1941-05

Professor John Henry Schaffner

Waller, Adolph E.

The Ohio Journal of Science. v41 n3 (May, 1941), 253-286
http://hdl.handle.net/1811/3171

PROFESSOR JOHN HENRY SCHAFFNER

ADOLPH E. WALLER,
Ohio State University

BOYHOOD BACKGROUNDS

A small boy herding cattle in a vast expanse of prairie may not seem important. Doubtless many small boys have engaged in that not too difficult task. They have fought flies, chewed straws, and tried to amuse themselves, perhaps thoughtfully. Most of them have just sat by, waiting until it was supper time and the end of the day's labors. It was lonely to some, boring to others, perhaps exhausting their patience to know that they were prisoners tied to the cattle they were to guard. Most such boys would not think of themselves or of their jobs as offering much. Yet to a mind alive with curiosity such a contemplative life presents rich possibilities. If a landscape is somewhat bare, or at least simple, the individual objects take on a new significance. To a mind eager to question, each rock, each dip in the terrain, each stream requires exploring. With the passing of hours and months, the seasons take on a perspective. With growth of plants the lengthening stems and spray of bloom unfold mysteries that demand investigation. What wonder that the dense prairie sod with its complex and teeming life should hold a world for a small boy's mind!

Such a boyhood background in Professor Schaffner's life circumscribed the making of a great mind. He was born in Marion County, Ohio, near the Agosta prairie, with forests enclosing it, but his family moved early in his life to Clay County, Kansas. The prairie area he had left in Ohio was a mere patch of grassland, an island of grass in a landscape of trees. In Kansas it was different. Grasses and grassland forms reached across the horizon, only interrupted where pioneers had planted some trees near their homes or along streams where a narrow strip of woodland marked the water course. Grasses and cattle were his companions in the long hours he had to remain at watch. Why the flatness? Why the great stretches of sky? The work of the glaciers was still a new idea and probably not mentioned in his school. His parents were busy and perhaps had no time for such wonders. Yet these were the thoughts uppermost in the boy's mind. Geology became his first love in science, though he was far from any one who could talk much about it and had few books that could help him. But no lack of training or of encouragement from the circumstances in which he grew up could take away the desire to know all he could know of the grasslands around him. It would seem that the great expanses of prairie in which he was so small must have left him with a sense of his own obscurity. In later life his modesty never permitted his own great accomplishments to affect him. Like the small boy of the prairie, he was there, ready to speak or to act if any one was interested. But as with the small boy on the prairie, only a few came his way. He never learned to shout to

attract the attention of others. The lonely life with the silent cattle also gave him a sense of his own competence. He was obliged to rely on himself. He formed the habits of self-dependence. He would act if he thought he was right. Having once made up his mind, nothing could move him to change his opinion as long as he thought he was right.

During the early days in Kansas the Schaffner family had to contend with the handicap of poverty. The house was the sod house familiar to many pioneer families of the grasslands. After working two years, the family had accumulated resources sufficient for the father to make a journey to Leavenworth, where a supply of lumber to build a more comfortable frame house was purchased. The lumber was paid for, but before the house was finished a raging prairie fire consumed it all. The Schaffner family, coming from Ohio, had not learned the precaution of plowing furrows to stop fires around the site selected for their wooden farm house. They were obliged to live for two more years in the sod house before again having enough money to buy lumber. This time the necessary strips of plowed land were prepared. After that, although there were a number of prairie fires, the house and the family were safe. In a reminiscent mood Professor Schaffner told this story to several members of the Botany Department staff as he recalled some of the exciting experiences of his boyhood.

Not only was the first Schaffner home of sod, but the earliest school house in the Clay Center area was a bank-sod house—a sort of basement structure. The walls and the roof cover were of sod. This was the school the elder sisters attended for several years. John spent most of his school years in a frame school house. It was a one-room building that served also as a social center, and in it were held the meetings of the debating society, the spelling matches, the Sunday School, and the box suppers. These were the pioneer's fun. There was one other—community singing. Schaffner was musically inclined. He was the only one in the school who could play the organ. He must have enjoyed this and talked about it for his parents at one time considered helping him to study music as a career.[1] This may have been in his college days, as Mr. Thomas A. Evans, Alumni Secretary of Baker University, Baldwin, Kansas, states that while Schaffner attended Baker he was in charge of the music at the Presbyterian Church and adds that Schaffner was gifted in playing the piano and organ and wrote poetry as a hobby.

The Schaffner family in many ways showed ingenuity and originality. The boys made mechanical wooden toys, and even a primitive *camera lucida*, which was set up for reflecting pictures on a screen. These amusements and visiting the neighbors occupied the long winter evenings. The parents were helpful in guiding their children toward instructive recreations.

Mr. D. C. Schaffner wrote: "By the time John started to high school it was taken for granted that he would go to college. Although the two older sisters taught school for a number of years after high school, they did not share this ambition for themselves but assisted

[1]This fact and much of the material at this point was kindly furnished by Mr. D. C. Schaffner, the younger brother, now Professor of Geology at Emporia College.

John and my younger sister and myself in college and graduate schools after each of us had taught in country schools. We formed a sort of teaching-and-going-to-college relay team." Of John, his brother wrote that "he was reticent but friendly. As far back as I can remember he never showed all of himself to anyone."

Science training was in a chaotic condition when young Schaffner at last was free to enter college; training in the classics was the only kind of education available in most of the colleges in the period from 1880 to 1900, and Schaffner's experiences were no different from those of many young men of his day. He was later to have a particular use for his knowledge of Greek and Latin in his scientific work. The classical tradition gave him a most careful training in the exact derivation of words, and his papers never contained new terms that were a polyglot mixture of Greek and Latin. His interest was captured by natural science, and it was geology that he first thought of pursuing.

As a further tribute to the Schaffner family it should be remarked that while the farm never was a source of wealth, it produced sufficient means and talents to be called remarkable. The younger sister is a noted attorney in Chicago; the younger brother, a geologist. The children were not bound down to the pioneer environment.

Probably the greatest inspiration toward research in botany for the boy John came from Dr. Charles Sylvester Parmenter, who was the teacher of biology and geology at Baker University. Dr. Parmenter was doubtless helpful also in securing for the young graduate of Baker University the job of teacher of natural sciences in the Methodist College at Mitchell, South Dakota. With all the delays of his high school and college years, John Schaffner was twenty-eight years old at the time he went to South Dakota. By then his path toward modern scientific study seemed to have become clear to him. After a year at the college at Mitchell he resigned his post to take up graduate studies at the University of Michigan. He remained for two years at Ann Arbor, where, under the guidance of Dr. Frederick C. Newcombe, he began intensive work in cytology.

He plunged at once into the most controversial subject of the moment, the question of cell organization at mitosis. His first paper dealt with the attraction spheres and centrosomes, present outside the cell nucleus, considered from the standpoint of their possible function during karyokinesis. This was a deep and difficult subject for a young research student to undertake. It was all the more ticklish from its didactic nature, since the most distinguished European cytologists were at that time at odds over their discoveries. Young John Schaffner had to master a reading knowledge of French and German to prepare his paper, since of the thirty-five references which he lists only two are in the English language.

THE YOUNG BOTANIST

While we know that Professor Schaffner was engaged in teaching the natural sciences at Mitchell College in South Dakota, we have been unable to trace his associates or to learn much of his development during the two years (1893–94) he remained in South Dakota. He published

his first two papers after he had gone to Michigan. The one on the centrosomes was published in 1894, the other on the embryo sac of the water plaintain, *Alisma plantago*, in 1896. Both came out in the *Botanical Gazette*, which was at that time undergoing revolutionary improvements as a scientific journal. Dr. Coulter, its editor, had just been called to Chicago by President Harper. Dr. Spalding, head of the Department of Botany at Michigan, was on very friendly terms with Coulter, serving as an associate editor of the *Gazette*. Young Schaffner's papers were approved by both Spalding and Coulter, and appeared in the *Gazette* just as it was being revised and expanded. It is significant that young Schaffner came in with the first wave of the swelling tide of interest in botany in the United States, a tide, the level of which was greatly raised by the Chicago group of botanists.

It was at Chicago that the young scientist really began his intensive training in botany. He was attracted by the work of Dr. John M. Coulter and the *Gazette*, where his first paper had appeared. Coulter's success with the old *Botanical Gazette*, of which he had been editor while at Lake Forest College, had been marked. His co-editors, Charles Barnes and J. C. Arthur, were still loyal, but when the University of Chicago with its rich Rockefeller endowment, was behind it, it could make the necessary expansion. Dr. Coulter chose carefully when new associate editors were added—Atkinson of Cornell, Thaxter of Harvard, Spalding of Michigan, and Trelease of the Missouri Botanical garden. These were impressive names, and the quality of the materials Coulter proposed to publish made the new editors willing to lend their prestige.

By 1897, its success having been noted abroad, and Dr. Coulter having had a chance to visit Europe, foreign associate editors were added. The beginning of the great botanic center that was to make the University of Chicago famous for so many years was a reality. The new names made the editorial board of the *Gazette* a roster of botanists of first rank. They were De Candolle of Geneva, De Toni of Padua, Engler of Berlin, Guignard of Paris, Matsumura of Tokyo, Noll of Bonn, Marshall Ward of Cambridge, Warming of Copenhagen, Wittrock of the Academy of Sciences of Stockholm. The editorial staff in the main had no duties, of course, but their names were on the fly-leaf of the *Gazette*. Coulter and the staff of the University of Chicago and the graduate students in botany, who by this time numbered ten or more, contributed much of the materials. The graduate students were not unworthy to contribute to the *Gazette*. Most of them became distinguished professors of botany. In the famous paper on *Lilium*[2] Dr. Coulter names nine, of whom Otis W. Caldwell, Henry C. Cowles and T. C. Frye are perhaps the best known. Coulter did not include the names of Charles J. Chamberlain and John H. Schaffner in this list because Chamberlain and Schaffner independently produced the papers on the pollen sac and the macrospore nucleus of Lilium which were the features of this paper and to which Coulter's contribution was mainly the introduction and the organization of the materials to be studied. In

[2]*Botanical Gazette*, Vol. 23, p. 412.

spite of its being thus buried, Schaffner's studies were the important ones and the ones which today are referred to as the beginning of the evidence in plants for the studies in Mendelism and heredity. Schaffner's paper should have been published as a separate contribution. Everybody knows that now. For it was not just more details in cytology. It was the one idea that the botanists, especially the geneticists, needed.

But Schaffner knew what he was doing. In his introductory sentence he said so. "Although a knowledge of the changes which take place in the reduction nuclei of plants and animals is of the utmost importance and will no doubt aid more than anything else in bringing about a correct interpretation of the facts of heredity, comparatively little has been done in this field, and the observations that have been reported disagree widely." There it was. He had done it, but it disagreed with earlier reports on chromosome behavior. Even Professor Coulter was afraid of it. The conclusion was too startling. And it was so unlike the conclusions of the European laboratories, which so authoritatively dominated the scene. Could it be that young Schaffner was right and some older famous heads were wrong? Let us quote some of the statements from the paper on *Lilium:*

> "Thus there is an actual transverse division of the chromosomes, the half of each original chromatin loop passing to opposite poles of the spindle. Each daughter nucleus, therefore, receives about as many chromatin granules as there were in the mother nucleus, and although there is no diminution in the number of chormatin granules, only half of the granules originally present in the mother nucleus are represented in each daughter nucleus. It will be seen that although the chromosomes are not all of the same size and length, yet if the chromatin band breaks at practically the middle point each daughter nucleus receives about the same number of chromatin granules; and since the chromatin granules are the same in number as in the mother nucleus it cannot be proper to speak of a reduction in the amount of chromatin, although only half of the original chromatin granules are represented. There is no reduction in number but a reduction of one-half in kind."

Whether Dr. Coulter approved or not, the paper had to be presented as a continuation of the morphological and cytological studies in progress, since a whole year's work was involved. But what would some of the foreign associate editors think of it? Was this young man too brash? He seemed quiet enough, but he could not be shaken in his conclusions, and the idea was startling. Now, forty-two years after it was published, we may say that Schaffner did not know he was supposed to agree with the European cytologists so he disagreed. We also may understand that since it was but a section of the planned program of *Lilium* studies it did not have the chance to attract the attention it deserved. It was true that it contained the history of the embryo sac, as the title might suggest. But it contained the startling observation of both a longitudinal and a transverse separation of chromosomes during meiotic processes. It was this type of division which was needed to

account for Mendelian proportions in offspring that botanists were soon to be looking for. Schaffner was the first botanist to see it. Since the main point was not fully emphasized, the credit for this first observation was not entirely awarded to young Schaffner. But if he was disappointed in this, he had no time to fret. For the following year he was called to Ohio State and began the development of a career which was to last for forty-two years.

THE OHIO STATE UNIVERSITY BOTANICAL LABORATORY

The young assistant in the Department of Botany was chosen by Professor William A. Kellerman, who had himself been for a number of years at the University of Kansas before coming to Columbus. Dr. Kellerman was broadly trained and a ready lecturer, with a special interest in mycology. Mr. Schaffner was to assume responsibility for as many of the other phases of botanical science as he felt inclined. None of them was organized. The trails needed to be blazed by pioneers in every department. But few institutions would be fortunate enough to get young men who could blaze trails in so many different directions.

Before assuming his duties at Ohio State Mr. Schaffner returned to Kansas. This annual journey in the summers to Kansas became a fixed pattern in his life, and while no complete record exists, he probably missed few summer visits to his home. In 1897 we have a record for this summer that he visited Cloud County, Kansas, and devoted his studies to the salt marshes. He lists the plants inhabiting the marked vegetation zones around the margins of the marsh in a contribution to floristic ecology. Not only is it recognized today that this pioneer paper on the floras of our inland salt marshes is a valuable scientific record, but it is also Contribution Number One from the botanical laboratory of Ohio State University. This paper appeared in the April, 1898, number of the *Botanical Gazette*. Before this, even Dr. Kellerman, who founded the *Journal of Mycology* and was for many years a contributor to it, had not thought of the device of crediting the Ohio State University's support of his efforts. At that time, of course, Professor Kellerman was already a man of high professional reputation. He had influenced many students, both in Kansas and in Ohio, and played an important part in the development of the work in plant pathology, which was to rise so brilliantly in the Department of Agriculture just organized at Washington—where, later, his son was to become the head of the work in plant pathology. But the plan of crediting the institution which was paying his salary had apparently not occurred to him. His young assistant in botany was to give Ohio State its appropriate recognition. It is symbolic of the fact that Schaffner was entering whole heartedly into a plan of life that was to bring forth every effort in the development of his chosen field.

In 1892 Ohio State University had a new Dean of Agriculture. Professor Thomas F. Hunt, who had previously held the chair of Agriculture at State College, Pennsylvania, was called to the post to succeed Doctor Townshend, who had just retired in his seventy-seventh year. At the same time, the Department of Botany and Horticulture was divided. Professor W. R. Lazenby, who had long held the double title,

was elected Professor of Horticulture. The title of Head of the Department of Botany was given to Professor William A. Kellerman. The building in which the classes in botany were conducted at that time is described in the catalogue of the university as follows:

> Botanical Hall was provided in 1883 by a state appropriation of fifteen thousand dollars. It is of brick and fifty feet long by forty feet wide. The whole structure is two stories in height. The general Botanical Laboratory occupies the second floor of Botanical Hall. It is 23x33 feet and is furnished with both movable and fixed tables. The latter are attached to the west and south walls near windows suitably shaded. Water, gas, and an evaporating hood are provided. The laboratory is equipped with compound microscopes of the Bausch-Lomb, the Leitz, and other patterns and accompanying each is a tray of tools and a case of reagents. There are more than fifty dissecting microscopes, also charts and several minor pieces of apparatus for experiments in vegetable physiology. Three smaller rooms are also provided as laboratories for special work as well as a dark room for photography. Other facilities for the illustration of the courses in botany and for practical training in the same are: a general herbarium including flowering plants, ferns, mosses, fungi, algae, a State Herbarium, a collection of fruits and seeds, valuable timbers, woods, grasses and various economic products of the vegetable kingdom; ornamental grounds and woodlands planted with a large variety of evergreen and deciduous trees and shrubs and a greenhouse with a fair collection of native and exotic plants.[3]

It should be said for the defense of this meager collection and the limited space that housed it, as we now may regard it, that it was representative of the conditions of the struggling state universities throughout the country. Only a few institutions were better equipped. In 1897, five years after Professor Kellerman had arrived, he listed in the department three herbaria, the general one, the state herbarium, and his own private herbarium of over 20,000 specimens. It had taken much effort and money to obtain these, and they were "deposited for use in the Botanical Dept."[4] In addition he had added a complete collection of native Ohio woods and a collection of native medicinal plants. But it should be said that botany as a science was beginning to emerge from the stage of concerning itself exclusively with description. It was turning to the dynamcis of plant life. Dr. Kellerman was one of the earliest to be aware that physiology needed to be studied and taught. He introduced a course in physiology and the text used was the best American volume of the day, written by Dr. Charles Barnes. Among other innovations this book included the term photosynthesis to replace the words "carbon assimilation" used by previous writers. In teaching the plant physiology Dr. Kellerman is said to have wandered

[3]Ohio State University Catalog 1893.

[4]Ohio State University Catalog 1897.

far from his subject during a lecture hour. He would touch on main points but would leave to his assistants the job of quizzing. With the limited equipment, the amount of solid laboratory experimentation remains highly speculative. This may have developed ingenuity as well as put a severe tax on the patience of the assistant.

From Cope's *History of Ohio State University* is the statement that in 1898 Townshend Hall was completed.

> No pains or expense had been spared to make the building complete and satisfactory in every respect, and it was at that time the finest building of the kind in the country. It at once became an object of pride and admiration to the farmers of the state and did much toward awakening their interest in agricultural education and in reconciling them to the university.

Townshend Hall was formally dedicated by President Canfield, Dean Hunt, and the Secretary of the Board of Trustees, Mr. Cope. Townshend Hall was the first building of the Neil Avenue group. It flanked University Hall and Engineering. Across the oval were Botanical Hall and Orton Hall, which housed the university library as well as the geology department. From High Street there were only the President's Home, the Armory, and Hayes Hall. Except for residences of faculty members, the rest of the campus was without buildings. The woodlot at the northeast corner still contained remnants of the original beech forest. The campus served as a local flora collecting ground. Legend has it that the showy orchid inhabited the banks of the small brook that divided the campus. Perennially Professor Lazenby was asked to landscape the campus, but no funds except for tree-pruning seem to have been available. Two or three abortive attempts to start an arboretum or at least a garden were foredoomed to failure as the demands for buildings and roadways grew.

Botany, however, did not stem from the local situation. The department somehow became a center of learning, toward which students were attracted, and all Ohio was its collecting ground. Professor Kellerman was soon to collect farther afield. He began in 1902 his series of visits to Central America to study tropical fungi; his records of types new to science became so numerous that he established the *Journal of Mycology* to serve for himself and for others as a medium of publication of the discoveries. While he was away the main teaching duties fell upon Schaffner. The University Catalog lists fourteen courses offered during the school year. Some of these were for students in the Arts College and some for the medical and pharmacy students, since at that time the applications of botanical science to medicine and pharmacy were still regarded as more significant than the applications to agriculture. The field of plant physiology was still largely unorganized, though Schaffner taught plant physiology with the slight equipment that the laboratory afforded. The entire university enrollment for the year 1898–99 was 1,149 students. Some of the contemporary members of the faculty included: Edward Orton, Professor of Geology and State Geologist, who had "retired" from the presidency of the university in

1881 to go back to his beloved science; Sidney Norton, in chemistry; Samuel Derby, in Latin; William Rane Lazenby, in horticulture and forestry; George W. Knight, in history, political science, and constitutional law; David S. Kellicott, in zoology and entomology, and Albert M. Bleile, in anatomy and physiology. Some of the young men of the faculty included Wilbur Seibert, Francis Caldwell, Embury Hitchcock, William McPherson, Joseph Russel Taylor, Charles B. Morrey, Clair Dye, Thomas French, Charles Bruce, John Bownocker, Francis Landacre, William L. Evans, C. E. Sherman, Charles Foulk, and William L. Graves. John F. Cunningham was appointed Fellow and laboratory assistant in horticulture and forestry at this time.

The improvement of teaching and research was to become a single unified objective for Schaffner. The slim equipment was to be fully used. More would come. The collections necessary for a knowledge of the plant life of the state were to be increased. The various branches of botany were all to be explored. His papers reported studies in widely separated fields of the botanical sciences. In ecology appeared a paper on the origin of timber belts and on the spread of buffalo grass. These papers, forgotten now, contain subject matter again of interest to conservation programs. Their suggestive value was forty years ahead of their time. In plant physiology he wrote about self-pruning of trees, nutation of sunflowers, maximum height of plants. On the subject of weeds, already becoming prominent causes of loss to farmers and adding millions of dollars annually to operating costs of farms, he described the peculiar method of seed dispersal in tumbleweeds. To algology he contributed a paper in 1902 on Kansas desmids. These were pioneer works on little-known matters. They were serving to enlarge the mind of the young investigator and teacher and to prepare the way for those who would later specialize in these several fields. General botany was beginning to delve into the mazes of the fundamentals of plant life. If Professor Kellerman's lectures possessed breadth and were given in an interesting fashion, young Schaffner's work would attempt to plumb the depths and provide the lectures with new perspectives. He wanted to know how plants live, more than he cared about their existence as objects to be described. He was beginning the expansion of not only his own mental equipment, but his insight into the plant knigdom was also being utilized by the head of the department and others. There were too many courses offered by the small staff. The Catalog for 1902–1903 lists twenty-seven undergraduate and six graduate courses. The general herbarium had grown to 30,000 specimens, and Professor Kellerman's was still kept as a separate collection. Schaffner had found time to do all of this departmental work by unremitting effort, in which he did not spare himself. But he wanted more consolidation of effort

The Biological Club offered both a social outlet and a means of consolidating effort. It was later to become the parent of the Ohio Academy of Science and of at least two national honorary societies with biology as the major interest. At the November sixth meeting in 1899 Schaffner was elected president of the Biology Club. Taking his duties seriously he presented a paper at the following meeting December fourth entitled "The higher Phagophytes of Ohio." In December he

went to the Cleveland meeting of the Academy and read two papers. He was elected a trustee and a member of the publication committee. At the meeting of June 4, 1900, of the Biology Club, he was elected Editor of the Ohio State University *Naturalist.* This became, with its name altered to the *Ohio Naturalist,* the official organ of publication for the Ohio Academy, and in 1916 had its name again changed to the *Ohio Journal of Science.* Professor Schaffner remained Editor through all its changes and expansions from 1900 to 1918. Professor Hine was associate editor and Professor Landacre business manager through a number of years.

From a diary in possession of Mrs. Schaffner the following entries are quoted:

"Nov. 28, 1901. Thanksgiving Day. We entertained Prof. W. C. Mills and family for dinner. In the afternoon I went with Mills to the O. S. U.–Kenyon football game. For supper we entertained John Bridwell, Frederick Tyler and Otto Jennings and brother."

"Nov. 29. Meeting of the Ohio Academy of Science. I read two papers entitled, "The self-pruning of woody plants" and "Plant ecology of Ohio; a general outline," the latter in connection with Mr. Tyler."

"Nov. 30. Meeting of the Academy. I read a short paper on "Observations on the origin of forest belts in Clay County, Kansas." In the afternoon I went to the meeting of the Columbus Horticultural Society." These entries along with the remarks of the preceding paragraphs indicate the zeal with which Assistant Professor Schaffner was executing his duties and carrying forward the enthusiasm for plant sciences he was developing at Ohio State.

The years 1906 to 1908 brought about many changes in the now well-established and growing Department of Botany at Ohio State. Professor Kellerman was devoting his attention more and more to his chosen life work. He was the editor and proprietor of the *Journal of Mycology* and in the habit of furnishing from his own pocket funds for publication if the subscription was not sufficient. He was preparing to add the *Mycological Bulletin* to his sheaf of duties. The herbaria were growing in importance and interest as many collections were added. Some of these were the collections of Central American fungi. The talk of a new building to replace the inadequate facilities for teaching and research had not brought about results, but they would come. Associate Professor Schaffner's salary was inadequately small, but he and Mrs. Schaffner both worked in the laboratory (on one salary), and he was beginning to save money for a trip abroad. Surely he deserved it. He had three score or so valuable papers published in different highly reputable journals, and the *Ohio Naturalist,* which he had edited from the beginning, was a definite success, largely through his efforts. There were graduate students, such as Gleason and York, making noteworthy progress and reputations for Ohio State. Gleason had gone to Illinois, York to the University of Texas, and Jennings to the Carnegie Museum at Pittsburgh. Schaffner seemed to have a way with the advanced students, especially when he was at work with them after class hours. He could talk to them freely then, and the new problems of a phylogenetic system of classification held their interest more than the routine

classroom lectures. The roof leaked whenever it rained, the rooms were cold on chilly evenings, but physical discomforts were not important if the work in botany was going forward.

In 1906 the first Mrs. Schaffner, the beloved Mabel, died. In the March number of the *Botanical Gazette* appeared a notable paper on chromosome reduction in *Lilium tigrinum*. This paper re-established Schaffner's conclusions on the relation between chromosomes and Mendelism that he had foreshadowed, though not completely stated, in 1897. In this 1906 paper he acknowledged his grateful indebtedness to Mabel, who had prepared the 200 serial slides that his studies had required. She had helped him toward the recognition that his earlier work should have had. The July news items of the *Gazette* briefly recorded her death after a short illness. The notice mentioned her ability as a botanist of promise.

Mabel Brockett Schaffner had been the constant ally of her husband. In addition to the preparation of the slides she had studied the embryology of Shepherd's Purse and paved the way for Schaffner's publication of the first complete account of the embryology of a seed plant. Diary entries for May 26–30, 1906, indicate that on his return from the funeral in Kansas he had stayed at the home of his friends the Mills', had visited Professor and Mrs. McCall, and on the thirtieth contains the following: "worked at Mabel's drawings. They are nearly done, only some dotting in one. She was so anxious to get them done. They are on Bursa, Shepherd's Purse." Schaffner would bury his grief in his work. There were many problems he wanted to talk over with others. He would ask for a leave of absence and complete his work for his Doctorate. But where and how and who would carry on? Dr. Kellerman was interested in Central America and his trips put the teaching burdens on Schaffner. This was undoubtedly the most trying period—the most confused and confusing. It is not difficult to foresee what would happen to a shy, affectionate and lonely man.

At church he met Mrs. Mary Morton Sample and in April, 1907, became engaged to her. She was the mother by a former marriage of a daughter Jean and the courtship as recorded in diary entries indicate that Schaffner was reviving from his despair and even becoming gay. He went to the theatre to see Maude Adams in Peter Pan, took Miss Jean and Mary to the circus, attended church regularly, often twice in one day, and on May sixth, the first anniversary of Mabel's death, he and Mary shared with sympathetic tears the emotion roused by the Columbus Oratorio Society's performance of Haydn's "Creation."

Dr. Alfred Dachnowski—now Dr. A. P. Dachnowski-Stokes—was asked to fill Schaffner's place and especially to teach plant physiology during the leave for the school year 1907–1908. Dr. Kellerman would forego his contemplated fourth journey to Guatemala to study and collect tropical fungi. Schaffner was reappointed associate professor at a salary of $1600 a year. On this and with his savings and perhaps some income from his share of the Kansas farm he would go abroad. He could live on very little.

In a letter from Professor Daniel C. Schaffner there is the following statement: "When John went to Europe for graduate work his inten-

tion was to study at Berlin or at one of the other great German universities. However, he found no one there interested in or more than even incidentally conversant with the problems that were uppermost in his mind at that time. Consequently he spent several months in study in Paris and the greater part of his year in Zurich. At both of these places he found men interested in scientific research as he understood it and spent the months in an atmosphere of friendly and stimulating surroundings."

Comparison of these statements with the diary shows disagreement of several points. Clearly, reading the diary shows the confusion in John Schaffner's mind at this period in his life. He was emotionally down and up in rapid successsion. His work in the department was beginning to count with both his students and his colleagues. He had been editing the *Naturalist* for seven years and teaching botanical sciences for ten. He was forty-one years old and his experiences had matured him. After his return from travel and study abroad he would be capable of developing the fullness of his powers. Perhaps he could find the answers to his problems. He was distinctly turning toward problems of classification and had published four papers on the subject by this time. The great exponent of taxonomy in Germany was Engler, and it may be that Schaffner thought and spoke of systematic botany and the physogenetic systems he was beginning to develop. But he would not have found Engler receptive to views from an unknown American who probably would stir up discord in the views Engler was proposing. The most he could hope for from Engler would be to add one more monograph to the already extensive series. But this was not what was in Schaffner's mind. He was not finding fault with detail in an existing plan of study. He was trying to establish his own grasp on the plant kingdom as a whole. Anyway, there is no record in the diary of what his exact views might be. He did not, however, have Germany as a main objective. He sailed from Philadelphia to Liverpool, August 17, visited Oxford and Stratford. He spent a few days in London, staying at 21 Montague St., spent a few days in Paris and arrived in Geneva on September 8. He matriculated in the University of Zurich on October 14. Here he found a group of co-workers who accepted him and made him welcome. His diary once more records some of his experiences. He visited a Russian student affair, the Zurich Botanical Society, went to concerts in the Ton-balle, gave a talk in German at the Botanical Society, and entered fully into a delightful and lively gathering of intellectual comradeship. He only crossed Germany at the end of his stay on his way to Bremen to the ship for America. He had enjoyed his period of study in Zurich and made a warm friend and life long correspondent of Dr. Hans Schinz.

But a curious thing happened in Columbus. Kellerman had an opportunity to go away that was too fine to be resisted. The Board of Trustees of Ohio State University had caught the spirit of the investigations that were attracting Dr. Kellerman and some of his graduate students. Plant life was to be studied where it grew. The Ohio State University campus was to extend to Central America. The following quotation is from a notice that appeared in *Science*, August 23, 1907:

A TROPICAL SCHOOL OF BOTANY

> Professor Doctor Kellerman of the Ohio State University, Columbus, Ohio, has planned a tropical school of botany for next winter which ought to attract the attention of some of our young men who are fitting themselves for their life work as teachers of botany. The session extends from December 19 to March 19, and will be held in Guatemala, Central America. The campus will be located at Zacapa, 100 miles from the coast, Los Amates, 40 miles inland, Izabal, on Lake Izabal, and perhaps also at Livingston, on the coast. Only a small number of young men will be accepted, and those who intend joining are advised to do so at the earliest day possible. The fee for three months, including traveling expenses, board and lodging, is $226.00. The project is one that should be of interest to botanists generally, as affording excellent opportunities for instruction along unusual botanical lines.

There was Kellerman's dream come true. He had been there on collecting trips three times previously. He saw in a land of smoking volcanos and great differences in altitude many opportunities to study a great range of plant life in the field. He would take care of the fungi and the others could collect specimens in other groups of the plant kingdom. So far as I am aware, this is the first time any university in the United States had authorized a School of Tropical Botany. Guatemala was a good choice. The railroad was started on the Atlantic side, and the United Fruit Company had its banana boats organized with excellent schedules for the journey across the Gulf of Mexico. Field work in geology and archeology could be fitted into botanical operations. Our dependence upon the tropics for a number of valuable and interesting products was just in its infancy. This was the time to go.

Looking at the exciting possibilities of the newly authorized School of Tropical Botany, Dr. Kellerman's dream seemed to have swept him off his feet. He seems now to have forgotten his own and Schaffner's teaching schedules. Perhaps Schaffner's plans for a doctorate degree could be adjusted later. Kudos meant little to Schaffner anyway. As Dr. Kellerman prepared to leave for Guatemala in December, 1907, perhaps some such thought flashed through his mind. There is no record that he wrote to Schaffner, nor any mention in the diary that Schaffner kept that he knew at this time that Dr. Kellerman was leaving. Certainly, Miss Detmers and Dr. Dachnowski could not manage the overloaded teaching program unaided. President W. O. Thompson sent for Schaffner. This confusion meant that Schaffner never obtained his doctorate. Also, the School of Tropical Botany had its first and last authorized journey.

Dr. Kellerman did not return. He died, presumably of malarial fever, March, 1908, and was buried in Zacapa. Three years later Professor Schaffner was appointed his successor as head of the department. On board the Kaiser Wilhelm der Grosse in Bremen, March 24, 1908, Schaffner received word of the death of Dr. Kellerman.

THE PRODUCTIVE YEARS

The growth of the University during the decade from 1910 to 1920 brought many changes. If the dedication of Townshend Hall in 1898 had helped "reconcile" the farmers, its expansion by 1910 and the outbreak of the war in 1914 put many unforeseen pressures upon faculty and student body. The department of botany under Professor Schaffner's chairmanship was provided with better space and facilities. In 1914, in Autumn, the present Botany and Zoology Building was opened for instruction. For the portion given over to botany there were some changes made that never suited Professor Schaffner. The west wings were each shortened about twenty feet and this curtailed the number of small research laboratories and instructors offices and scrapped plans for the elevator to the fourth floor where the enlarged herbarium was to be located. The building was given a high pitched roof and the spaces under the eaves were to contain dioramas, stilled life of animals and plants. Funds for these were never available, so the top floor was left largely unused during the first ten years the building was occupied. It was said at the time the building was opened in 1914 that the department would never be large enough to fill the available space. Within less than five years of the opening of classes in the new building the enrollment had reached a thousand. Many circumstances, including a new appreciation of the relation of botany to agriculture and horticulture as well as its pursuit as a basic science contributed to the enlarged demands placed by students on the staff. Professor Schaffner had built well. Not a building merely, but his views of botanical sciences were sound, as the contributions now so steadily flowing from his pen showed.

Again at a time when there were changes in the department and adjustments to be made, Professor Schaffner was occupied by personal emotional disturbances. Mary Morton Sample Schaffner died in September, 1914, and was buried in Washington, Pennsylvania. However, he attended the meeting of the American Association for the Advancement of Science in December with Professor W. G. Stover. At the meetings he served as a delegate to the Sigma Xi meeting and was elected to membership in the recently formed Botanical Society of America. In June, 1916, Professor Schaffner was married to Miss Cordelia Garber who became the mother of three children: Grace Odile, John, and James.

In 1918 the diary records "I resigned the headship of the Department of Botany and am now Professor of Botany doing mostly research work." This period from 1918 to the close of his life is the most productive. Here his researches and publications ripened to display the wisdom that those who knew him at this time learned to appreciate. His diary of that period no longer records in detail his publications or his strivings. He has begun to think about the effect of his writings on others—to sit back and plan with a greater sweep the advances of knowledge.

In the earlier years he may not have perceived that his efforts in consolidating the research in cytology and morphology would result in the life cycle studies being widely used by others. They were published in the *Ohio Naturalist* and his privately printed *Laboratory Outlines*.

From there they found their way to textbooks and have appeared in many places from 1915 on through the years. The same may be said of the studies that proceeded from the embryology of Sheperd's Purse for which he always gave the credit of great help to Mabel Schaffner. All of botany was moving toward a better understanding of plants. Schaffner was no longer alone in his work as he had been when he started. And in the more intensified studies that developed in the twenties respectful recognition of the pioneering work of the early days of Schaffner was not lacking.

Perhaps the most satisfactory evidence of the soundness of Schaffner's views came in the field of taxonomy. The series, "The Classification of Plants," was begun in 1905 and continued until 1922. The series entitled "Principles of Taxonomy" ran from 1924 to 1931. In both series a total of twenty-two papers appeared in the twenty-six years. His studies were based on an examination of the fundamental structures of plants. Surely this topic was not new to botanists, yet in Schaffner's hands it began to yield amazing results. He seemed to have an almost uncanny ability to rearrange plant series that clarified the many evolutionary problems. From an entirely unrelated field of studies, namely the study of serum reactions, European workers, notably Mez and his co-workers, of the University of Breslau, proposed an evolutionary sequence which in its main features agreed with the Schaffner system. In passing rather briefly over this noteworthy contribution, since it is too loaded with a vocabulary and technical details to expand the subject here, one may say that the difference between Schaffner's treatment and the older works on taxonomy is the application of the newer knowledge of plants to a phylogenetic system. His insight into the developments of plants enabled him to go forward rapidly where others had been misled by the mazes of detail. As a young graduate student at Chicago he had accepted the Engler system enthusiastically as a great improvement. Later he found that a new era was initiated by Bessey's use of the Bentham and Hooker system in 1894. In 1905 Schaffner published an outline of the classification of plants. In 1910, in the second edition of his *Laboratory Outlines*, he included a "tree" of the sixteen phyletic groups. In 1928 his *Field Manual of the Flora of Ohio* followed his phylogenetic treatment consistently.

His statement of the fundamentals may be found in the following quotation from his "Phylogenetic Taxonomy of Plants."[5]

> Botanical science has at last advanced far enough that a rather conclusive taxonomy can be established on a true evolutionary basis. But in order to discern the taxonomic system of plants properly, so as to avoid reasoning from the particular to the general, the botanist must certainly be familiar with the general characteristics of the whole plant kingdom, have a knowledge of life cycles, and also must be somewhat acquainted with paleontology and with ecological relations. The principle of organic change along definite lines will then become profoundly evident.

[5]Quart. Rev. Biol. Vol. 9, p. 131.

From the broad canvas on which he painted the parade of the whole plant kingdom through the ages, he looked on at the struggles of the newly rising and dynamic subject of genetics. After his discovery of the behavior of chromosomes in *Lilium* that contained the basis for Mendelian heredity, the account of the relations was published by Sutton in 1902. Schaffner did not return to the subject in a publication until 1905, when he used the title that should have been employed in the *Lilium* paper, "The Nature of the Reduction Division and Related Phenomena." There were five papers intervening, and in 1910 appeared the paper, delivered when he had been president of the Ohio Academy of Science at its 1909 meeting. Its title was, "The Nature and Development of Sex in Plants." This subject occupied him more or less consistently for the rest of his career. More than any other single subject, it showed how definitely he maintained his position in controversy if he thought he was right. It is of fundamental interest to biologists to see how from the beginning Schaffner's non-Mendelian view of sex was close to being the correct view. There were in all, twenty papers published on the nature and determination of sex. In these he was mainly upholding his position that sex is an expression of a physiological state and must be viewed as male, female, and neuter and that it cannot be determined by the chromosome structure as in ordinary shifting Mendelian phenomena. Instead, the chromosome and its transfer was to be regarded as a manifestation of some larger control in the set-up of the complicated life processes of the cell.

It was only a step, but an important one, to pass from such a concept of sexuality to the experimentation in sex reversals. Here he found the way to demonstrate in many different plants that sex reversals could occur either in the presence or absence of the extra chromosome. In all there were sixteen papers on the subject of the control and reversal of sex. At the beginning of the series of publications most biologists were indifferent or actually hostile to the concept of non-Mendelian sexual phenomena. Toward the end he had many followers who saw in the idea of ecological control of sex the explanations of their own specialized fields of investigation. As a result of his endeavors, I for one, feel that Schaffner's work has broadened the researches in genetics to admit some of the concepts of physiology and ecology hitherto lacking. Again looking for a short statement which may serve to summarize Schaffner's position, I take the liberty to quote his words:

> Any attempt to seek an explanation of sexuality and sex in terms of a balance of genes instead of a balance of physiological states would be beside the mark, since in all of these processes the balance of genes apparently remains the same.[6]

This paper ends with the suggestion that the study of the principles of reversal as worked out in plants may throw some light on human cases as they occur in medical history.

The eleventh paper in the series on determinate evolution contains perhaps Professor Schaffner's only quotation from the Bible, although

[6]Bull. Torrey Bot. Club, Vol. 60, p. 96.

he was throughout his life a constant church member. He had completed a series of extreme evolutionary trends in plants and compares some of these to the human brain. He ends the paragraph with the remark quoted from Psalms: "I am fearfully and wonderfully made." Here is for Schaffner an expression of the intense curiosity that animated his long and useful career.

THE BIBLIOGRAPHY

The full citation of all of his papers follows. There is no other place, at present, where the entire list is to be found excepting this account. The Torrey Index has only about two-thirds of the full list.

It is hoped by this citation to show better than by the biographical sketch the full rounded activity of a truly great mind.

There were in all three hundred sixteen papers and books found in compiling the bibliography.[7] The following list presents them chronologically.

CHRONOLOGICAL CLASSIFICATION OF PAPERS

1894—	1	1918—	2
1895—	0	1919—	5
1896—	1	1920—	3
1897—	3	1921—	4
1898—	10	1922—	5
1899—	12	1923—	7
1900—	7	1924—	5
1901—	13	1925—	10
1902—	17	1926—	10
1903—	22	1927—	9
1904—	8	1928—	8
1905—	16	1929—	10
1906—	11	1930—	7
1907—	3	1931—	8
1908—	6	1932—	5
1909—	10	1933—	6
1910—	9	1934—	5
1911—	3	1935—	5
1912—	8	1936—	4
1913—	4	1937—	5
1914—	7	1938—	7
1915—	7	1939—	4[8] (Unpublished)
1916—	2		—
1917—	2		316

The true significance of Professor Schaffner's contributions stands out if we attempt to classify the recorded writings. It is only then that

[7]Mr. Victor Greulach and Miss Ruth Krehl were of material aid in compiling the bibliography.

[8]Only the unpublished papers recorded in "Papers from the Dept. of Botany" by Prof. Schaffner are included here.

the wide grasp of the Plant Kingdom which was his becomes evident. The groupings are as follows:

CLASSIFICATION OF PAPERS BY SUBJECT

I. Systematic Botany (110)
  1. Taxonomy
    a. "Classification of Plants" series (1905–1922).....12
    b. "Principles of Plant Taxonomy" series (1924–1931).....10
    c. Studies of the genus *Equisetum* (1912–1938).....17
    d. Miscellaneous (1912–1938)..... 6
  2. Floristics
    a. Catalogs, supplements and records of Ohio Plants (1900–1939)....49
    b. Keys and Manuals (Ohio and adjacent states) 1903–1931.....13
    c. Lists of lower plants (Mostly for Kansas) 1901–1910..... 3

II. Evolution (15)
  1. "Studies in Determinate Evolution" series (1928–1938).....12
  2. Miscellaneous (1898–1938)..... 3

III. Ecology (26)
  1. Prairie vegetation (1899–1926)..... 3
  2. Ohio vegetation (1902–1914)..... 3
  3. Kansas vegetation (1898–1907–1938)..... 3
  4. Equisetum ecology (1928–1934)..... 4
  5. Miscellaneous (1899–1930).....13

IV. Genetics (23)
  1. The nature and determination of sex (1910–1937).....20
  2. Mutations (1906–1925)..... 3

V. Cytology (12)
  1. Studies related to genetics and reproduction (1896–1915)..... 8
  2. Mitosis, etc. (1894–1908)..... 4

VI. Physiology (36)
  1. Growth (1898–1905)..... 7
  2. Self-pruning (1901–1909)..... 5
  3. Rejuvenation (1926–1928)..... 2
  4. The control and reversal of sex (1919–1936).....16
  5. Miscellaneous (1898–1932)..... 6

VII. Morphology (38)
  1. Life cycles (1897–1906)..... 8
  2. Floral structure and development (1897–1937)..... 4
  3. Equisetum (1908–1938)..... 7
  4. Miscellaneous (1901–1938).....19

VIII. Laboratory Procedure (41)
  1. Histological methods (1898–1900).....13
  2. Other laboratory methods (1900–1902)..... 4
  3. Laboratory outlines and manuals (1902–1915).....24

IX. Miscellaneous (29)
  1. "News and Notes," etc. (1898–1915, 1935).....12
  2. Terminology (1902–1906)..... 2
  3. Pathology (of Equisetum) 1931..... 1
  4. Zoology (1909–1923–1929)..... 3
  5. Book reviews and reports.....11[9]

[9]Not included in the total of 316.

LIST OF PAPERS ARRANGED IN THE GROUPS SHOWN ABOVE

I. Systematic Botany

1. Taxonomy

a. "Classification of Plants" series

The classification of plants, I. Ohio Nat. 5: 298–301. 1905.
The classification of plants, II. Ohio Nat. 6: 386–390. 1905.
The classification of plants, III. Ohio Nat. 6: 513–516, pl. 32. 1906.
The classification of plants, IV. Ohio Nat. 9: 446–455. 1909.
The classification of plants, V. Ohio Nat. 9: 489–494. 1909.
The classification of plants, VI. Ohio Nat. 11: 289–298, Fig. 1. 1911.
The classification of plants, VII. Ohio Nat. 12: 409–419. 1911.
The classification of plants, VIII. Ohio Nat. 13: 70–78. 1913.
The classification of plants, IX. Ohio Nat. 13: 101–130. 1913.
The classification of plants, X. Ohio Nat. 14: 198–203. 1914.
The classification of plants, XI. Ohio Nat. 14: 211–214. 1914.
The classification of plants, XII. Ohio Jour. Sci. 22: 129–139. 1922.

b. "Principles of Plant Taxonomy" series

Principles of plant taxonomy, I. Ohio Jour. Sci. 24: 146–160. 1924.
Principles of plant taxonomy, II. Ohio Jour. Sci. 25: 219–242, pl. 1. 1925.
Principles of plant taxonomy, III. Ohio Jour. Sci. 26: 294–311, Fig. 1, 2. 1926.
Principles of plant taxonomy, IV. Ohio Jour. Sci. 27: 249–261. 1927.
Principles of plant taxonomy, V. Ohio Jour. Sci. 28: 69–85. 1928.
Principles of plant taxonomy, VI. Ohio Jour. Sci. 29: 133–140. 1929.
Principles of plant taxonomy, VII. Ohio Jour. Sci. 29: 243–252. (illus.). 1929.
Principles of plant taxonomy, VIII. Ohio Jour. Sci. 29: 289–299, Fig. 1. 1929.
Principles of plant taxonomy. IX. Ohio Jour. Sci. 30: 261–272, Fig. 1–3. 1930.
Principles of plant taxonomy. X. Ohio Jour. Sci. 31: 77–96. 1931.

c. Equisetum

An undescribed *Equisetum* from Kansas. Ohio Nat. 13: 19–22. 1912.
North American species of *Equisetum* north of Mexico. Amer. Fern Jour. 17: 65–75. 1921.
How to distinguish the North American species of *Equisetum*. Amer. Fern Jour. 13: 33–40; 67–72. 1923.
Equisetum laevigatum and its near relatives. Amer. Fern Jour. 14: 41–46. 1924.
Main lines of evolution in *Equisetum*, I. Amer. Fern Jour. 15: 8–12. 1925.
Main lines of evolution in *Equisetum*, II. Amer. Fern Jour. 15: 35–39, pl. 3. 1925.
Equisetum variegatum Nelsoni, a good species. Amer. Fern Jour. 16: 45–48. 1926.
On the trail of *Equisetum* for four thousand miles. Amer. Fern Jour. 16: 81–92. 1926.
Diagnostic analysis and phylogenetic relationship of the main groups of *Equisetum*. Amer. Fern Jour. 20: 11–18. 1930.
Studies of *Equiseta* in European herbaria. Amer. Fern Jour. 21: 90–102, pl. 9. 1931.
Diagnostic key to the species of *Equisetum*. Amer. Fern Jour. 22: 69–75; 122–128. 1932.
Miscellaneous notes on *Equisetum*. Amer. Fern Jour. 23: 18–20. 1933.
Equisetum kansanum in Missouri. Amer. Fern Journ. 23: 64. 1933.
Kansas species of *Equisetum*. Amer. Fern Jour. 24: 36–38. 1934.
Distinguishing *Equiseta* with one or two rows of tubercles on the ridges. Amer. Fern Jour. 28: 121. 1938.
The distribution of the exclusively North American species of *Equisetum*. Amer. Fern Jour. 29: 45–47. 1939.

Chinese Species of *Equisetum*. Bull. Fan Inst. Biol., Bot. Ser. IX, No. 2, June 30, 1939. (With L. C. Li).

d. Miscellaneous

A revised taxonomy of the grasses. Ohio Nat. 12: 490–493. 1912.
Collecting horsetails along the way. Amer. Fern Jour. 18: 14–21. 1928.
Phytogenetic taxonomy of plants. Quart. Rev. Biol. 9: 129–160, Fig. 1, 2. 1934.
The proper name of the water horsetail. Amer. Fern Jour. 26: 91–94. 1936.
The importance of phylogenetic taxonomy in systematic botany. Ohio Jour. Sci. 38: 296–300. 1938.
The natural orders of the true mosses. Bryologist 41: 57–63. 1938.

2. Floristic

a. Catalogs, lists, etc. of Ohio plants.

Addition to the Ohio flora. Ohio Nat. 1: 16. 1900.
Ohio tumbleweeds. Ohio Nat. 1: 129. 1901.
Ohio tumbleweeds. Ohio Nat. 2: 174. 1902.
The flora of Little Chicken Island. Ohio Nat. 3: 331–332. 1902.
Ohio stations for Myriostoma. Jour. Mycol. 8: 173. 1902.
Poisonous and other injurious plants of Ohio. Ohio N.a. 4: 16–19; 32–35, 69–73. 1903.
Lycopodium prorphilum in Ohio. Ohio Nat. 5: 301. 1905.
Check list of Ohio trees. Ohio Nat. 6: 457–461. 1906.
Check list of Ohio shrubs. Ohio Nat. 8: 205–209. 1907.
Plants on the Ohio state list not represented in the state herbarium. Ohio Nat. 9: 413–415. 1908.
Six hundred plants of general distribution in Ohio. Proc. Ohio Acad. Sci. 5: 254–261. 1909.
Trees of Ohio and surrounding territory. Proc. Ohio Acad. Sci. 5: 73–191. 1909. (Special paper No. 15.)
The gymnosperms of Ohio. Ohio Nat. 10: 9–12. 1909.
New and rare Ohio plants. Ohio Nat. 10: 39. 1909.
The pteridophytes of Ohio. Proc. Ohio Acad. Sci. 5: 265–305. 1910. (illus.)
Additions to the flora of Cedar Point III (with M. E. Stickney and C. A. Davis). Ohio Nat. 10: 61–63. 1910.
A proposed list of plants to be excluded from the Ohio catalog. Ohio Nat. 10: 185–190. 1910.
Viola pedata in Ohio. Amer. Bot. 21: 143–144. 1915.
Filmy-fern native in Ohio. Amer. Fern Jour. 25: 17–18. 1935.
New and rare Ohio plants added to the state herbarium in 1910. Ohio Nat. 11: 246. 1910.
New and rare plants of Ohio. Ohio Nat. 12: 457. 1912.
New and rare plants added to the Ohio list in 1912. Ohio Nat. 13: 36. 1912.
Catalog of Ohio vascular plants. Ohio Biol. Surv. Bull. 2: 125–247. 1914.
New and rare plants added to the Ohio list in 1914. Ohio Nat. 15: 432. 1915.
Additions to the catalog of Ohio vascular plants for 1915. Ohio Jour. Sci. 16: 104. 1916.
The grasses of Ohio. Ohio Biol. Surv. Bull. 9: 256–329. 1917.
Additions to the catalog of Ohio vascular plants for 1916. Ohio Jour. Sci. 17: 132–136. 1917.
Additions to the catalog of Ohio vascular plants for 1917. Ohio Jour. Sci. 18: 99–100. 1918.
Additions to the catalog of Ohio vascular plants for 1918. Ohio Jour. Sci. 19: 293–298. 1919.
Additions to the catalog of Ohio vascular plants for 1919. Ohio Jour. Sci. 20: 131–136. 1920.
Additions to the catalog of Ohio vascular plants for 1920. Ohio Jour. Sci. 21: 128–135. 1921.
Additions to the catalog of Ohio vascular plants for 1921. Ohio Jour. Sci. 22: 91–94. 1922.

Additions to the catalog of Ohio vascular plants for 1922. Ohio Jour. Sci. 23: 107–114. 1923.
Additions to the catalog of Ohio vascular plants for 1923. Ohio Jour. Sci. 24: 107–116. 1924.
Additions to the catalog of Ohio vascular plants for 1924. Ohio Jour. Sci. 25: 130–138. 1925.
Additions to the catalog of Ohio vascular plants for 1925. Ohio Jour. Sci. 26: 169–182. 1926.
Additions to the catalog of Ohio vascular plants for 1926. Ohio Jour. Sci. 27: 95–101. 1927.
Additions to the catalog of Ohio vascular plants for 1927. Ohio Jour. Sci. 28: 205–214. 1928.
Additions to the catalog of Ohio vascular plants for 1928. Ohio Jour. Sci. 29: 81–92. 1929.
Additions to the catalog of Ohio vascular plants for 1929. Ohio Jour. Sci. 30: 98–108. 1930.
Additions to the catalog of Ohio vascular plants for 1930. Ohio Jour. Sci. 31: 299–307. 1931.
Revised catalog of Ohio vascular plants. Arranged according to the phyletic system of classification; with notes on the geographic distribution in the state, based mainly on specimens in the Ohio State Herbarium of the Ohio State University. Ohio Biol. Surv. Bull. 5: 89–215. 1932.
Additions to the catalog of Ohio vascular plants for 1931. Ohio Jour. Sci. 32: 158–161. 1932.
Additions to the revised catalog of Ohio vascular plants, I. Ohio Jour. Sci. 33: 288–294. 1933.
Additions to the revised catalog of Ohio vascular plants, II. Ohio Jour. Sci. 34: 165–174. 1934.
Additions to the revised catalog of Ohio vascular plants, III. Ohio Jour. Sci. 35: 297–303. 1935.
Additions to the revised catalog of Ohio vascular plants, IV. Ohio Jour. Sci. 36: 195–203. 1936.
Additions to the revised catalog of Ohio vascular plants, V. Ohio Jour. Sci. 37: 260–265. 1937.
Additions to the revised catalog of Ohio vascular plants, VI. Ohio Jour. Sci. 38: 211–216. 1938.

b. Keys and manuals

A key to the common families of seed plants. Pub. by the author. May 1, 1903.
Key to the genera of Ohio woody plants, based on leaf and twig characters. Ohio Nat. 5: 364–373. 1905.
Key to the genera of Ohio woody plants in the winter condition. Ohio Nat. 5: 277–286. 1905.
Key to the Ohio dogwoods in the winter condition. Ohio Nat. 6: 419. 1905.
Key to Ohio poplars in the winter condition. Ohio Nat. 5: 271. 1905.
Key to Ohio walnuts based on twig characters. Ohio Nat. 5: 307. 1905.
Spring flora. (W. A. Kellerman, H. A. Gleason and J. H. Schaffner) Columbus, Ohio. February 10, 1906.
A key to the families of seed plants in the central and northern states. Columbus, Ohio. 1912.
Key to the fruits of the genera of trees of the northern United States. Ohio Nat. 12: 506–512. 1912.
Field manual of trees. Columbus, Ohio. 1914.
A key to the families of seed plants in the central and northern states. 3rd rev. ed. Pub. by the author. 1915.
Field manual of the flora of Ohio. 1–638. Columbus, Ohio, R. G. Adams Co. 1928.
Manual of Ohio weeds (H. A. Runnels and J. H. Schaffner). Ohio Agric. Exp. Sta. Bull. 475. 1931.

c. Lists of lower plants

A list of Kansas Desmids. Ohio Nat. 1: 100–101. 1901.

Myxomycetes of Clay County, Kansas. Trans. Kan. Acad. Sci. 19: 204. 1905.

Edible and poisonous Mushrooms. Ohio State Univ. Agric. Coll. Ext. Bull. 5(9): 1–16. 1910.

II. EVOLUTION

1. "Studies in determinate evolution" series.

The general course of evolution in the plant kingdom. Studies in determinate evolution I. Ohio Jour. Sci. 28: 277–291. 1928.

Orthogenetic series involving a diversity of morphological systems. Studies in determinate evolution II. Ohio Jour. Sci. 29: 45–60, Pl. 1–3. 1929.

Orthogenetic series resulting from a simple progressive movement. Studies in determinate evolution III. Ohio Jour. Sci. 30: 61–79, Pl. 1–7, Fig. 1. 1930.

Long-continued determinative orthogenetic series. Studies in determinate evolution IV. Ohio Jour. Sci. 31: 1–16. 1931.

Characteristic examples of accumulative progressive evolutionary movements. Studies in determinate evolution V. Ohio Jour. Sci. 31: 346–367. 1931.

Orthogenetic evolution of degree of divergence between carpel and foliage leaf. Studies in determinate evolution VI. Ohio Jour. Sci. 32: 367–378, Fig. 1–24. 1932.

Color in various structures and the so-called principle of selective adaptation. Studies in determinate evolution VII. Ohio Jour. Sci. 33: 182–191. 1933.

Duplicate evolution of peculiar perianth structures in the sedge family and the Composites. Studies in determinate evolution VIII. Ohio Jour. Sci. 34: 306–315, Fig. 1–14. 1934.

The tendency toward progression or perfection development in plant evolution. Studies in determinate evolution IX. Ohio Jour. Sci. 36: 80–101, Pl. 1, 2. 1936.

Examples of orthogenetic series in plants and animals. Studies in determinate evolution X. Ohio Jour. Sci. 37: 267–287, Fig. 1, 2. 1937.

Extraordinary developments at near the end of evolutionary series. Studies in determinate evolution XI. Ohio Jour. Sci. 39: 67–82. 1939.

The nature of the evolution of the fundamental potentialities in the plant kingdom. Studies in determinate evolution XII. Ohio Jour. Sci. 39: 327–347. 1939.

2. Miscellaneous

Atavism in certain Compositae. Jour. Col. Hort. Soc. 13: 127–129. 1898. Ohio State Univ. Agric. Student 5: 90–92.

Atavism in the Watermelon. Ohio Nat. 3: 370–371, Fig. 1. 1903.

Progression of sexual evolution in the plant kingdom. Ohio Jour. Sci. 22: 101–113. 1922.

III. ECOLOGY

1. Prairie

The spreading of Buffalo Grass. Bot. Gaz. 27: 393–394. 1899.

The characteristic plants of a typical prairie. Ohio Nat. 13: 65–69. 1913. (Includes an enumeration of species of plants to be found.)

Observations on the grasslands of the central United States. Ohio State Univ. Studies. Contrib. in Bot. 178: 1–56. 1926. Fig. 1–12.

2. Ohio

Plant ecology of Ohio. Ann. Rept. Ohio State Acad. Sci. 10: 67–74. 1902. (With F. J. Tyler.)

Ecological study of Brush Lake. Proc. Ohio Acad. Sci. 4: 151–165, Fig. 1, 2. 1904. (Special paper No. 10.)

A preliminary survey of plant distribution in Ohio. Ohio Nat. 15: 409–418. 1914.

3. Kansas

Notes on the Salt Marsh plants of northern Kansas. Bot. Gaz. 25: 255–260. 1898.

Development of the forest belts in the northwestern part ot Clay County, Kansas. Trans. Kansas Acad. Sci. 20: 74–79. 1907.

Spreading of Opuntia in over grazed pastures in Kansas. Ecology 19: 348–350. 1938.

4. Equisetum

Rabbits eat *Equisetum praealtum*. Amer. Fern Jour. 18: 98–99. 1928.

Fluctuation in *Equisetum*. Amer. Fern Jour. 18: 69–79. 1928.

Geographic distribution of the species of *Equisetum* in relation to their phylogeny. Amer. Fern Jour. 20: 89–106. 1930.

Heredity and environment in relation to character expression with special reference to intermittent characters in *Eqyisetum*. Rev. Sudamer. Bot. 1: 8–17. 1934. (Revista Sudamerica de Botanica.)

5. Miscellaneous

Origin of timber belts. Bot. Gaz. 27: 392–393. 1899.

The maximum height of some common plants, I. Asa Grey Bull. 8: 19–20. 1899.

The maximum height of plants, II. Ohio Nat. 1: 39. 1901.

The maximum height of plants, III. Ohio Nat. 2: 1 2. 1901.

The maximum height of plants, IV. Ohio Nat. 3: 319. 1902.

The maximum height of plants, V.. Ohio Nat. 4: 23. 1903.

The struggle for life on a certain sandbar. Ohio Nat. 5: 302–303, Fig. 1. 1905.

An interesting *Botrychium* habitat. Ohio Nat. 10: 8–9. 1909.

Xerophytic adaptions of *Apocynum hypericifolium*. Ohio Nat. 10: 184–185, Fig. 1. 1910.

Ecological varieties as illustrated by *Salix interior*. Ohio Nat. 14: 255–256. 1914.

Effect of lightning on trunk of *Platanus occidentalis*. Bot. Gaz. 80: 226–227, Fig. 1. 1925.

A remarkable fern habitat. Amer. Fern Jour. 16: 79–81, Pl. 6. 1926.

The ecological determination of twisted hypocotyl and other peculiar expressions in hemp. Amer. Nat. 4: 367–379. 1930.

IV. Genetics

1. The Nature and Determination of Sex

The nature and development of sex in plants. Proc. Ohio Acad. Sci. 5: 327–350. 1910.

The expression of sexual dimorphism in heterosporous sporophytes. Ohio Jour. Sci. 18: 101–125. 1918.

The nature of the dioecious condition in *Morus alba* and *Salix amygdaloides*. Ohio Jour. Sci. 19: 409–416. 1919.

Dieciousness in *Thalictrum dasycaroum*. Ohio Jour. Sci. 20: 25–34. 1920.

The dioecious nature of buffalo grass. Bull. Torrey Bot. Club 47: 119–124. 1920.

The sexual nature of vegetative or dichotomous twins in *Arisaema*. Ohio Jour. Sci. 22: 149–154. 1922.

Observations on the sexual state of various plants. Ohio Jour. Sci. 23: 149–159. 1923.

The time of sex determination in plants. Ohio Jour. Sci. 23: 225–240. 1923.

Expression of the sexual state in *Sagittaria latifolia*. Bull. Torrey Bot. Club 51: 103–112. 1924.

Sex determination and sex differentiation in the higher plants. Amer. Nat. 59: 115–127. 1925.

Synapsis considered as a sexual phenomenon. Ohio Jour. Sci. 25: 183–189. 1925.

Questionnaire on certain facts bearing on the theory of sexuality and chromosome constitution. Science II 63: 384–385. 1926.

The nature and cause of secondary sexual states with special reference to *Typha*. Bull. Torrey Bot. Club 53: 189–208. 1926.

Sex-limited characters in heterosporous sporophytes. Ohio Jour. Sci. 27: 19–24. 1927.

Sex-limited characters and allosome linked heredity. Ohio Jour. Sci. 27: 105–126. 1927.

Sex and sex-determinations in the light of observations and experiments on dioecious plants. Amer. Nat. 61: 319–332, Fig. 1. 1927.

Extraordinary sexual phenomena in plants. Bull. Torrey Bot. Club 54: 619–629. 1927.

Heredity and sex. Ohio Jour. Sci. 29: 1–26. 1929.

Observations and experiments on sex in plants. Bull. Torrey Bot. Club 62: 387–400, Fig. 1. 1935.

Stability and unstability of sexual conditions in *Morus alba*. Jour. Heredity 28: 426–427. 1937.

2. Mutation, etc.

A successful mutant of *Verbena* without external isolation. Ohio Nat. 7: 31–34. 1906.

A remarkable bud sport of *Pandanus*. Jour. Heredity 10: 376–378, Fig. 14. 1919.

What happened to the *Pandanus* bud sport? Jour. Heredity 16: 62. 1925.

V. CYTOLOGY

1. Studies related to reproduction and genetics.

The embryo-sac of *Alisma plantago*. Bot. Gaz. 21: 123–132, Pl. 9–10. 1896.

The division of the megaspore of Erythronium. Science II 10: 565–566. 1899.

The nature of the reduction division and related phenomena. Ohio Nat. 5: 331–340. 1905.

Chromosome reduction in the microsporocytes of *Lilium tigrinum*. Bot. Gaz. 41: 183–191, Pl. 12, 13. 1906.

Synapsis and synizesis. Ohio Nat. 7: 41–48, Pl. 4. 1907.

On the origin of polar conjugation in the angiosperms. Ohio Nat. 8: 255–258. 1908.

The reduction division in the microsporocytes of *Agave virginica*. Bot. Gaz. 47: 198–214, Pl. 12–14. 1909.

The chromosome mechanism as a basis for Mendelian phenomena. Ohio Nat. 15: 509–518, Fig. 1. 1915.

2. Mitosis, etc.

The nature and distribution of attraction-spheres and centrosomes in vegetable cells. Bot. Gaz. 19: 445–459, Pl. 33. 1894.

Karyokinesis in the root tips of *Allium cepa*. Bot. Gaz. 26: 225–238, Pl. 21, 22. 1898.

Artificial production of the sickle stage of the nucleus. Jour. App. Micros. 2: 321–322. 1899.

The centrosomes of *Marchantia polymorpha*. Ohio Nat. 9: 383–388, Pl. 21. 1908.

VI. PHYSIOLOGICAL STUDIES

1. Growth

Observations on the mutation of *Helianthus annuus*. Bot. Gaz. 25: 395–403. 1898. (Illus.)

The mutation of Helianthus. Bot. Gaz. 29: 196–200. 1900 (Illus).

Notes on the nutation of plants. Ohio Nat. 4: 30–32, Fig. 1, 2. 1903.

Leaf expansion of trees and shrubs in 1904. Ohio Nat. 5: 210–213. 1904.

Six nutating plants. Ohio Nat. 5: 214–215. 1904.

Leaf expansion of trees and shrubs. Ohio Nat. 5: 363. 1905.

Artificial parthenocarpy. Jour. Heredity 26: 261–262, Fig. 1. 1935.

2. Self-pruning

Notes on the self-pruning of trees. Ohi. Nat. 1: 29–32, Fig. 1–4. 1901. (With F. J. Tyler.)

The self-pruning of woody plants. Ohio Nat. 2: 171–174, Fig. 1. 1902.

Observations on self-pruning and the formation of cleavage-planes. Ohio Nat. 3: 327–330. 1902.

Additional observations on self-pruning. Ohio Nat. 6: 450–451. 1906.

How plants shed their branches. Ohio State Univ. Agric. Coll. Ext. Bull. 5(4): 4–10. 1909.

3. Rejuvenation

The change of opposite to alternative phyllotaxy and repeated rejuvenations in hemp by means of changed photoperiodicity. Ecology 7: 315–325, Fig. 1. 1926.

Further experiments in repeated rejuvenations in hemp and their bearing on the general problem of sex. Amer. Jour. Bot. 15: 77–85, Fig. 1. 1928.

4. The control and reversal of sex.

Complete reversal of sex in hemp. Science II 50: 311–312. 1919.

Influence of environment on sexual expression in hemp. Bot. Gaz. 71: 197–219, Pl. 11, Fig. 1. 1921.

Reversal of the sexual state in certain types of monecious inflorescences. Ohio Jour. Sci. 21: 185–198, Pl. 1–2. 1921.

Control of the sexual state in *Arisaema triphyllum* and *Arisaema dracontium*. Amer. Jour. Bot. 9: 72–78. 1922.

Sex reversal in the Japanese hop. Bull. Torrey Bot. Club 50: 73–79, Pl. 23. 1923.

The influence of relative length of daylight on the reversal of sex in hemp. Ecology 4: 323–334. 1923.

Experiments with various plants to produce change of sex in the individual. Bull. Torrey Bot. Club 52: 35–47. 1925.

The influence of the substratum on the percentage of sex reversal in winter-grown hemp. Ohio Jour. Sci. 25: 172–176. 1925.

Siamese twins of *Arisaema triphyllum* of opposite sex experimentally induced. Ohio Jour. Sci. 26: 276–280, Fig. 1. 1926.

Control of sex reversal in the tassel of Indian corn. Bot. Gaz. 84: 440–449, Fig. 1–3. 1927.

Fluctuation of the point of sex reversal in *Sagittaria latifolia*. Amer. Jour. Bot. 16: 191–195. 1929.

Progeny resulting from self-pollination of staminate plant of *Morus alba* showing sex reversal. Bot. Gaz. 87: 653–659. 1929.

Sex reversal and the experimental production of neutral tassels in *Zea mays*. Bot. Gaz. 90: 279–298, Fig. 1–4. 1930.

The fluctuation curve of sex reversal in staminate hemp plants induced by photoperiodicity. Amer. Jour. Bot. 18: 424–430, Fig. 1. 1931.

The production of vestigial and sterile sex-organs through sex-reversal and neutral sexual states. Bull. Torrey Bot. Club 60: 89–97. 1933.

Offspring of a self-pollinated reversed carpellate plant of *Morus alba*. Bot. Gaz. 98: 425–428. 1936.

5. Miscellaneous

Demonstration of the flow of latex in the stipules of *Ficus elastica*. Jour. App. Micros. 1: 201. 1898.

Plants with nodding tips. Ohio Nat. 5: 267, Fig. 1. 1905.

Nodding of the terminal heads of *Silphium laciniatum*. Ohio Nat. 7: 39. 1906.

The diurnal nodding of the wild carrot and other plants. Ohio Nat. 12: 474–475. 1912.

The sprouting of the two seeds of the cocklebur. Ohio Nat. 14: 216–217. 1914.

Propagation of *Equisetum* from sterile aerial shoots. Bull. Torrey Bot. Club 58: 531–535. 1932.

VII. MORPHOLOGY

1. Life cycles

Contributions to the life-history of *Sagittaria variabilis*. Bot. Gaz. 23: 252–273, Pl. 20–26. 1897.

Contribution to the life history of *Lilium philadelphicum*. The division of the macrospore nucleus. Bot. Gaz. 23: 430–452, Pls. 37–39. 1897.

A contribution to the life history and cytology of *Erythronium*. Bot. Gaz. 31: 369–387, Pl. 4–9. 1901.

The life cycle of an Angiosperm. Gamophyllous 1: 57–59, 65–67. 1901.

The life cycle of a Gymnosperm. Gamophyllous 3: 17–21, Pl. I. 1903.

The life cycle of a heterosporous pteridophyte. Ohio Nat. 5: 255–260. Fig. 1. 1905.

Sexual and non-sexual generations. Ohio Nat. 6: 473. 1906.

The life cycle of a homosporous pteridophyte. Ohio Nat. 6: 483–488, Fig. 1. 1906.

2. Floral structure and development

The development of the stamens and carpels of *Typha latifolia*. Bot. Gaz. 24: 93–102, Pl. 4–6. 1897.

A general system of floral diagrams. Ohio Jour. Sci. 16: 360–364, Pl. 27. 1916.

The flowers of the golden-club. Amer. Bot. 43: 99–103. 1937. (Illus.)

The fundamental nature of the flower. Bull. Torrey Bot. Club 64: 569–582, Pl. 12, 13. 1937.

3. Equisetum

The air cavities of *Equisetum* as water reservoirs. Ohio Nat. 9: 393–394. 1908.

Spiral shoots of *Equisetum*. Amer. Fern Jour. 17: 43–46, Pl. 2. 1927.

The occurrence of three and four-angled branches in *Equisetum arvanse*. Amer. Fern Jour. 19: 24–26. 1929.

The flowers of *Equisetum*. Amer. Fern Jour. 19: 77–82. 1929; 119–126, Pl. 8, 9. 1930.

Six interesting characters of sporadic occurrence in *Equisetum*. Amer. Fern Jour. 23: 83–90, Pl. 4. 1933.

Random observations on *Equisetum*. Amer. Fern Jour. 25: 6–11. 1935.

Root hairs of *Equisetum praealtum* Raf. Amer. Fern Jour. 28: 122. 1938.

4. Miscellaneous

Petioles of the cottonwood. Ohio Nat. 1: 28. 1901.

Perennial tumbleweeds. Ohio Nat. 1: 67–68. 1901.

Ohio plants with contractile roots. Ohio Nat. 3: 410. 1903.

Deciduous leaves. Ohio Nat. 4: 163–166. 1904.

Some morphological peculiarities of the Nymphalaceae and Helobiae. Ohio Nat. 4: 83–92. 1904.

Ohio plants with extra floral nectaries and other glands. Ohio Nat. 4: 103–106. 1904.

The jacket layer in Sassafras. Ohio Nat. 4: 192–193, Fig. 1. 1904.

Twigs of the common hackberry. Ohio Nat. 5: 215–216. 1904.

Mat plants. Ohio Nat. 5: 265–266. 1905.

Ohio plants with extra floral nectaries and other glands. Ohio Nat. 6: 399. 1906.

Winter buds of Ohio trees and shrubs. Ohio Nat. 6: 505–507. 1906.

Leaf markings of certain Ohio plants. Ohio Nat. 11: 243–245. 1910.

Leaf markings of plants. Amer. Bot. 17: 5–10. 1911.

The North American lycopods without terminal cones. Ohio Nat. 12: 497–499, Fig. 1–4. 1912.

Peculiar varieties of *Amaranthus retroflexus*. Ohio Nat. 15: 469–471, Fig. 1. 1915.

Unusual dichotomous branching in *Vernonia*. Ohio Jour. Sci. 19: 487–490, Fig. 1. 1919.
Dichotomous branching in *Equisetum*. Amer. Fern Jour. 14: 56–57. 1924.
Ginkgo, a flowerless seed plant. Amer. Jour. Bot. 14: 126–128, Fig. 1. 1927.
Spiral systems in the vascular plants. Bull. Torrey Bot. Club 65: 507–529. 1938.

VIII. Laboratory Procedure

1. Histological methods

An improved paraffin embedding dish. Jour. App. Micros. 1: 11. 1898.
A permanent stain for starch. Jour. App. Micros. 1: 181. 1898.
Imbedding spores and pollen grains. Jour. App. Micros. 1: 202. 1898.
A suggestion to slide box makers. Jour. App. Micros. 1: 224. 1898.
General methods in botanical microtechnique. I. Jour. App. Micros. 2: 225–227 (No. 1). 1899.
General methods in botanical microtechnique. II. Jour. App. Micros. 2: 257–260 (No. 2). 1899.
A convenient washing apparatus' Jour. App. Micros. 2: 226. 1899.
A good killing fluid. Jour. App. Micros. 2: 465. 1899.
A design for a convenient staining dish. Jour. App. Micros. 2: 559. 1899.
Note on staining stems, roots and rhizomes. Jour. App. Micros. 2: 284. 1899.
Note on permanent mounts of pollen. Jour. App. Micros. 2: 341. 1899.
A differential stain for cell structures. Jour. App. Micros. 3: 799. 1900.
Mounting in glycerine. Jour. App. Micros. 3: 961. 1900.

2. Other laboratory methods

The laboratory notebooks. Jour. App. Micros. 3: 887–888. 1900.
Note on microscope cover. Jour. App. Micros. 3: 888. 1900.
Collecting and preserving microscopic plants. Ohio Nat. 1: 16. 1901.
Oculars for general laboratory work. Jour. App. Micros. 5: 1646. 1902.

3. Laboratory outlines

Laboratory outlines, I. Jour. App. Micros. 5: 1639–1645 1902.
Laboratory outlines, II. Jour. App. Micros. 5: 1698–1700. 1902.
Laboratory outlines, III. Jour. App. Micros. 5: 1798–1799. 1902.
Laboratory outlines, IV. Jour. App. Micros. 5: 1852–1854. 1902.
Laboratory outlines, V. Jour. App. Micros. 5: 1896–1897. 1902.
Laboratory outlines, VI. Jour. App. Micros. 5: 1934–1935. 1902.
Laboratory outlines, VII. Jour. App. Micros. 5: 2013–2014. 1902.
Laboratory outlines, VIII. Jour. App. Micros. 5: 2055–2056. 1902.
Laboratory outlines, IX. Jour. App. Micros. 5: 2093–2094. 1902.
Laboratory outlines, X. Jour. App. Micros. 6: 2134–2135. 1903.
Laboratory outlines, XI. Jour. App. Micros. 6: 2185–2186. 1903.
Laboratory outlines, XII. Jour. App. Micros. 6: 2237–2239. 1903.
Laboratory outlines, XIII. Jour. App. Micros. 6: 2275–2277. 1903.
Laboratory outlines, XIV. Jour. App. Micros. 6: 2330–2332. 1903.
Laboratory outlines, XV. Jour. App. Micros. 6: 2387–2388. 1903.
Laboratory outlines, XVI. Jour. App. Micros. 6: 2471-2474. 1903.
Laboratory outlines, XVII. Jour. App. Micros. 6: 2517–2522. 1903.
Laboratory outlines, XVIII. Jour. App. Micros. 6: 2571–2576. 1903.
Laboratory outlines, XIX. Jour. App. Micros. 6: 2611–2627. 1903.
Laboratory outlines, XX. Jour. App. Micros. 6: 2689–2700. 1903.
Laboratory outlines for general botany. 93 pp. Columbus, Ohio. 1905.
Laboratory outlines for general botany. 2d ed. 101 pp. Pub. by the author. 1908.
Laboratory outlines for general botany. 3rd ed. 125 pp., Pl. 1, 2; Fig. 1–17. Columbus, Ohio. 1913.
Laboratory outlines for general botany. 4th ed. 128 pp. Pub. by the author. 1915.

IX. MISCELLANEOUS

1. "News and Notes," etc.

The Botanical Department of Ohio State University. Jour. App. Micros. 1: 188. 1898.
Announcement. Ohio Nat. 1: 1–2. 1900.
News and notes. Ohio Nat. 1: 48. 1901.
News and notes. Ohio Nat. 1: 106. 1901.
Notice of A. J. Pieters' work on plants of western Lake Erie. Ohio Nat. 2: 166. 1901.
News and notes. Ohio Nat. 4: 23–24. 1903.
News and notes. Ohio Nat. 4: 47. 1903.
News and notes. Ohio Nat. 4: 47. 1903.
News and notes. Ohio Nat. 4: 74. 1903.
News and notes. Ohio Nat. 4: 148. 1903.
News and notes. Ohio Nat. 9: 394–395. 1908.
A new laboratory guide for High School botany. Ohio Nat. 10: 40. 1910.
Introductory, "Ohio Jour. Sci." Ohio Jour. Sci. 16: 1–2. 1915.

2. Terminology

On the use of some common botanical terms. Ohio Nat. 2: 215–218. 1902.
Terminology of organs in various conditions of development. Ohio Nat. 6: 541–544. 1906.

3. Pathology

Injurious fungus parasite of *Equisetum*. Amer. Fern Jour. 21: 75. 1931.

4. Zoology

Chromosome difference in *Ascaris megalocephala*. Ohio Nat. 9: 506–508. 1909.
A duck with webless feet. Ohio Jour. Sci. 23: 207–208. 1923.
Extension of the natural range of two mammals in Clay County, Kansas. Trans. Kans. Acad. Sci. 31: 61–62. 1929.

If we attempt to cast into form some of the outstanding achievements indicated by the long list of writings perhaps the following may serve:

1. Contains the first report for Botanical Science of the behavior of the chromosomes in the process of meiosis. This cytological advance embodied in the paper on *Lilium* in 1897 antedated by two or three years the rediscovery of Mendel's work.

2. The diagrammatic representation of life cycles now extensively used in text books first appeared in the published works of Professor Schaffner.

3. These papers contain the first complete series of illustrations of the embryology of a seed plant. As in the above case, these illustrations have been widely used in text books, or have been the suggestion for further research.

4. From morphological studies there developed a system of plant taxonomy differing from the widely used European systems but finding substantiation and agreement in the testing of natural relationships of serological methods.

5. Constantly upheld the stand that sex inheritance cannot be regarded for most organisms in the same light as simple Mendelian traits. In such organisms as possess a special chromosome associated with sex and in which sex reversal has not yet been shown to occur, Professor Schaffner took the position that sex is part of a physiological reaction system distinct from the Mendelian system.

6. Demonstrated experimentally principles of sex reversal. By the use of physiological and ecological methods Professor Schaffner was able to show that sex expression could be controlled. Vegetative divisions or "Siamese twins" cuold be developed as male or as female, in response to environmental conditions.

7. Through the examination of neutral states and the existence of inter-sexes in a wide range of forms in the plant kingdom, showed that only where the time of sex determination coincided with the reduction processes could sex expression appear to resemble superficially ordinary Mendelian expression.

8. Upheld the principle that all Mendelian inheritance is superimposed upon the fundamental inheritance in organisms.

9. Demonstrated the major evolutionary trends in the plant kingdom by an original system of comparative study.

10. Outlined the evolution of potentialities in the plant kingdom.

11. Became internationally recognized as an authority on the genus *Equisetum* and contributed numerous revisions to the interpretation of this group.

12. Since the subject of *Equisetum*, and the works on reproduction and sex reversal are of such paramount interest, a brief additional classification of these items is appended.

SPECIAL CLASSIFICATIONS:

Equisetum.

1. Taxonomy	15
2. Ecology	4
3. Physiology	1
4. Morphology	7
5. Pathology	1
	28

Sex and Reproduction.

1. The nature and determination of sex	20
2. The control and reversal of sex	16
3. Life cycles	8
4. Floral structure and development	4
5. Cytological studies	8
6. Nutations	3
	59

MEMORABILIA

The passing of a great mind that has been an inspiration for others always brings recollections. We have shared a personality, we have momentarily apprehended a vision that is not ordinary. We build into a great picture only if we do not try to pretend that the subject of our thought was without weakness. From a number of letters from which the following statements are quoted the reader will find some of those endearing human traits not always perceptible in reviewing the accomplishments of a creative worker. I wish here to express my appreciation to the authors of the letters written to me, and to thank Mrs. Schaffner for the first one quoted. Not all letters received have been used, since the same thought was expressed by different writers.

WILLARD M. KIPLINGER, Washington, D. C.

"I remember the days when Professor Schaffner showed us that scum from the lake was full of marvels. I remember the classes in the old building which, they now tell me, is to be torn down. I remember the occasional gentle exasperation of Prof. Schaffner over the laggard understanding of the boys and girls that botany was a science, and not "just leaves." I remember our wide eyes when we were told that in some European universities Ohio State University in America was known merely as the location of Professor Schaffner. I remember when you and he were married. And now the years have passed and you have three children for which I am glad. And you have lost him, and we have lost him, and I'm sorry."

CHARLES J. CHAMBERLAIN, University of Chicago.

"Schaffner came to the University of Chicago in the autumn of 1896, attracted by the prestige of John Merle Coulter, who had become our first Head Professor of Botany. He was doubtless attracted also by the brilliant young palaeontologist, Dr. George Bauer, who had excellent material from the Galapagos Islands. He studied throughout the year with Bauer. His principal work, however, was in botany. Schaffner knew that most of Coulter's work had been of the "Gray's Manual" type of botany, but he also knew that Coulter was dissatisfied with the Rochester Code and was making the Engler and Prantl system, with its series of evolutionary lines, the basis for a more natural taxonomy.

This system, with a series of life histories, was the basis for the earlier courses in morphology at the University of Chicago.

Schaffner took the advanced morphology in Gymnosperms and Angiosperms. He also engaged in research in morphology throughout the year and published two papers which became classics, the life history of Sagittaria and the Macrospore Nucleus of *Lilium philadelphicum*.

On account of the unfortunate wording of the title of the *Lilium* paper, it was many years before Schaffner received the credit he deserved. In this paper he proved that Strasburger and Guignard, leaders in cytology of that day, were wrong in their claim that in the reduction of chromosomes in Angiosperms, there is a double longitudinal splitting. Schaffner described a transverse splitting at the second division. Later it was shown that Schaffner's transverse splitting was a separation of whole chromosomes. This, however, was comparatively unimportant, because Schaffner had proved a qualitative division in the Weissman sense instead of a quantitative division as Strasburger and Guignard claimed. Schaffner's figures show the situation as it is now seen with the most approved technique.

Schaffner was a profound thinker and an enthusiastic investigator, full of initiative, and he brought to our new department as much as he gained from it.

Schaffner and I became warm friends and, although technically I was instructor and he student, our relations were throughout those of colleagues.

He probably thought I was somewhat in advance, at least in taxonomy, but this was really not the case. For two seasons an undergraduate who had tramped the Chicago area for years with the Professor of Botany of the old University had

taken me with him to collect material for classes made up largely of high school teachers. He knew all the ferns, flowers, and shrubs, so that I already knew many of the plants of the dunes region which were new to Schaffner.

Schaffner came to the University of Chicago expecting to take the Ph. D. degree, but in the spring quarter he was called to Ohio State University.

Schaffner and I have kept in contact with each other, and I regard him as one of the foremost botanists our country has ever produced."

H. A. GLEASON, New York Botanical Gardens.

"I was 22 years old when I applied and received a fellowship at Ohio State University. Having lived in the college town where I received my undergraduate training, it was also my first year away from home. For this reason, as well as my age, I was in a rather receptive mood and I had not been at Ohio State very long before I began to profit by my contact with Schaffner. Officially, I had nothing to do with him. I was assistant to Kellerman; as such I had charge of the herbarium, helped Kellerman in one or two of his classes, and during the first term registered for work under him in the graduate school. From this work I learned nothing, nor did I absorb much more from the minor courses which I took outside the Department of Botany. As a result, I did little or no class work during the second term, and had not registered at all during the third term.

I must have become acquainted with Schaffner very shortly after my arrival in Columbus. He was then a tall and very bashful man in his thirties. He occupied the very poorly equipped laboratories on the second floor of the old botany building, consisting, as I recall them, of one room of about 15x30 and another about 15x15. I do not remember whether he had an office of his own, or not. In the larger room were a few tables and a long table built against the wall, extending one full side and across one end. Here his handful of students sat on stools to carry on their laboratory work which was mostly morphological in nature. From time to time, I used to listen to his lectures. These were delivered to the floor, not to the students, in a sort of rambling, drawling monotone. I do not think his students, sophomores and juniors mostly, got much instruction or inspiration from them.

Schaffner and several of the graduate students were inveterate workers. I arrived at the building every morning at 7:45, and, except for two intervals for meals, kept steadily at it until eleven in the evening. Schaffner was always there late in the afternoon, and very frequently back again at night. Then with none of the formality of the classroom, we had dozens of interesting discussions, all of Schaffner's bashfulness and diffidence was forgotten and the arguments swept back and forth from one to the other until it was time to go home and to bed. Our discussions were mostly on evolution and phylogeny and Schaffner was loaded to the brim with ideas on both. Today, I do not remember a single point which was brought out in any of these numerous discussions, but I can say that the importance of phylogeny was so firmly impressed upon my mind that it was never forgotten, and that as a result I have consistently ever since attempted to introduce phylogenetic ideas into all of my taxonomic research.

The first Mrs. Schaffner was then alive. I must have seen her several times; I remember nothing about her activities or interests. I picture her now as a comparatively small but plump woman with a round rather attractive face and black hair, smoothly brushed down. It seems to me also that Schaffner addressed her as Mabel.

The graduate students at that time, if this will be of any interest to you, included Lumina Riddle, Clara Mark, Mabel MacKinley, Caroline Cormack, Jim Macowen, H. H. York, and myself. There may have been a few others; if so, I have forgotten them. We used to have many good times together, to which Kellerman and Schaffner were sometimes invited, and which they always seemed to enjoy very greatly. I remember one of these on Hallowe'en in 1904, when the girls cooked an oyster supper in the laboratory with the two professors as our guests.

H. H. York, as you must know, is now Professor of Botany at the University of Pennsylvania and it is possible that he can give you some further light on Schaffner. I have no idea what has happened to the others."

B. W. WELLS, North Carolina.

"As my mind goes back to the Ohio State days and I view the scene with the long perspective of twenty-eight years, one of the few monadnock's rising sharply from the campus plain is the towering intellect of Professor Schaffner. It was this quality of intellectual vigor and the tremendous range of his knowledge which resulted from it, that made Professor Schaffner one of the greatest botanists of his time. To have studied under him was one of the special privileges of my life.

As an undergraduate I worked in the 'Old Botany Building' above the Spring. There in addition to the prosecution of his cytological and systematic researches which he energetically carried on with his teaching, he had another self-imposed duty and that was the protection of the museum from the rain. As regularly as the showers came Professor Schaffner would quickly distribute the nondescript collection of pans, knowing from long experience just where the worst leaks were located. Instead of allowing the disturbing influence of a disintegrating building to affect him, he compensated for the building's deficiencies and carried on—the work, his botanical study was above everything to him and he conveyed this enthusiasm to his students who sometimes needed it when they too suffered from the rain or cold.

Professor Schaffner was at his best in conversation with his students and associates. He was almost a spendthrift with his time when it came to helping his students to a deeper insight into the special fields in which he was interested. I profoundly realize now that many horizons are broader today simply because Professor Schaffner took me on some of his long excursions in the realm of scientific and philosophical biology

It is with greatest satisfaction that I record my profound appreciation of the personality and activities of one of the most virile and original thinkers, painstaking investigators and inspiring teachers who has appeared in the field of American Botanical Science."

ROBERT F. GRIGGS, George Washington University.

"John H. Schaffner was one of the two or three men who most influenced my development. Upon analysis of my debt to him as compared with that to others who took the trouble to give of themselves to a young boy, it becomes clear that he contributed more to my store of factual materials and more especially to the biological principles developed from those facts than did any other.

He had, it seems to me, two outstanding endowments. The first I have already suggested. His remarkable mind. The second would come under the head of heart.

He had none of those easy tricks of a good mixer which make it possible for a man really of mediocre caliber, of the cheer-leader type, to carry with him a noisy crowd of rotarians, and so Schaffner was short of what commonly goes by the name of 'personality.' But he had something far finer though it did not bring him so much in the way of promoting his own advancement.

I have seen him sit by the hour discussing philosophy and religion with some student who after being brought up in a narrowly orthodox home found himself all at sea in the free atmosphere of the university. Not a few of our alumni, who have lived the most valuable lives, owe their orientation to his clear vision of fundamental moral and religious issues and his willingness to help them over the difficult transition from juvenile to adult philosophy.

I have often wished I knew more of his early years. Growing up largely alone on the Kansas prairie he never had the training in dealing with people which would have made him a leader of men. But somewhere in that lonely farmhouse there must, I think, have been keen intellects which contributed a rich heritage, and trained the mind of the boy in no ordinary fashion. One thing that makes me think that at least one of his parents must have had an exceptional mind is the fact that his sister was for a long time consultant to the Wisconsin legislature, drafting laws and advising as to social and legal progress the world over—certainly a position which required a high order of intellectual discrimination.

Schaffner's mind had a most remarkable clarity, carrying him straight to correct conclusions regardless of authoritative opinion to the contrary. Perhaps the best illustration of this quality was his early discovery, before the turn of the century, that there was a true reducing division in the meiosis of plants. In those

days the dogma of the great German cytologist, Strasburger, ruled American laboratories to such an extent that they could see only what Strasburger had found. Strasburger held that the reduction division consisted of two equational splits of the chromosomes, so that any differential sorting out of chromatin material between the daughter cells was impossible. Schaffner, studying his slides saw a true reduction division, insisted on it, and would not recant. But his professors would not let him publish his results and he was not sufficiently pugnacious to fight the matter through to a successful issue. A year or two later Mendel's law was rediscovered, it became clear that a true reduction was required to explain the facts of alternative inheritance. Then everybody could see what he had found and reducing divisions were described from every laboratory.

If Schaffner could have dominated authority and compelled the publication of his findings, he would have become the leader in the new cytology which developed our present far flung chromosome theory of heredity."

FIRMAN E. BEAR, Rutgers, New Jersey.

"Professor Schaffner was an embodiment of the best in a man of science. His vast store of knowledge in his field made him so humble that folks passed him by without realizing who he was, or what he stood for. I am glad to have been numbered among his students and friends."

L. E. MELCHERS.

"The passing of Prof. John Henry Schaffner brought definite memories of him and Ohio State back to me.

The opportunity to have had worked with a man of his character and ability is an enviable experience. Why, as a student, was I drawn to Prof. Schaffner and what did I admire about him?

I admired his modest, unassuming, unselfish manner; characteristic of his everyday life. He never was too busy with his own research and interests to assist students and seemed especially patient in helping someone who could not comprehend some point in botany. I still can see him explaining a point to some student, spending hours, first from one approach then from another angle.

I remember Professor Schaffner best in the environment of the 'old botany building,' where I studied botany at Ohio State. He created an atmosphere which I enjoyed. The old, inadequate, under-equipped botany building, long ago a thing of the past,[10] was my choice of places on the campus—it wasn't the building that counted—there was my teacher who was a master of numerous fields of botany. I loved his enthusiasm, his sense of humor, his contagious chuckle, for he always could see a funny side of things. The loyalty to his host of friends and his helpfulness to a fellow in trouble was well known. Little did I dream that I would locate in the state most often mentioned by him—Kansas. He inspired me to seek the truth, to be alert and accurate in my observations, and certain of my conclusions.

I shall not review his scientific contributions, but I wish to mention one of the many, which is outstanding; his work on the 'nature and control of sex.' John H. Schaffner in the botanical world is a famous name. Well may Ohio State be proud of having had on its roll such a faculty member. It is a cherished memory to have studied with this teacher and to have had him as my friend."

A. B. STOUT, New York Botanical Gardens.

"There are nearly fifty reprints in my files that bear the name 'John H. Schaffner' and several of these have the handwritten notation 'With the author's regards.' Most of these publications deal with the phenomena of sex in plants. They emphasize the physiological and developmental aspects of sex expression. They survey in a very comprehensive way sex behavior in the entire plant kingdom. There are extensive observations of the actual conditions and there are numerous important results of experimental studies, especially on the influence of

[10]This building was turned over to the State Department of Health when the present Botany and Zoology Building was completed in 1914.

environmental factors on the expression of sex. To me these papers have, through these various years, brought much of inspiration and I for one am glad to record my indebtedness to the work and the writings of John H. Schaffner."

CHAS. C. DEAM, Bluffton, Indiana.

"My personal acquaintance with Professor Schaffner began at an annual meeting of the A. A. A. S. about 30 years ago. He religiously attended the meetings of the American Association of Science and I met him almost annually at them. I associated with him at these meetings more than with anyone else. I found him always the same congenial fellow. His habits were exemplary. His life from boyhood to the end was one of simplicity. His deportment, language, and his writings all follow this law of simplicity. His writings evince a vast store of fundamental knowledge which he used to work out his theory of plant evolution. This achievement will always remain as a monument to his industry, research, and logical study.

As a teacher he was unexcelled. I know two of his pupils who now hold the chair of botany, one in a college and one in a university, who told me of his ability and how they revered him. His hobby, a study of the Equisetaceae, made him the foremost authority on the genus Equisetum of North America. When discussing with him the Indiana Equiseta, I recall how well he knew our species in every detail. The achievements of Prof. Schaffner are surely enough to satisfy the aspirations of the most ambitious."