SCIENCE

FRIDAY, FEBRUARY 1, 1918

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

THE NEAR FUTURE OF BOTANY IN AMERICA[1]

THE honor of the vice-presidency and chairmanship of Section G came to the speaker following the removal, by death, in 1916, of Professor T. J. Burrill, who was originally elected to preside at the New York meeting last year. We may fittingly pause for a moment to recall to memory the one who, had he been spared, would have addressed us on this occasion. Older than the present speaker by nearly thirty-five years, he would have spoken out of a rich experience to the profit of us all. He was, as you well know, a pioneer in the science of phytopathology, the discoverer of the first recorded bacterial disease of plants, a successful teacher and scientific administrator, and a man whose nobility of character and genial disposition endeared him to all who knew him.

The title of this address was chosen and the body of it completed before it had occurred to me to consult the Proceedings of the fifty-first meeting of the association to see what might have been the subject of the vice-presidential address at the preceding Pittsburgh meeting, in June–July, 1902. It is therefore doubly interesting to note that Dr. Galloway's subject was "Applied Botany, Retrospective and Prospective."

The pendulum of the Section has thus completed what my professor of physics used to call one complete swing-swang,

[1] Address of the vice-president and chairman of Section G, Botany, of the American Association for the Advancement of Science, Pittsburgh, December 29, 1917.

both geographically and mentally. I make my own Dr. Galloway's statement that he chose his subject, "for the reason that it seems desirable at this time to emphasize some of the things that appeal to us as possibly having a marked influence on the future development of botanical work;" and also his further statement, even more true to-day than sixteen years ago, that it is one of the most hopeful signs of recent changes in botanical science "that our progress has constantly been in the direction of a stronger place in the world's usefulness and a higher plane of scientific thought."

A writer in a recent magazine has said:

> That the war is going to make great changes in the political, economic and social conditions of the world, in ethical values and in moral standards, any fool can see.

The members of Section G, as indeed the entire membership of the American Association for the Advancement of Science, may well inquire, and are inquiring at this time, what the effect of the world war is going to be on science. To scientific men it is self-evident that the methods of modern science will be in no wise affected by the war. To the end of time, as we firmly believe, truth must be ascertained by the well-tested method of observation, inference and deductive verification.

And the content of science—the great body of truth? There was a time when it might have been fundamentally altered by political or religious upheavals. It is comparatively modern history that the fact of the earth's axial rotation stood or fell as orthodox doctrine with religious and political changes. We believe that day is forever past, and that the content of science, now and hereafter, will always be determined by the unbiased test of observations and hypotheses. But in certain definite ways science can not help but be profoundly affected by the present world conflict.

In the first place, the war must eventually make it more evident than ever to the thinking portion of our citizens (including even legislators, if we may indulge in a little Christmas optimism), that science is a necessity for any modern state. They were the fanatics of the French Revolution that declared, as they severed from its body the head that introduced exactitude into chemical research, "The republic has no need of savants."

In the face of the Hun's bombastic and naïve iteration of Teutonic superiority in all departments of human endeavor, it is specially interesting to note that, since the execution of Lavoisier, no state has officially committed the fallacy of such a doctrine except Austria! Said Francis I., of Austria, to a group of professors in 1815:

> *I have no need of learned men,* I want faithful subjects. Be such; that is your duty. He who would serve me must do what I command. He who can not do this, or who comes full of new ideas, may go his way. If he does not I shall send him.[2]

Germany has never formally disavowed her use of scientific men, but the Right Hon. J. M. Robertson, in a recent pamphlet, recalls Heine's opinion that all German philosophers and their ideas would have been suppressed by wheel and gallows but for the intervention of Napoleon in 1805.[3]

The present war has made it universally recognized that science and scientific

[2] Hazen, "Europe since 1815," p. 19.

[3] An echo of this condition is the old student song, current in the University of Berlin as late as 1877:

The original German version localizes the place where freedom of thought and speech were held in such restraint:

"Wer die Wahrheit kennet und sagt sie frei,
Der kommt *in Berlin* auf die Stadt-Vogtei."
"Who knows the truth and freely speaks
On him the law its vengeance wreaks."

method are prime essentials for the welfare of a state. Germany has taught the world other lessons besides the futility of international infidelity, the ineffectiveness of barbarism in a world of civilization, the weakness of terrorism and low insult when confronted by patriotism and by individual and national self-respect. She (though not she alone) has taught the civic value of science.

The failure of England to recognize the civic value of science has been publicly noted in recent debates in the House of Lords. A notable case in point, of special interest to botanists, is the passing of a resolution (now happily repealed) to suspend the publication of the *Kew Bulletin*. Remarking on this, *Nature* (in a recent number) declared that,

> unless we learn in time the lessons which this war is enforcing on every side, namely, that the way of prosperity in the future lies in promoting scientific knowledge *and utilizing the results of scientific investigation* (italics mine), it will make but little difference in the long run whether we win the war or not.

And again:

> . . . the same official lack of appreciation of the importance of scientific inquiry and research, which was a matter of common knowledge amongst our competitors before the war, still continues to sap the foundations of our recognized claims to our foreign possessions, which should largely rest on the encouragement of their material development on sound economic, and therefore on scientific lines.[4]

Science for science's sake, like art for art's sake, may be a noble sentiment, but its limitations should not be lost sight of. Society is justified in asking of every scientist, as of every other man, of what use can you be in the body politic? But though there is no place for the useless, usefulness may not always be at once apparent. "It is perfectly natural," said John Tyndal,[5] "for persons who have little taste for scientific inquiry and less knowledge of the methods of Nature, to feel amused, if not scandalized, by the apparently insignificant subjects which sometimes occupy the scientific mind. They are not aware that in science the most stupendous phenomena often find their suggestion and interpretation in the most minute—that the smallest laboratory fact is connected by indissoluble ties with the grandest operations of Nature." Huxley, also, long since pointed out that as Saul found a kingdom while seeking his father's asses, so many great discoveries have resulted from the pursuit of illusions which seemed asinine to the uninitiated.

Thus, one hundred years ago nothing could probably have seemed more remote from the practical affairs of everyday life than the use of pollen and the relation between insects and flowers, yet a few decades sufficed to show that that knowledge is fundamental to the experimental investigation of heredity and the prosecution of practical plant breeding. While one can not, and indeed should not, always go deliberately after the immediately applicable, there is no reason why scientific men should be loath to do so, nor be in danger of scientific ostracism when they do. Those who may be inclined to take issue with this point of view need only recall the illustrious names of Sir Humphry Davy, of Lord Kelvin, of Count Rumford, and, in botany, of Thomas Andrew Knight, Louis Pasteur, Marshal Ward and others. Botanists, of all men, recalling their dependence upon microscopes and microtomes, thermometers and evaporimeters, balances and thermostats, and especially on aniline dyes, should be the last to belittle the value and dignity of applied science.

It is a pleasure to note what is, no doubt,

[4] SCIENCE, June 22, 1917, pp. 630–631.

[5] "New Fragments," p. 143.

in some of your minds already, that the history of botany during the past two decades is of such a character that the above paragraph comes perilously near having the appearance of setting up a straw man in order to knock him down. Fortunate for botany that this is so, for there has never been a time in the world's history when every individual, every nation, organizations of every kind, every science and every other intellectual discipline have been under such compelling necessity of demonstrating their usefulness. Germany, by unchaining a world war, has unintentionally conferred one of the greatest of blessings on mankind; she has compelled us to think greater thoughts, to seek higher ideals, to achieve greater things than ever before. By the most savage assault ever made on civilization, wrecking universities, bombarding churches and school houses, burning libraries, destroying orchards and forests, ruining laboratories and scientific apparatus,[6] she has compelled every nation, every department of knowledge to become as useful as possible.

Recognizing how almost impossible it is for thinking men, living in the most momentous period of the world's history, to hold their minds for long at a time on any subject not more or less directly connected with the great world events now taking place, it has seemed to the speaker that the only topic suitable for consideration on this occasion is the utility of botanical science, with special reference to suggestions for a botanical program in the near future in America. What modifications, if any, are necessary, in the present program of organized botany, in order to make it more preeminently a useful science?

Chemistry, physics, mathematics, meteorology, are all directly useful in the conflicts of war, enabling men to manufacture high explosives, and to fire them with speed and accuracy under most unfavorable conditions of weather. But it has recently been the proud boast of medicine that she has been useful in wartime only in preventing sickness or alleviating suffering. Botany may also enjoy whatever comfort is to be derived from this proud boast. It is indeed true that one of the poisonous gases used by the Germans in the present war is produced from the seeds of the tropical plant, sabadilla (*Sabadilla officinalis* Brandt), and this suggests that botanical exploration, might (with the cooperation of chemistry in the bloody work!) render services of direct value in active fighting. But, with almost negligible exceptions, the services which botany can render the state are those needed in times of peace as well as war, are directly constructive rather than destructive, and contrary to a general impression, are indispensible and far-reaching.

It is now universally recognized that the most effective preparedness consists in keeping always prepared. The most effective safeguard against tuberculosis is to live *always* so as to insure a sound vigorous body, resistant to any attack of the disease. The surest and most efficient way to insure adequate food, fibers, timber, paper and other plant products necessary in time of war is to encourage and support *at all times* the study of plant physiology and ecology, plant breeding, plant pathology, scientific forestry and research in agronomy, horticulture and general agriculture.

The surest way to make botany useful is to follow out a program of research in pure science; for practical needs are almost always met by applying to some special case that which is at hand ready to be applied, and which was not ascertained with ulti-

[6] Old and apparently favorite German practises. See, for example, M. Vallery Radot's "Life of Pasteur," Eng. tr., pp. 188–192.

mate uses in view. That there can be no applied science unless there is first something to apply, is a truism; it appears to be one of the most difficult ideas for the layman to understand, and yet we are almost entirely dependent upon laymen for the funds necessary for research in pure science.

I have tabulated, below, some of the various ways in which research and the fruits of research in botany may contribute to our national resources in peace, and thus to preparedness for war or for any other crisis.

1. RESEARCH IN PURE SCIENCE

(*a*) Genetical studies to ascertain the principles of heredity in man and animals as well as in plants.

(*b*) Plant physiology, increasing, among other things, our knowledge of the nutritional needs of crops, and affording a rational basis for fertilizing, crop-rotation and other crop problems.

(*c*) Plant ecology. The economic value of ecological studies was discussed by Professor Cowles in his vice-presidential address before Section G, in 1914. As he then pointed out, one could not foresee that a study of the succession of vegetation on the sand dunes of Lake Michigan, stimulated merely by interest in pure science, might afford the only basis for the just settlement of a lawsuit in Arkansas involving property rights to the extent of several millions of dollars. Yet such was the case, as many of my hearers recall.

Even more significant is the application which has been made of our knowledge of wild vegetation to determine what agricultural crops are best adapted to a given region.

Several years ago the speaker was asked to make a study of a certain locality to ascertain whether a widespread injury to vegetation was or was not caused by fumes from the stacks of near-by manufacturing plants. By careful measurements of the thickness of the layers of annual growth of tree trunks it was shown that an abrupt decrease in growth and vigor was contemporaneous with the establishment of the manufacturing plants. This, with other evidence, rendered a final decision easy and certain.

On the basis of Crocker and Knight's studies of the effect of illuminating gas on carnation flowers, together with other evidences, I have several times submitted a report that saved a gas company an expensive lawsuit, and also secured justice to the florist.

It might have been difficult 10–15 years ago to forsee what economic good, if any, could result in a careful mapping of the geographical distribution of *Sphagnum* moss, yet, according to Rendle, *Sphagnum* has come to be greatly needed for surgical dressings, and all information as to *Sphagnum* areas, their accessibility, size purity of growth, etc., has assumed large importance.

Very few persons would have imagined that a study of the fermentation of horse-chestnut seeds would have in it any possibilities of practical application, but we learn that thousands of tons of these seeds are now required in Great Britain in the manufacture of munitions of war, and that every ton of seeds used means the saving of half a ton of grain. So instances might be multiplied.

(*d*) Plant pathology, including a study of the life histories of parasitic organisms, affording information essential for a rational diagnosis, prophylaxis, and treatment; the physiology, ecology, and geographic distribution of phytopathogenes.

To one who can appreciate the value of research only in terms of dollars and cents,

it may be pointed out that the comparatively new blister rust of white pines is threatening with destruction trees estimated to have a total value of about $400,000,000. Measures for combating this disease were discussed at the International Forestry Conference, at Washington, D. C., in January, 1917. It is common knowledge among botanists that the annual loss in this country from imported plant pests amounts to hundreds of millions of dollars. Would an expenditure of a million dollars a year be too much to promote botanical research that might reduce this loss by 50 per cent. or even by 25 per cent.

(*e*) Pharmaceutical experiment stations, for the promotion of investigations, of drug plants and poisonous plants. So far as the speaker knows, the Wisconsin Pharmaceutical Experiment Station, established four years ago, is the only state institution of the kind in the United States, though generous provision is made for pharmaceutical research by several commercial firms, including experimental gardens, laboratories, and investigators.

2. EDUCATION

(*a*) The publication of books and magazines of reliable popular, as well as technical information about plant life, and the history, scope, aims, methods, results, and value of botanical science. A general knowledge of "first aid" for poison-ivy and poison-sumach, and a knowledge of poisonous and edible mushrooms might, under easily imagined circumstances, be of inestimable value to an army in the field.

(*b*) Botanical exhibits in museums, showing the economic value of the fruits of botanical research. According to the *Official Bulletin* of the National Committee on Public Information (July 25, 1917), the Smithsonian Institution has announced that the Division of Mineral Technology, of the United States National Museum, in keeping with its policy of interpreting the technical aspects of the mineral industry to an ever-widening public, has prepared a graphic and striking set of exhibits designed to present in true perspective the significant features of the fertilizer situation.

Why do we not read of graphic and striking exhibits demonstrating to an ever-widening public the value to society of applied botany? Surely the materials for such an exhibit are abundant and of genuine popular interest.

(*c*) Promotion of the study of botany in high schools and colleges, involving

(*d*) A more serious consideration of such educational topics as the content of the high-school and college courses. Should the introductery course in the agricultural college differ from that in the college of liberal arts? What revision, if any, of the present high-school and college courses will probably be necessary or desirable after the war in order that botany may hold its own and keep properly adjusted to the changes that will surely come in education in general? It is not desirable that every botanist give attention to such problems, but they are important; their solution one way rather than another may make a great deal of difference in the number and caliber of the young men who decide to devote themselves to botany; and there is every reason why their solution should not be left entirely to pedagogues.

3. EXPLORATION

The director of a large museum once remarked to the speaker at a scientific meeting where an enthusiastic explorer, just returned, reported the discovery of ten species new to science, "What a pity!" Notwithstanding the large element of truth in that remark, the discovery of new spe-

cies may have real value. If one could only, for example, fill in the gaps between cycads and ferns, or between monocots and dicots! But such work as is now being carried on by the Office of Foreign Seed and Plant Introduction, of the U. S. Department of Agriculture, with the deliberate purpose of discovering useful plants hitherto unknown or little known, and establishing them in new countries will do more toward winning respect and support for our science from the general public than will the discovery of a new lichen or of a new moss, and is quite as likely to result in valuable scientific contributions. The world is indebted to Fortune, a botanical explorer and collector, for the introduction of the tea plant into farther India.

4. SANITATION

(*a*) The purification of potable water from deleterious vegetable life, including the microscopic examination of water; a problem fairly well solved at present.

(*b*) Afforestation of the watersheds of city reservoirs.

5. AGRICULTURE AND HORTICULTURE

(*a*) Studies of soil-fertility, crop-rotation, ensilage, utilization of unproductive soils, plant diseases. Our friends the chemists have always claimed the credit for most of our knowledge of soil fertility, but most botanists have never been able to shake off the superstition that somehow or other the successful growing of crops is, in part at least, a botanical problem. It now turns out[7] that the transformation of rock phosphate, the oxidation of sulfur, and the oxidation of iron in soils, all essential to soil fertility, are probably accomplished by physiological processes of the soil flora, partly by the bacteria, but to a larger degree by several species of molds. Whether the formation of available potassium is also dependent on the action of molds remains to be determined, and a whole series of problems here opens up, equally important to pure and to applied science.

(*b*) Plant breeding, the application of the fundamental principles of genetics to the production of varieties of larger yield, better quality, resistant to disease and drought, adapted to soils hitherto of little agricultural value (as blueberry culture on the pine barrens of New Jersey and elsewhere), or adapted to various climatic conditions.

For example, recent experiments of Pritchard[8] indicate that differences in the size and sugar content of individual beet roots show no evidence of inheritance. They are fluctuations, and play no part in the improvement of sugar beets. Pritchard concludes that the cost of analyzing mother beets is an absolute waste of money. But a certain European firm is accustomed to carry out several hundred thousand analyses annually in the selection of roots for seed production.[9] These analyses entail a very large annual expenditure. It therefore becomes a problem of considerable economic as well as scientific importance. Many other similar problems could be readily mentioned.

6. FOOD, FIBER, AND DRUG SUPPLY

(*a*) The cultivation of drug plants as crops, and the endeavor to secure varieties superior in yield or quality.

(*b*) Study of the absolute and relative food value of various plants, especially of those little known or little used for food; the utilization for food, drink, and fibers

[7] Brown, P. E., "The Importance of Mold Action in Soils," SCIENCE, N. S., No. 46, 171–175, August 24, 1917.

[8] *Jour. Amer. Soc. Agron.*, 8: 65–81, 1916.

[9] Harris, *Am. Nat.*, August, 1917.

of plants not hitherto considered of value for such purposes.

For example, a shortage of tea in Hungary has resulted in an investigation of the leaves of various species of brambles (*Rubus*). Nearly 2,000 cwt. of leaves was collected by school children from 12,000 localities. Some of the results are reported as favorable.[10]

The Brooklyn Botanic Garden has recently been asked by a large paint company to recommend a plant that will yield a fiber that may be substituted for rags in making felt paper for roofing, and other similar purposes. This fiber is needed at once at the rate of about 10,000 tons a year. The company has been trying *Zostera*, but not with entire success.

Inquiry has also been received for a substitute for jute that can be grown in this country successfully in commercial quantity.

A most valuable program of work along these lines has recently been published by The Botanical Raw Products Committee of the National Research Council. Why should such investigations be left largely to chemists, physicians, and others, as has commonly been done heretofore?

7. FORESTRY

(a) Much has already been accomplished, by the excellent work of our forest schools, toward the development of scientific forestry. The successful cultivation of trees in city parks and streets is still a baffling problem. The reforestation of devastated areas in northern France and Belgium will demand the fullest possible knowledge of the principles and practise of arboriculture and forestry. Preparation for such emergencies can be made only in time of peace and can not be accomplished in a hurry.

[10] *Internat. Rev. of Sci. and Prac. Agr.*, 8: 47–48, January, 1917.

8. CONSERVATION

(*a*) So much has been published and spoken on this topic within recent years, that it needs only to be mentioned here. There are still many important unsolved problems relative to the conservation of forests and of garden crops by canning and drying; the utilization of forest products, and substitutes for them (*e. g.*, substitutes for wood pulp in paper making) and the conservation of soil fertility.

To one who has never given much thought to this subject the above may seem like an ambitious program. To the members of Section G, of course, it does not. Much of it, fortunately, is already under way; many items have been omitted. The *First Report* of the Committee on Botany of the National Research Council tabulates several other problems already undertaken. What is needed is to prosecute these problems with more system and vigor, to secure more ample funds for carrying on the work, and to insure that every botanist assumes the proper attitude of intelligent sympathy toward the whole program. May I not briefly call attention to three or four of the problems which seem to be more pressing than some of the others, and the solution of which should be included in the botanical program of the near future.

1. *Increased Facilities for Publication.*—This audience does not need to be reminded of the pressing need of additional opportunity for publishing the results of investigation. Botanical research was never produced in this country of better quality and in such large quantity. It is surprising how easy it now is to secure a program of research papers in botany. Between April and October, 1917, there have been held two meetings of botanists in New York City alone at which a total of fifty-two papers were offered embodying the unpublished results of research. This is exclu-

sive of papers read at numerous meetings of local societies. In the meantime many more additional papers have appeared in print. According to a computation by G. F. Scott Elliot, there were printed in 1905 more than a quarter of a million pages of botanical contributions, in eight or nine different languages. By 1914 this number must have been increased to at least 300,000 pages, though there has been a falling off in England and Europe since the outbreak of the war. But only a portion of the annual output of manuscript is provided for. Most of our botanical periodicals now have in hand copy enough to more than fill their next volume, and some are eighteen months ahead.

How are the necessary additional facilities to be secured? The most economical way, for both publisher and subscriber, would be to enlarge existing magazines, increasing the number of pages, and the frequency of issue, and where necessary, making two volumes a year. The overhead charges for publishing would thus not be greatly, if any, increased, and there would be an immense gain in restricting the number of separate journals to be cited, to be kept track of, and subscribed for.

The problem is also closely bound up with that of botanical organization, to be briefly spoken of in a moment. Three separate societies, each with a membership of five or six hundred, and annual dues of from five or six dollars, might, with successful advertising and a subsidy, each issue a specialized magazine of modest proportions. But where are the subscribers to be found? Chiefly among botanists, of course; but the minimum number necessary for each journal would mean a total membership of from 1,500 to 1,800. To secure this would necessitate considerable overlapping of membership. For one person to support all three would entail dues of from $15 to $18, in addition to subscribing to any abstract journal that might be established. With other professional demands, such a tax would be burdensome or prohibitive to many, if not the majority, and would entail the great disadvantage of depriving them of ready access (which one's personal copy gives) to literature not directly bearing on their special interest, though more or less related to it. Nothing could be more unfortunate, though an abstract journal or a journal along the lines of *Science Progress,* would tend to counteract this.

Before further steps are taken toward the establishment of additional periodicals, careful consideration should be given to the question of how existing journals may be enlarged or modified to meet the present needs, and what kind of additional journal, if any, is needed. It is not improbable that an annual payment of not more than ten dollars might suffice to meet membership dues in an enlarged Botanical Society of America, and at the same time enable the member to receive two and possibly three periodicals. The chemists have already accomplished this. I do not mean these words to have an air of finality, but merely to present phases of the problem that should be given most thoughtful consideration.

2. *Abstract Journal.*—The very bulk of publication has now rendered a journal of botanical abstracts a most urgent necessity. No one, if he desired, could possibly find time to read all the articles published in full; not even those more directly in line with his own special interest. To keep reasonably intelligent as to what is going on in botany outside of one's own specialty is almost impossible. The "Notes for Students" in the *Botanical Gazette,* and the abstracts in the *Experiment Station Rec-*

ord and other journals have been a boon to all of us, but are now proving inadequate. The opportunity is ripe for the establishment of a journal of botanical abstracts in America; such an opportunity may never again recur; it should not be allowed to pass.

3. *A Popular Journal.*—Our science would greatly profit from the publication of a journal, of the high character of, for example, the *National Geographic Magazine*, seeking to interpret to the general public in an interesting and authoritative manner the methods and results of botanical science. There is ample material for such a publication, and it would be heartily welcomed by the great body of high-school teachers of botany, as well as by many amateurs and nature lovers.

4. *Botanic Gardens.*—The speaker will certainly be excused from urging the value and need of botanic gardens. Ways in which they not only further the cause of botanical science, but may serve an entire community, as well as its public-school system, are so numerous, as has already been demonstrated, that the members of the Section and of the Botanical Society of America might well become interested in an organized effort to secure the establishment of botanic gardens of reasonable size and scope, but of scientific and educational worth, in every American city of 10,000 or more inhabitants.

5. *Need of More Popularizing.*—The Latin nomenclature in botany is about all that is left to remind us of a period, not so very far distant, when the fruits of scientific research were kept inaccessible to all but the learned few by being published in a foreign, and even in a "dead" language. At that period, owing to lack of educational opportunities for the masses, the general public could hardly have understood or appreciated the subject-matter of science even if published in the vernacular. Happily the situation is different now, for although the scientists have difficulty in understanding each other, the general public shows an intelligent and eager appreciation of the results of modern science, if only it is presented in non-technical language. The difficulty is to get popular articles and books from those most competent to prepare them. Faraday and Lodge in physics, Tyndall and Duncan in chemistry, Herschell and Ball in astronomy, Geikie and Winchell in geology, Huxley and Agassiz in zoology, Errera and Gray in botany did not hesitate to give time to the writing of popular articles and books; and I never heard any one suggest that their research or their reputations as leaders in scientific thought suffered in the least thereby. For several years, however, there has been a general disposition in botany to follow the lead of an erstwhile famous trust magnate, and let "the public be damned," leaving popular interpretation to reporters and professional popularizers. As a natural result, popularizing and substantial scientific work came to be regarded in certain quarters as mutually exclusive, and the reputation of our science, outside of its own charmed circle, suffered much. A botanist holding a purely research position, but having undoubted ability at popularizing, recently expressed to me his hesitancy at writing anything popular for fear his reputation would suffer among his botanical contemporaries.

But on what do I base my plea for more popularizing? First, on the altruistic basis that we owe it to the public. To contribute toward raising the general level of intelligence is a duty as well as a privilege, especially in a democracy; to those having

the gift it ought to be a genuine pleasure and satisfaction.

Second, on a purely selfish basis. Like practically all other sciences, botany has now reached a stage where further advance is largely dependent upon laboratories and a more or less elaborate and expensive equipment, including library facilities, costly apparatus and laboratory assistants. The time has passed when board and room and traveling expenses are enough. 'Tis money makes the mare go, in botany as elsewhere, but until the millenium has less the appearance of being viewed through the little end of the telescope, botanists will be dependent upon outside sources for adequate financial support. But such sources will fail, or continue wholly inadequate, as now, so long as the dwellers outside the walls have no lively appreciation of the fact that money needs science just as truly as science needs money.

Only a few months ago an attempt was made by the speaker to enlist the interest of certain seedsmen and nurserymen in furthering research in plant diseases. Letters were sent to various firms and individuals whose interest in such a proposition was mainly taken for granted. These letters contained the following statement:

> The importance of increasing our knowledge of the causes and prevention of plant diseases is evident to every one who is interested in growing plants on a large scale. An enormous amount of investigation is now in progress in this country, along this line, but it is obvious that an opportunity for the prompt publication of the results of these investigations is essential to progress. Opportunities for such publication are, at present, very limited, and practically without any financial backing, except for the publications of the federal and state government. The latter publications are open only to officials, and are far from equal to the demand. Will your firm not be willing to give this matter serious consideration, and grant a personal interview between the undersigned and some member of your firm?

The following reply was received:

> *Dear Sir:* Your favor of the 29th inst. duly received. In reply thereto would say that, while we realize the importance of the work you are interested in, yet we feel, from a business standpoint, that the burden of such work should not fall upon us or similar houses. We take every precaution (*sic*) to keep stock healthy and true to type. We are satisfied that a great deal of the disease is due to improper cultivation, and when proper conditions of growth are supplied, disease is very rarely to be met with. Of course, unfavorable seasons will occur; conditions will arise which are absolutely beyond the control of the cultivator; but *we are satisfied that no amount of investigation as to the causes of disease affecting field crops can ever result in avoiding it.* (Italics mine.) We feel it will be unnecessary for you to come in to talk to us on the subject, as we are satisfied that nothing could be achieved thereby!

Hope springs eternal in the human breast, and so I attacked the enemy's salient with a little asphyxiating gas, as follows:

> Such a view (as yours) is diametrically opposed to the results of the investigations on plant diseases carried on in nearly every civilized country during the past twenty-five to thirty years. Of course proper cultivation is always essential to the health and success of our crops, but these researches have yielded an abundance of positive evidence that most plant diseases, like many human diseases, are contagious, being caused by bacterial and fungous parasites, or by insects, and are, in very many cases, subject to control, or at least to remedial treatment, which is a matter quite apart from proper or improper cultivation.
>
> May I not cite such well-known cases as the wheat rust, which caused a loss of $67,000,000 in the United States in 1891; the oat smut, which caused a loss of over $13,000,000 in the state of Wisconsin alone in 1901–13; the late blight of potatoes, which caused a loss of $10,000,000 in the state of New York in the one year of 1904, the black rot of cabbage (loss $50,000 in Wisconsin in 1896); and the leaf spot of violets (loss $200,000 in the United States in 1900).
>
> Each of the above diseases is perfectly well known to be caused by a parasitic fungus, and remedial measures, which a knowledge of the nature and cause of the disease has made it possible

to prescribe, have resulted in very greatly diminishing these enormous financial losses.

I might also mention wilt-resistant cotton and cow-peas, wilt-resistant tobacco and flax, rust-resistant asparagus and durum wheat, grape vines resistant to *Phylloxera*, cantaloupe resistant to leaf-spot disease, and many others, all showing that the matter of plant diseases is quite apart from the methods of cultivation.

Since many diseases are known to be transmitted from crop to crop by being carried by seeds, it would seem as though such information would be considered as of fundamental importance to all seedsmen and nurserymen, and that is why it was a matter of such genuine surprise to me that such houses do not feel any interest to cooperate in the advancement of our knowledge by rendering even moderate financial assistance.

I then expressed my firm conviction that every large seedsman could materially increase his business and his profits by the appointment of a plant pathologist, and a plant breeder, and that the appointment of a pathologist by seedsmen and nurserymen would, some day, be as much a matter of course as the appointment of a chemist now is for a dye-works.

The courteous reply to this read, in part, as follows:

Your very interesting letter was duly received, and we have carefully noted contents. . . . We desire to say that we think it is not the province of the individual to take up the burden of such effort as is mentioned in your letter.

The moral of this is, ladies and gentlemen, that you can lead a horse to water, but you can not make him drink. You can never get a man to put his money into anything he doesn't understand or that doesn't interest him, no matter how important or worthy the cause may be; and in this incident I find one of the most cogent arguments why scientific men should make it a part of their main business to interest and enlighten the general public concerning the nature and value of scientific work. How can we expect men to endow scholarships and fellowships for botanical research when their conception of the science, if they have any at all, may be adequately stated by the expression, "How to know the wild flowers"? Botanic gardens and the popular magazine referred to a moment ago, will contribute to the end desired, but we need more books, and lectures, and magazine articles of literary as well as scientific value, written for the people by the leaders in botanical science.

6. *Botanical Organization.*—Closely connected with the problem of securing an enlightened and interested constituency is the character of scientific associations. On first thought it might appear desirable that scientific specialization should be reflected in the organization of small groups of workers on the basis of their special interests. But here, again, there is danger that one of the most important advantages of organization may be lost sight of. I refer to the opportunity of making science recognized outside of scientific circles as a force and a necessity in the larger affairs of life. It is a mistake to imagine that our botanical clubs and societies are solely for individual convenience and advantage; they also exist, or should exist, for the larger purpose just stated. There frequently arise occasions when science, as such, needs to make itself felt, to assert itself by taking group action. Organized effort is often necessary to secure desirable legislation or to thwart undesirable or vicious legislation. A memorial to the Congress urging an appropriation for botanical exploration in South America, backed by an association of 50 or 100 members of a botanical society would, in all probability, have little effect in securing the desired legislation, but something might be accomplished by several thousand botanists in one large vigorous association. It requires eternal vigilance now to combat the pernicious anti-

vivisection propagandum; how hopeless it would be with science unorganized, or organized only in small scattered groups. In matters touching the place of botany in education, the content of the course of study, the conservation and scientific utilization of plant resources by the nation, appropriations for research, provision for publication, as mentioned above, the influencing of public opinion in many ways, and on numerous other occasions requiring effective group action, the advantage of one strong, dignified, aggressive organization, known and respected by the general public should be at once recognized.

It is from such considerations as these that I believe it is highly desirable that there should be such an organization as the American Association for the Advancement of Science, and especially that botanists should contribute as much strength as possible to the association by supporting a botanical section. It is an immense advantage, and might conceivably become a matter of critical moment, to have a strong national federation of all the scientific activities of the nation.

It is for similar reasons that I believe a segregation of botanists into several relatively small organizations, in certain ways, would be disastrous to the best interests of botanical science. "In union there is strength" is as true for science as for politics. The ideal condition would seem to be one large organization, representing botanical science as a whole, but comprising as many sections as size and coherence of various special interests may justify. It would be a real misfortune to undo the good accomplished in 1906 by the federation of several smaller organizations into the Botanical Society of America. The Botanical Society of America needs every botanist as truly as does every botanist need the society.

7. *Botanical Education.*—There are weighty reasons why the study of botany should form a part of the schooling of every one seeking a liberal education, unless we are prepared to abandon the age-old principle that intellectual culture, *per se*, has intrinsic value as well as does vocational proficiency. A general course, without laboratory work, consisting largely of illustrated lectures and assigned readings, touching on the history of the science, its philosophical aspects, its relations to knowledge as a whole, and to problems of every-day life, should be more generally introduced into our colleges. Such a course would not only result in a more widespread intelligence about plants and the science of plants, but would be certain to increase the number of those electing botany as a life work. It would be valuable for those intending to practise law, medicine, theology or journalism. If democracy is to survive, says a recent writer, not only must culture be shot through with practical efficiency, but practical efficiency with culture. The first course in botany should always be planned on the supposition that it is not only the first course, but may also be the last.

Contrary to a prevalent notion, statistics show that botany as a high-school subject has rapidly lost ground during the past few years. This is due largely to the absence of any organized effort to adapt the science in accordance with the present-day tendency to place every subject on an industrial basis. The Report of the Commissioner of Education for 1916 shows that, between 1910 and 1915, the enrollment in botany in the high schools of the United States decreased 44 per cent., only 7.9 per cent. of the total high-school enrollment taking botany. The enrollment in agriculture has increased from 4.55 per cent. to 6.92 per cent., and in domestic science from

4.14 per cent. to 12.69 per cent. As Downing[11] has pointed out, these and other similar figures indicate that

> Botany and zoology are apparently giving way to related subjects that either appeal to school authorities as more effective educationally or to the public as more closely allied to every-day affairs. . . . The data for botany and zoology are indicative that another decade will see these biological subjects eliminated from the high-school curriculum.

From similar data compiled for the state of Missouri, a committee of the Missouri Society of Teachers of Mathematics and Science conclude that

> There is no longer any demand for science for science's sake in the curriculum of the secondary school.

The situation is a challenge to all who are or who should be interested in the place and function of botany in the schools.

The solution of the problem lies not in reducing botanical instruction to a purely vocational basis, but in joining with all scientific and educational forces to combat the vicious tendency to commercialize all popular education. President Butler has declared that "the growing tendency of colleges and universities to vocationalize all their instruction," is "closely related to poor teaching." It is also closely related to distorted ideas of relative values, and to poor scholarship, and threatens insidiously to undermine the very foundations of applied science. As Professor Keyser[12] has effectively stated:

> It is said that intelligence is good because it prospers us in our trades, industries and professions: it ought to be said that these things are good because and in so far as they prosper intelligence.

In conclusion, a brief word concerning the aims and content of advanced botanical education for those intending to enter botany as a profession. Here two clearly distinct problems stand out: the teaching of botany and the education of botanists. The two are not synonymous. One needs to have something more than a knowledge of law to make a successful lawyer, something more than a knowledge of disease and *materia medica* to make a successful physician, something more than a knowledge of plants to measure up to what should be the highest ideals of a botanist. Knowing all the botanical facts, one should also be able to see his science in long perspective, to understand the painful and halting steps by which a science of botany gradually emerged from the cultivation of vegetables and simples, its relation to other sciences, to the intellectual and economic life of mankind, and to the broad philosophical problems, the solution of which is the final goal, the deepest satisfaction and the largest justification of all intellectual endeavor. One should not only be intelligent in his subject; he should also be intelligent about his subject. If we see no further ahead than chromosomes and genes, species and sieve tubes, mutants and enzymes, important as these are, we are of all men most miserable. The outstanding names in the history of botany, as in every other science, are of those who have had a broad philosophical grasp of their subject.

In botanical education, also, we should never lose sight of the fact that the man is more important than the science. There is not time to go into details; what I have in mind is said better than I can say it in a short note by Curtis in SCIENCE for August 24, 1917 (pp. 182–183). The idea is succinctly stated in the last sentence, which I here paraphrase: To teach botany is one thing; to teach men to be botanists is a greater task.

I once heard the late Hamilton Wright

[11] Downing, Elliot R., "Enrollment in Science in the High Schools," SCIENCE, N. S. Vol. 46, 351–352, October 12, 1917.

[12] SCIENCE, N. S., Vol. 41, 447, March 26, 1915.

Mabie, referring to German scientists, quote some one as having said: In no nation have the scientific men dived deeper in the sea of knowledge, nor staid down longer, nor come up muddier. By all means let us dive deep, and explore widely; but for the sake of ourselves, as well as of our science, let us see to it that our advanced and graduate courses do not produce men who come up muddy. C. STUART GAGER

SCIENTIFIC EVENTS

MINING IN ALASKA IN 1917

THE annual report on the mineral resources and mineral production of Alaska in 1917 is now in preparation under the direction of G. C. Martin, of the Geological Survey, Department of the Interior. Some of the important features of this report relating to mining development during the year are abstracted in the following statement. Complete statistics of the mineral production of Alaska can not be collected within less than three or four months after the close of the year, but meanwhile it is desirable to publish the preliminary estimates here given, which are believed to vary not over 5 per cent. from the actual figures.

The value of the mineral production of Alaska in 1917 is estimated at $41,760,000, exceeding that of any previous year except 1916, which was $48,632,000. The decrease in 1917 was therefore about $6,870,000. During 33 years of mining Alaska has produced over $391,000,000 worth of gold, silver, copper, and other minerals.

Alaska mines are believed to have produced gold to the value of about $15,450,000 in 1917, compared with $17,240,000 in 1916. The total value of the gold mined in the Territory is now about $293,500,000, of which $207,000,000 has been won from placers. In 1917 about 88,200,000 pounds of copper was produced in Alaska, valued at about $24,000,000. The production in 1916 was 119,600,000 pounds, valued at $29,480,000. The total copper produced to date is 427,700,000 pounds, valued at $88,400,000.

The value of Alaska's lesser mineral products in 1917 was about as follows: Silver, $1,050,000; coal, $300,000; tin, $160,000; lead, $160,000; antimony, $40,000; tungsten, chromium, petroleum, marble, gypsum, graphite, platinum, etc. $600,000. The year 1917 marks the first production of chromium in Alaska, and about 81 ounces of platinum was saved in placer gold mining at several widely separated localities.

The data in hand indicate that the value of the placer gold output in 1917 was $9,850,000; in 1916 it was $11,140,000. The decrease was due chiefly to restriction of operations because of the high cost of supplies and the scarcity of labor. The placer output was increased only in the Tolovana, Marshall, and Ruby districts and at the new Tolstoi camp.

About 33 gold-lode mines were operated in 1917, compared with 29 in 1916. The value of this lode-gold mined decreased from $5,912,000 in 1916 to about $5,250,000 in 1917. The decrease was due chiefly to the disaster at the Treadwell mine. Southeastern Alaska, especially in the Juneau district, is still the only center of large quartz-mining development in the territory. Next in importance is the Willow Creek lode district. Gold-lode mining on Prince William Sound, Kenai Peninsula, and in the Fairbanks district is at a standstill.

The copper production of Alaska in 1917 was about 88,200,000 pounds, valued at about $24,000,000. This is less than the production in 1916, which was 119,600,000 pounds, valued at $29,484,000, but is greater than the production of any other year. The reduction in output was due largely to labor troubles at the Kennecott-Bonanza mine. During the year 17 copper mines were operated, compared with 18 in 1916–18 in the Ketchikan district, 6 in the Prince William Sound district, and 3 in the Chitina district. The enormous output of the Kennecott-Bonanza mine, in the Chitina district in 1917 as in previous years, overshadowed that from all others.

MILITARY MEDICAL RESEARCH IN FRANCE UNDER THE RED CROSS WAR COUNCIL

THE American Red Cross reports that the War Council has appropriated $100,000 for