

joint report. The complete report will be published later in SCIENCE.

Appropriate resolutions were passed respecting the late Professor W. O. Atwater, of Wesleyan University, and Professor G. P. Clark, of Syracuse University, both members of the society.

The following officers were elected for the ensuing year:

President—Professor W. H. Howell.

Secretary—Professor Reid Hunt.

Treasurer—Professor W. B. Cannon.

Additional members of the Council—Professors J. J. Abel and G. Lusk.

Forty-five members of the society were in attendance during the meeting.

LAFAYETTE B. MENDEL,
Secretary

SHEFFIELD SCIENTIFIC SCHOOL,
YALE UNIVERSITY,
NEW HAVEN, CONN.

WILLIAM SMITH CLARK: HIS PLACE AS
A SCIENTIST AND HIS RELATION TO
THE DEVELOPMENT OF SCIENTIFIC
AGRICULTURE¹

It is no ordinary occasion of rejoicing or of interest in the progress of technical education which brings us together here to-day, but rather is it an event full of significance and rich in the promise of benefits to that great industry which must ever be recognized as the foundation of all national prosperity. This event has a two-fold significance, in that it marks one feature in the celebration of the fortieth anniversary of the foundation of this college; but more particularly that it celebrates the dedication of this dignified and well-equipped building, abundantly suggestive of lofty ideals, persistent endeavor and resolute purpose, to the service of scientific research and to the memory of one whose most cherished plans lay in the domain of botanical science; whose best influence was

¹ An address delivered at the opening of Clark Hall, Massachusetts State College, October 2, 1907.

exerted in behalf of scientific agriculture when that science was yet in its infancy; whose best energies were directed toward laying—strong and sure—the foundations of an institution whose mission he believed it to be to become a leader in agricultural education. These ideals have been largely realized through the influence this college has exercised upon domestic agriculture and the progress of this important branch of industry in far-off oriental lands; and now, through the renewed vigor imparted to it in recent years by a wise policy of practical encouragement, and under the administration of your new president, it would seem as if the coming years were to be rich in the fruits of a widening and deepening influence upon the interests she holds in her keeping.

It is a matter of special gratification that I am privileged to witness the great progress this institution has made since its foundation in 1867, and more particularly the very rapid advances of the last two decades. As one who enjoyed the peculiar friendship which comes through close association in scientific work and the companionship of the teaching profession, it affords me a peculiar sense of satisfaction to be able to participate in the dedication of this building, designed as it is to stand as an exponent of the best scientific ideals, and as a memorial of one who not only exerted a strong influence upon his profession and upon those who were fortunate enough to come under his teaching, but for whom I have always entertained a high personal regard, and to whom I feel indebted for some of the best inspirations of my professional career.

The particular purpose of my presence here to-day is not so much to present you with a biographical sketch of President Clark, as to direct your attention to his relations to the development of botanical science in this country; to show what influ-

ences have been associated with his scientific work; and to indicate both the present position of and the future outlook for those special lines of research in which he always manifested a keen interest, and in which he would have taken an active part had circumstances permitted him to continue his useful life. But inasmuch as a clear insight into a man's scientific aptitudes, his capacity for research and his influence upon his chosen profession can be gained only through a knowledge of his temperament, mental attitude and early training, I may be pardoned for reference to some of those personal characteristics which distinguished him among his associates, and which were best revealed to those intimately connected with his scientific work and familiar with his thoughts and aspirations. Through the perspective afforded by time, it becomes possible to gain that just appreciation, and to establish that correct measure of his work, which are possible only when a man's efforts are divested of those less important but often numerous factors which tend to minimize and obscure.

President Clark used to relate with a certain element of justifiable pride, but never in a spirit of boastfulness, that as a boy he always made it a rule to run faster, jump farther and higher, fight harder and swim more strongly, than any of his companions. The determination to excel in whatever he undertook was one of the first of his traits to impress itself upon the stranger. Those who knew him intimately, readily appreciated this side of his character and understood that the dogged persistency with which he pursued any cherished plan, or sought to gain the ascendancy in competition, was an important factor in his career. It carried him through the civil war and the terrible days of the wilderness campaign; it placed this institution on a secure and enduring founda-

tion, which, in spite of its apparent lack of progress for many years, and the periods of despondency which at times come to all healthy organisms, will make it abundantly able to sustain that splendid superstructure of usefulness which seems to lie before it. It carried him to the far-off east, where his memory is firmly enshrined in the hearts of the Japanese, who, to this day, hold his name in the highest esteem as that of one who conferred great benefits upon their country. Throughout his entire career, the force of his living example was of inestimable benefit to his students, and of far greater value than spoken words. These, when uttered, were generally few but full of virile force and significance, and certain to leave a lasting impression. On one occasion he wished to have a number of diagrams to illustrate his lectures on botany, and for this task he selected one of his graduate students to whom such work was entirely new. The unfortunate student was presented with a figure embodying much difficult detail, and was told to reproduce it upon an enlarged scale. Claims of inexperience in such work were not heeded, and the only response to the plea of inability was contained in the very curt command "Do it." Being thus driven to an extremity, and having his pride touched, the student did draw the diagram to the satisfaction of President Clark, and afterwards produced several hundreds of other figures for the same purpose. The phrase "Can not" was entirely unknown to President Clark, but his simple watchword "Do it" seemed to be the slogan guiding him to success in whatever he undertook, as it has since then served to inspire several generations of students in more than one land. An intense enthusiasm characterized his attitude toward everything which he regarded as worthy of his attention, and this spirit successfully bridged many a difficult situation which might have been full of

impossibilities for one of a less sanguine temperament.

A keen judge of men, he always surrounded himself with those who could not only execute with ability, but who were able to appreciate and participate in his own enthusiastic efforts. Those who are familiar with the earlier years of this college will readily recall that they were conspicuous for the able men by whom he was supported, all of whom have made their mark in their chosen callings: Stockbridge, than whom none has made a deeper impression upon modern agriculture; Miller and Peabody, profound and careful students of the mathematical sciences; H. J. Clarke, whose name for a brief period shed luster upon this institution through his knowledge of the biological sciences; Goodell, cultured and versatile, and in his later years the able president, well beloved of all who knew him. These were the men who helped to make this institution what it is, whose record is written large in the great book of life, and whose memories will ever be an inspiration to future generations of students. But among this galaxy of able men there was one whose selection for so important a post in the new college was based in part upon student friendship at Göttingen, but more upon a keen appreciation of sterling worth; one whose ability as a scientist continues to shed luster, add renown and lend dignity to this institution; and it is a matter of special congratulation that he is yet with us to participate in this act of tribute to the memory of an old friend—Dr. C. A. Goessmann.

President Clark's professional career was begun in fields quite distinct from those which he cultivated in later years. Under the guidance of Professor Hitchcock, he acquired a great taste for geology, and this, together with a special aptitude for chemistry, led him to choose this branch

of science in connection with mineralogy, in which he had gained distinction as a student. It was in pursuit of a further knowledge of these subjects that he went to Göttingen to seek instruction at the hands of eminent German specialists, at a time when it was just becoming fashionable for American students to complete their studies and professional training at German universities. This step was taken at one of the most critical periods in the development of American science, which was then in a state of transition from generalization to specialization. Owing to his keen perception and quick observation, as well as to his ready appreciation of anything which tended in the direction of progress, the experience gained during his residence abroad was of great service in after years. The one great lesson which this period of his life seems to emphasize is the important reciprocal relations of botany and chemistry, and the teachings of his later years always brought into prominence the idea that, for the professional botanist, a thorough groundwork of chemistry is not only essential, but that the more one specializes in botany the wider should be his knowledge of chemistry. At the present day, with our strong tendencies toward narrow specialization, we are in great danger of losing sight of this fundamental fact, and I would impress upon students and teachers the great importance of shaping courses of study in such ways as to secure and maintain a proper balance between these two subjects.

While yet a student at Amherst College, President Clark had followed the usual course in botany as then prescribed by the college curriculum, and although he was not particularly drawn to the subject at that time, he nevertheless pursued it with characteristic zeal and gained proficiency in the methods then in vogue. These were based upon the Linnæan school, which

taught the doctrine of the fixity and special creation of species, and regarded purely morphological and taxonomic questions as the chief aim of the science. His keen perception and receptive mind nevertheless enabled him to see, while yet a student in Germany, a very different future for botanical science. This was first brought to his attention on the occasion of a visit in 1850, to the Royal Gardens at Kew, England, then under the able direction of Sir William J. Hooker. He there observed for the first time the enormous resources of plant life, and the extent to which plants are capable of contributing to man's welfare; he there saw in the *Victoria regia* and in many other rare and striking examples of exotic plants the great possibilities they presented for an extension of man's intellectual and esthetic interests; and in the vast amount of material gathered from all quarters of the globe he recognized the great opportunities for an extension of scientific knowledge along the most attractive and useful lines. He became profoundly impressed with the importance and the far-reaching character of the problems thus presented, and from that time on his thoughts were largely occupied with botanical questions. It was the experience gained at that time which had so marked an influence upon the early plans for the development of this college. This was eventually expressed, among other ways, in the formulation of plans for a botanic garden, unfortunately never realized; in the construction of the Durfee Plant House, and in the building of a botanical museum, both very modest but exceedingly useful efforts to follow the suggestions of the Kew Garden, from which institution the first skilled gardener was obtained. More than this, however, it permitted the formulation of plans upon a broad basis, and an intelligent and far-reaching conception of the true relations

in which scientific knowledge must always stand toward scientific agricultural practice.

It is certainly true that an institution such as this must always be prepared to educate a certain number of men in the theory and practice of agriculture, but all modern experience tends to show with increasing force the subordination of such training to that which gives a man a special skill in some one or more of the sciences which may be applied to that industry. No more striking instance of the correctness of this point of view could be obtained than one which was brought to my notice recently, as contained in an address delivered to the West Indian students of McGill University by Sir Daniel Morris, commissioner of agriculture for the West Indies. Sir Daniel has supervision of the agricultural interests of the entire British West Indies, including Honduras, Guiana and other colonies within the continental area. His experience in the agricultural needs of that region has been both wide and prolonged, and the services he has rendered are such as to give his opinion special weight. In directing the attention of his hearers to the useful and lucrative careers which are open to properly-qualified men, and the great influence they may exert in the promotion of agriculture there, he placed special emphasis upon the statement that special knowledge of purely agricultural problems, gained elsewhere, would be useless. What is needed are men specially trained in those sciences such as chemistry, plant pathology, plant physiology and entomology, which may be applied directly to the solution of great problems relating to conditions of soil, diseases of plants, the general question of nutrition and the operation of destructive insects. Through such channels it would be possible for an expert to gain the confidence of the farmer and

confer the most lasting benefits upon the agriculture of the region.

It was this point of view which gave to this college its real stability where others have shown so much weakness or have failed in their original purpose, and it is a continued recognition of this relation which will secure for the future the leading rôle which it should occupy and which I feel confident it will always maintain.

The experience of those early years was gained at the most interesting period in the history of botanical science. Darwin, adding the result of his own critical investigations to those of previous observers, had been able to sum up the work of one hundred years and present an intelligent conception of the reproductive processes in the higher plants, together with a knowledge of the relations which insects bear to such processes; both Darwin and Wallace were at that time engaged upon that memorable work which threw such a flood of light upon the origin of species, abolished the old conception of special creations and gave to the world one of its most powerful intellectual impulses; Lawes and Gilbert were deeply engrossed in attempts to solve the nitrogen problem and the broader question of plant nutrition in general; the modern microscope was then in its infancy; microtomes were as yet almost unknown; and the various critical methods of differential staining and other methods in technique which have contributed so much to the advancement of scientific research, were entirely foreign to the knowledge of the so-called microscopist. But among German botanists there was, nevertheless, a movement in progress to cast aside the fetters which for so long a time had bound the science to a purely morphological and taxonomic point of view, and to seek a wider, more attractive and more broadly useful field of investigation in the domain of anatomy and physiology. Many prejudices

and preconceived notions had to be overcome, but this was successfully accomplished by Sachs, whose memorable work, published in 1874 and soon translated into English, opened up an entirely new vista and established what has since come to be known as the new school of botanical science. The dogmatism which had for so long a time characterized and dominated scientific thought and teaching rapidly gave way to speculation and freedom of thought, and the way was thus opened for the introduction of those reforms which have followed in such rapid succession during the last thirty years. Hypotheses which were regarded as all-sufficient in 1860 or 1875 have become greatly modified or even abandoned within the last ten years; physiology has assumed a new position and importance and is to-day directing the general course of investigations in whatever department of the subject of botany they may lie; pathology has attained to a position of dignity, attractiveness and importance which not only enlists the energy of the best-trained minds, but appeals with special force because of the great scientific and economic importance of the results which flow from it. The influences which were thus at work during the earlier period of President Clark's professional career were such as to produce a profound impression upon an observing mind, and even those of us who can recall the closing years of this transition period retain a very vivid impression of the powerful stimulus afforded by the alluring prospects presented by the new lines of research, and the opportunity for profitable discovery presented by the new methods.

The trend of thought and the spirit of investigation thus awakened appealed to President Clark with peculiar force and led him to place the new opportunities before his students with successful results, and he may be regarded as one of the first

in America to adopt this advanced position. He thus set in motion at this college influences of the greatest importance to the progress of botanical science, which, centering here, later extended to far-away Japan, where such views had not then become known, to various parts of the United States and eventually to Canada. It is a matter of no small moment, and one upon which this institution may well be congratulated, that it was one of the pioneers in giving to the new world correct conceptions of the principles of the new school of botany, in accordance with which it has been possible to realize the great scientific and economic achievements of the last quarter of a century within the domain of that science.

President Clark's claim to scientific recognition rests not so much upon his actual achievements in research as upon his administrative capacity and the intelligent manner in which he stimulated and encouraged investigation on the part of others. As a matter of fact, his only exploit in original botanical work is recorded in the report entitled "The Phenomena of Plant Life." In this paper he undertook to present the results derived from a repetition of Hales's classic experiments, but with greatly improved apparatus of his own devising. This work extended over a period of three years and dealt with a variety of phenomena of great popular interest and much scientific importance. But the portion which claims our special attention is that relating to the movement of sap in trees. To this obscure problem which had claimed the attention of botanists, and had been the subject of more or less profound investigation for three hundred years, he contributed new facts of great value. Although the subject has, of late, received renewed attention, and the resources of greatly improved methods and apparatus have been utilized, the results

obtained here in 1874-76 remain unchallenged. Indeed, they afford some of the most reliable data obtainable, and one of the best explanations of the phenomena within the limits of the ground covered. No discussion of the subject can be entered upon without reference to this important work. I desire to emphasize this fact, not only because it indicates the great scientific value of the problems which President Clark was prepared to enter upon, as well as his capacity for their solution, but it serves to make clear his connection with another movement of great significance and far-reaching importance. But before leaving this aspect of our subject, one other item must be added to the scientific work thus indicated, as represented by his successful efforts with respect to the introduction of new or little-known species of Japanese plants. The collections at this college afford abundant evidence of the zeal with which this work was carried out, and the success which attended his efforts.

In 1834 John Bennett Lawes, afterwards Sir John, established at Rothamsted, England, a special station for the investigation of problems relating to the nutrition of plants. This work was suggested by the celebrated investigations of De Saussure, and for a period of nine years it was carried on in a tentative way. But in 1843 it was entered upon on an enlarged scale with improved facilities; and through the cooperation of Dr., afterwards Sir, Henry J. Gilbert the work was carried out on the original lines until the death of the latter brought it under the management of a special trust devised by Sir John Lawes some time before his death. The subsequent establishment of a system of experiment stations throughout Germany, but under government control, gave this movement a powerful impulse which eventually brought it across the Atlantic to our own shores. The example thus set made a deep

impression upon the receptive mind of President Clark, and it was one of his cherished plans that such a station should be established here. This hope has been realized, although the fulfilment was not accomplished until several years after his death; though it must be conceded that his scientific observations, together with those of Goessmann and Stockbridge, constituted the real commencement of the Hatch Experiment Station, and gave a powerful impulse to a movement which at that time was hardly more than a suggestion, but which has since resulted in the establishment of similar stations throughout the United States and Canada.

My first recollections of President Clark go back to that early period in the infancy of this college, when technical training in the principles and practise of agriculture was an untried problem; when the young institution was forced to grapple with all the uncertainties of a future which too often received the open and hostile criticism of many otherwise intelligent and progressive citizens. Many were the sore trials and bitter disappointments of those early years, but, fortunately, there was a man at the helm who never wavered in his firm conviction that the agriculture of the future must rest upon a sound basis of scientific knowledge, and who never swerved from what he regarded as a correct policy. To his task he brought not only firm convictions, but an enthusiasm and determination which enlisted the respect and hearty sympathy of all his colleagues, as well as of many influential friends; carried conviction to the wavering and brought success where failure might have been looked for. His critics have been wont to censure him for an enthusiasm which they believed to sometimes carry him beyond the limits of safety, and this may have been true in some instances. Enthusiasm is one of the first requisites

of a successful teacher and investigator, and although due conservatism in its exercise is most desirable, an excess is no more to be condemned than undue caution. It was a favorite maxim of President Clark's that a man who never made a mistake was one to be carefully watched. The most successful of men are guilty of errors of judgment which find their justifiable excuse in the great value of their achievements. The over-cautious man who never blunders is thereby characterized by the possession of negative qualities which are rarely, if ever, capable of contributing materially to the general progress and welfare. Boldness of action and resolute decision, promptness of execution, tempered by a cool and accurate judgment, are the qualities which bring success and command the respectful consideration of our fellow men.

As one of those who were intimately associated with President Clark in his work in Japan, and who, from its very inception, was able to gain an intimate knowledge of his purposes, it is proper that I should make some reference to that portion of his career which had to do with a most progressive, intelligent and refined people of great intellectual power. His entire period of service under the Japanese government extended over less than one year, but during that time he laid the foundation of a most successful college of agriculture, which has since outgrown its original purpose and has enlarged its sphere of usefulness to that of a university, of which the college of agriculture remains one of its most important features. Several of the students who commenced their courses of study under the guidance of President Clark have since then studied in the United States, from whose leading universities they have taken higher degrees with distinction. One of these now presides with ability over the destinies of the new uni-

versity at Sapporo; another is a distinguished professor of botany in the same institution; a third enjoys eminence as one of the most distinguished literary men of Japan, with a high repute as a scholar in foreign lands; while others have won distinction in various callings in their native land.

There is probably no part of President Clark's work which has left so enduring an impression and influence as his participation in the efforts of Japan to introduce the best in our western civilization. His success in this undertaking was based in part upon his appreciation of great public utilities, and in part upon his enthusiasm and ability as a teacher; and it was largely in consequence of the stimulus imparted by him that so many of the students of the Sapporo College sought and won distinction in the domain of science and literature. His administration at Sapporo was governed by the same broad-minded policy and comprehensive views that gave success to the parent institution, and it is one of the most prominent features of both colleges that, in spite of his strong, scientific inclinations, he recognized the importance of a liberal culture combined with ability to meet the practical issues of life. It is this breadth in scientific training, this all-round culture and capacity for work, and ability to deal with every-day problems, that has given to the graduates of both institutions the element of success—they have been trained to the best ideals of useful citizenship.

I should like to enlarge upon the present position of and future outlook for both physiology and pathology in this institution, because of the important historical relation in which President Clark's work stands to both of these very important subjects, but the limitations of the present occasion will not permit me to do so. But I can not avoid a reference, in closing, to

the very important connection which must ever exist between the work of this college and the biological sciences. It requires but a moment's reflection to appreciate the enormous values represented by the various agricultural interests directly affected by the operation of disease and the depredations of destructive forms of insect life. For this reason, if for no other, the study of zoology must always find a prominent place in the curricula of institutions dealing with agricultural problems. But when we further reflect that such interests are, after all, secondary to those in which botanical science is concerned, because all forms of animal life are primarily dependent upon plants for their sustenance, it becomes evident that the study of botany, in its many-sided aspects, is of paramount importance, and that it is, after all, the real foundation of scientific agriculture. For this reason it finds a peculiarly appropriate place in our agricultural colleges, and I have for a long time been under the impression that there are no institutions where it may be more profitably cultivated, not only with reference to its direct application to the solution of great economic problems, but with reference to its purely scientific aspects; for, after all, the practical side becomes possible only after the purely scientific side has been dealt with. It is for these reasons that economy is finally gained by securing to botanical departments a competent staff and a thorough equipment in buildings and apparatus; and the fact that this dedication is being held to-day is abundant evidence that the people of Massachusetts appreciate to the full the far-reaching importance of the work to be executed here, under the able direction of Dr. Stone and his assistants.

But I would further point out that nature's processes, although exceedingly certain of fulfilment, are nevertheless exceedingly slow. If it has taken 500,000,000 of

years to shape this earth and render it a fit habitation for man, man himself must not be impatient if he is required to spend a few years of arduous toil that he may unlock some of the doors which so carefully guard nature's secrets. Sixty-three years sped on their way from the time when Boussingault first endeavored to ascertain the source of nitrogen in plants, until a satisfactory explanation was reached through our knowledge of the action of root tubercles; and for more than sixty years Lawes and Gilbert sought the solution of plant nutrition without gaining the end in view.

The laws of nature are not kept on draught, as it were, to be drawn in large or small quantity, according to the demand. To present a problem to an investigator and expect an immediate solution, or an immediate practical application, is to be prodigal of a costly equipment, to sacrifice unnecessarily the best and most carefully trained intellectual strength, and to bring discouragement and invite failure. It is, no doubt, true that when a commonwealth has invested a large amount of capital in specially trained men and expensive apparatus, it is reasonable to ask for results, and with this no fault can be found. The danger lies in the fact that sufficient opportunity is not allowed for the careful working out of a problem in all its scientific aspects. Under conditions of haste and undue pressure, the results, if worth anything, are very likely to be incomplete and unsatisfactory, and in too many cases they must be subject to costly revision. I feel disposed at this time to make an appeal to the citizens of this commonwealth to secure to the investigators who will occupy this building, as well as to all others in this college, freedom for the future, from an incubus which, in the history of our experiment stations of the past, has for many years been prolific of disastrous results.

I do this because this building should stand as an exponent of the best scientific work and thought, and because I know of no body of men, other than the citizens of Massachusetts, to whom such an appeal may be made with greater assurance of an intelligent hearing, and a fairer prospect that they will apply the remedy, *patience*.

And now to the students of this college, as to those who are to follow you in after years, my best hope is that as you view this building from across the campus, or as you enter its halls for the pursuit of science, you may ever hold it as an inspiration to high ideals, persistent effort and unflinching purpose; and that in whatever walk of life your lot may be cast, you will ever keep before you the example of him whose name it bears, taking up your burden of life in all cheerfulness and hope, and whatever your task may be, with the firm resolve to "Do it."

D. P. PENHALLOW

McGILL UNIVERSITY

SCIENTIFIC BOOKS

Memoir and Scientific Correspondence of Sir George Gabriel Stokes. Selected and arranged by Professor J. LARMOR, Sec. R.S. Cambridge. The University Press. 1907. Vol. I., pp. 475; Vol. II., pp. 507.

Biographical literature, if one may judge by the notices which have been written of late years, appears to admit of criticism more easily than almost any other form of history which is not written entirely from the point of view of the student. Whenever, as in the present case, the materials are plentiful and easy of access, the reader is almost entirely at the mercy of the writer, so that the latter may, by his method, give what impression he will of the character which he desires to unfold. In any case, it is a difficult matter to settle what is of permanent value in the life of any man who has left his mark on the men of his generation or who has added to the general store of knowledge. The difficulty is not less