependent upon it. The rapid changes taking place in population, the filling up of sparsely settled regions, the shifting of general commercial centers, and the unification of commerce in all its branches will bring more and more imperative demands for plants and their products. With these demands will come the necessity for knowing more of such plants, how to use them to the best advantage, and how to increase the possibilities of production so as to meet the demands of the times. These great questions will necessarily force themselves upon the attention of the state through the demands of the people, and the state will on its part require of those charged with this important work investigations which must necessarily be far-reaching in their importance.

The shaping of these lines of work will, as already pointed out, depend in large measure upon the wisdom and farsightedness of botanists themselves. The fact will not be lost sight of that to attain the highest results the true spirit of scientific work must be kept constantly in the foreground. I maintain that this can always be done in such a way as to command the respect and confidence of the scientific world and at the same time secure the practical aid which must necessarily be at hand if anything is to be accomplished at all. So much, therefore, for the probable future attitude of the state toward botany and botanical science. The high place which botany and botanical work have taken in the affairs of nations during the past few years makes it evident that in the years to come this position will not only be maintained, but materially advanced in numerous directions.

And now let us turn to another somewhat general question which it seems to me must necessarily receive careful consideration in the near future, and that is the effect of the present tendency to extreme specialization in botany. No one, I

think, will question the value of a division of labor in science as well as in other pursuits, but the danger comes from carrying this division too far. The specialist is likely to be a dreamer, and a dreamer is dangerous. He is apt to see things of his own creation and not as they actually exist. I have been fortunate in being placed where I could study the specialist, and while I can not help but admire and encourage the patience and persistency with which a special problem is pursued, I am confronted every day with the fact that a concentration of mind on one subject is apt to distort the vision and bring on a sort of neurasthenia, difficult to combat and wholly unaffected by argument. Now there is danger in this sort of thing, not so much where the specialist is surrounded by other specialists, for here each will have a tendency to dehypnotize the other, if I may use such an expression. The difficulty comes where the specialist is necessarily much alone, where he will not be subject to rude awakenings which will come if his work is under the eye of others. Just as the present tendency in political economy is toward a temporary division of labor rather than a permanent division, so it must be with specialization in botany. From all the signs specialization has reached its extreme development, as is evidenced by the fact that we are beginning to realize something of its dangers. In the near future, therefore, we may expect to see a movement toward better unification of the many special lines of botanical work. Rather than division there will be integration where imaginary lines which have been built up will come down and unification will follow.

When we come to consider carefully some of the effects of specialization during the past few years, we are led to the conclusion that it has had more or less of a tendency to cause working botanists to group themselves into castes. Like other castes, these sometimes look upon each other with more or less respect, and again with more or less disdain. In other words, the tendency to concentrate one's effort on a special subject naturally has a tendency to develop more or less egotistical and conceited ideas as to the importance and value of such subjects. Hence, there is produced a sort of aristocracy which prevails more pronouncedly in some cases than in others. For example, the cytologist is pretty apt to look with more or less commiseration on what he considers his less fortunate brother who may be working just outside the range of the plant cell. Then again, the worker who has branched off into some special morphological line, systematic line or physiological line, even though these may be broad branches of botanical science, considers that his particular field is naturally preeminent, and that in handling his problems he must do so without full regard for the consideration of all the questions involved in the other problems. No one can question the fact that specialization has been of great value, particularly during recent years. It has emphasized the importance and necessity for a concentration of energy in one direction. While this is true, experience has shown, as already pointed out, that such concentration necessarily limits one's field of vision, and as a result the true facts, and especially their relationships, can not always be determined. The reaction against this feeling, which is just beginning to be noticeable, is due no doubt to the gradual realization of the fact that all scientific problems are more or less interdependent. We are coming more and more to see that not only are scientific problems in a particular field interdependent, but that all lines of science are closely related, and that to consider them in the most intelligent and far-reaching manner they must be looked upon as part and parcel of one great whole.

Hence, we look to the twentieth century for material changes in this matter of special work and special problems. There will be closer relationships established in the various lines of investigation, not only so far as concerns different phases of botanical work, but other branches of science as well.

Brief reference has already been made to the educational advances which are likely to be made in botany. But these were educational advances of an indirect sort, which naturally arose out of, or in connection with, pure research. Of course all work is educational, but in the sense that we now use the term we mean work that will in the future be conducted in our schools, universities and colleges. In the light of the developments in this field during the past twenty-five years it would seem hazardous to predict what the future is likely to bring forth. Twenty-five years ago the subject of botany in any of our best educational institutions meant primarily teaching in systematic botany. Naturally, the bringing together, grouping and naming of our more or less virgin flora attracted first consideration. Thus systematic botany received an impetus which it maintained for a considerable time. The weakness of the work, however, was to be found in the fact that the problems dealt with had little to do with living subjects. Plants were gathered, named, mounted and placed in herbariums, and the whole question of proper relationships was based on unsound and fallacious reasoning. Naturally, the paramount question here was one of names, and we are still struggling in a maze of doubts and uncertainties which are the direct outcome of our efforts to correct what appeared to be a growing evil.

Perfection, however, is never reached in a leap. Human nature must have experience to guide it, so that we must look upon all that has been done in the past in the matter of systematic work as essential to broader views and broader aims for the future. It is believed, therefore, that systematic botany in the twentieth century will take on new strength as a result of an increasing study of living plants and a better understanding of the manner in which species come into existence. The complicated problem of species relationships will no longer be a matter of more or less guesswork, but will be considered in the light of the results of actual experimentation with the plants themselves.

In this connection the question of meeting some of the requirements for study in this and allied fields will have to be considered. The experience of the old world in the matter of botanic gardens is such as would suggest caution in any attempt to emulate what has been accomplished there. Representative collections of living plants are highly important and valuable, but in bringing them together the fact should not be lost sight of that botany can in the future be advanced by giving more heed to the esthetic side of the work than has been done in the past; that is, assuming that collections of living plants are for study and general educational effect, much of their value in both directions may be lost by adhering too closely to rigid systems. Collections meeting every requirement for study and having great value in a general educational way will probably be maintained in what is more likely to be a natural system. Such collections can, moreover, be maintained at much less expense than the stereotyped ones, and will do much to bring the science of botany home to large numbers of people who can appreciate a bit of lovely landscape, but can see nothing in the little plots and formal labels so suggestive of cemeteries. In other words, it seems to me that the old idea of botanical collections, with small groups of plants representing certain systems of botanical

nomenclature or certain systems of botanical grouping, will give place to natural gardens where may be grouped herbaceous, shrubby and other plants in such a way as to appeal to the mind through the eye. Unquestionably a much greater appreciation of botany and botanical work can be brought about by gardens of this kind, and it is believed that great encouragement will be made in the matter of their development at educational institutions wherever opportunity affords.

In morphology and physiology we shall expect to see more and more important problems worked out by experimental methods. Less attention will be given to the mere accumulation of facts without proper coordination. The value and importance of experimental morphology are already beginning to be realized; that is, experimental morphology from the standpoint of work on plants in their natural environment rather than under laboratory conditions. The same is true of physiology. In the past our knowledge of plant physiology has been largely based on laboratory work and studies of one or more individual plants. From such data broad generalizations have been made, which, as time has shown, have in many cases been erroneous. In other words, it has been found unsafe and unreliable to base generalizations in the matter of the life processes of plants on laboratory experiments alone. The physiology of the future will undoubtedly pay more heed to the broader questions of plant life in their relation to environment and their adaptation in general to surrounding conditions. In other words, ecology in its broad sense is to be an important factor in the future study of plants. In the past we have had a school of scientific workers arise and endeavor to demonstrate that the growth of plants is controlled in large measure by the chemical properties of the soil. More recently another school has developed in which the physical properties of the soil are pointed out as the chief factors in influencing life processes. Those who study plants themselves can not accept such generalities. It is not safe. Future ecological studies will undoubtedly furnish much new light on the true relationships existing between plants and their environment. These questions must naturally receive a great deal of attention for the reason that many of the most important problems in agriculture, horticulture and forestry will be based upon them.

It is in pathology that we shall expect to see very important advances within the near future. This science is just on the threshold of its development. From the purely utilitarian standpoint it will be of vital consequence, and everything in the nature of strengthening it will necessarily need to receive most careful thought. The pathology of the future will have its groundwork in physiology. Less and less attention will undoubtedly be given to the mere question of remedial measures, and more thought will be paid to the causes of plant diseases and the relation of environment to these causes. The highest type of pathological work, in other words, will be in the field of preventive measures, either by the correction of unfavorable conditions or by developing plants in such a way that they can meet conditions which are not favorable.

In the light of these probable developments, an important question to consider is: Where are the workers to come from and how are they to be trained? Undoubtedly in the future much greater interest will be taken in botanical work in our educational institutions, for the reason that it is gradually coming to the knowledge of young men that there is a demand for persons well trained in plant lines. As a matter of fact, during the last few years the supply of

such men has not been equal to the demand. The reason for this is not far to seek, for there still exists in the minds of most young men who go to college an idea that their future welfare in large measure depends on taking some academic course. It seems important and necessary, therefore, that botanists should put forth their best efforts to bring about a better appreciation of the advantages to be gained in the field of botanical work. A number of colleges and universities already have courses of study which pretty well equip graduates for the advanced work in botany now required. In the future there will be more, and at the same time there will be a greater encouragement for applied work than there is at present. In most colleges it is not practicable at the present time to give men the necessary training for government work. A few years ago this was different, for at that time a graduate from one of our best universities was able at once to meet the general requirements of government investigations. The government requirements, however, have been broadened, so that men capable of handling the problems which now present themselves must necessarily have some preliminary experience with men and affairs before they are in a position to take up independent problems. With a good foundation training in botanical science, especially plant physiology and pathology, a good training in languages and a proper appreciation of the relation of science to practice, men can soon get a sufficient grasp of broad problems to make themselves exceedingly valuable. Those who from temperament or for other reasons are interested only in pure science must necessarily have their field of work limited. For this reason it is believed that in the future colleges will more and more endeavor to emphasize the value and importance of applied work.

After reviewing, necessarily with more or less haste, these various questions as to the probable future development of botany, I have left for the last the question which seems to be of primary importance, for upon a proper appreciation of it will depend much of the success of whatever is undertaken in botanical lines during the years to come. I refer to the necessity for properly organizing the botanical forces which not only exist now, but which are likely to come into existence as the years go by. We have developed in this country a group of botanical organizations, all of which are doing good work and most of which have arisen largely out of the exigencies of the moment. There has as yet been little attempt toward a proper coordination of these various forces, with the object of bringing about unity of action upon all matters which will be for the best interest of botany and botanical work in the broadest sense of the word.

This society was organized primarily to take the lead in botanical work in America. Its standards are high and should be maintained. Criticism, if criticism may be offered, of the work of the society, is that it has so far not developed the individuality that might have been developed, in the light of the questions which were in mind at the time of its organization. The papers which are offered do not differ materially from those presented by other societies and organizations. To my mind it has not been so much a question of the presentation of papers as some would think. Unless the papers presented can be in some way made different from those offered in other organizations, there is little to be gained by presenting them except affording an opportunity for those who wish to bring their problems before coworkers. It would seem to me that this society might very well dispense with a considerable portion of this plan, and devote its energies more in the future to broad questions of shaping policy

in botanical work generally throughout the country. To accomplish this, it is realized that the aid and cooperation of all other botanical societies should be secured. No question is raised as to the value and necessity of other botanical organizations. We do not believe that there are too many of them, but that there is a woeful lack of proper unification and coordination was shown at the last Washington meeting, where the number of papers presented was so great that it was impossible for visiting botanists to take anything like advantage of them. In the future it is hoped and believed that existing botanical organizations can be continued and their integrity and independence maintained, but at the same time it would seem highly important that some steps be taken toward unification. There would seem no reason why the Botanical Society of America should not be the medium for bringing this about, and why, through its efforts, there should not be effected an organization representing the various botanical societies throughout the country which would affiliate with this society and assist in shaping a general policy on all matters affecting the welfare of the science.

The time seems ripe for bringing about this result. Never was botany more prosperous, never more aggressive. On the threshold of the twentieth century we stand, knowing our strength and only needing to weld it into harmonious action to make it vital and lasting. Let us join hands and do our best to bring this about.

Beverly T. Galloway.

*VITALISM AND MECHANISM IN BIOLOGY AND MEDICINE.**

Until some sixty years ago the prevalent view was that nearly all life phenomena were guided essentially by an all-pervading vital force. Even after the discovery by Wöhler in 1828 of the possibility of producing synthetically such an organic substance as urea, such a universal mind as that of Johannes Müller was still clinging to the belief in the all-powerful force as the creator and harmonizer of the various mechanisms of the living body. The belief in the omnipresence of an all-creating vital force furnished little stimulus for laborious studies of the innumerable mechanisms of life. In the forties of the last century, however, there came a change. With the improvement of the methods of investigation, with the rapid progress in organic chemistry, with the establishment of the law of conservation of energy in physics, with the successful application of physical and chemical laws to some of the intricate problems of life, the conviction developed that a great many of the mysteries of life will resolve themselves into physics and chemistry, and this belief gradually grew in some quarters into a theory that all life phenomena are nothing else but complex phenomena of the inorganic world. As just in those days it was recognized in physics that all energies can be converted into motion, and that the mechanical energy is the essential principle in the inorganic world, the new theory which made no distinction between the animate and inanimate phenomena became known as the mechanical theory of life. Right or wrong, this theory was of incalculable benefit to the progress of the biological sciences. The conviction that all parts of life are accessible to an analysis by the methods employed in natural science, stimulated then and stimulates now thousands of patient investigators in their indefatigable attempts to unravel an infinitely small fraction of the mysteries of life. Vitalism had a paralyzing effect. The mechanical conception of the life phenomena

* Introductory remarks made at the D. W. Harrington lectures on 'Œdema, a Consideration of the Physiological and Pathological Factors Concerned in its Formation,' delivered at the University of Buffalo, November 30, December 1, 2 and 3, 1903.