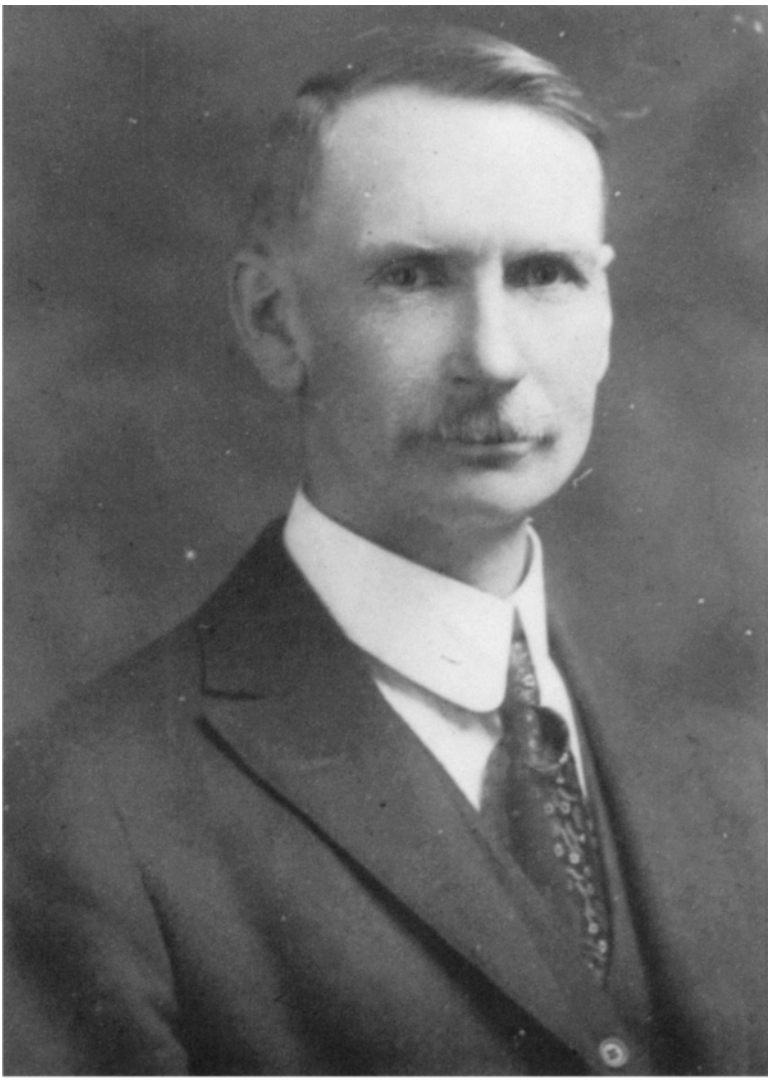

C. L. Shear

Annu. Rev. Phytopathol. 2000. 38:19–29

C.L. SHEAR: Gifted Mycologist, Plant Pathologist, and APS Founder

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Key Words USDA, plant pathology history, American Phytopathological Society, cotton root-rot, cranberry diseases, black rot of grape

■ **Abstract** Cornelius Lott Shear was one of the most influential plant pathologists of the early twentieth century. He was first and foremost an excellent mycologist who did pioneering research on pathogenic fungi and, as a senior pathologist with the USDA's Bureau of Plant Industry, studied important crop diseases and offered useful control measures. Shear's successful research enhanced his reputation among his fellow pathologists and allowed him to embark on what was perhaps his most significant contribution to plant pathology, his pivotal role in the creation of the American Phytopathological Society in 1908. Shear felt that an independent society dedicated to the unique needs of plant pathologists would facilitate communication and cooperation among practitioners. Between his scientific research and his role in the creation of APS, Shear stands out for the enormous impact he had on his science.

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INTRODUCTION

C. L. Shear is best remembered for his contributions to systematic mycology in the late nineteenth and early twentieth centuries. His reputation as a gifted mycologist began with the publication of three centuries of his exsiccati, *New York Fungi*, between 1893 and 1896. By 1910, he had become a recognized authority on the Pyrenomycetes. His life history studies, for example, helped untangle confusion in the genus *Glomerella*. His thorough investigations of *Endothia* established the Asiatic origin of the chestnut blight fungus. Later, with B.O. Dodge, he would

publish a classic paper on *Neurospora*. There also were many careful studies on fungal nomenclature (10).

Less known, however, are C.L. Shear's contributions to plant pathology. In the first decades of the twentieth century, at a time when plant pathology was rapidly gaining acceptance and prestige in America, Shear had the expertise to adapt his mycological skills to agriculture. The results were several key investigations of diseases of economic plants with significant contributions to fundamental knowledge as well as applied benefits to growers. Moreover, Shear's excellence as a practitioner in the developing science of plant pathology gave him the credibility and stature to serve as a leader in the science and to become a major figure in the founding of the American Phytopathological Society (APS). Through the efforts of Shear and several other key individuals, the establishment of the APS in 1908 signaled in no small way "that phytopathology was a discipline of growing prominence and one worthy of recognition among the ranks of the biological and agricultural sciences" (2).

THE EARLY DAYS

Cornelius Lott Shear was born near Albany, New York, on March 26, 1865, during the last months of the American Civil War and only 17 days before the assassination of President Abraham Lincoln. The son of Henry and Mary (Speenburg) Shear, Cornelius grew up in a rural, agricultural setting and attended country schools. In 1888, he graduated from Albany State Normal School, where he had studied under Edward A. Burt, noted mycologist and teacher. In Albany, Cornelius came to know the influential New York State mycologist, Charles Peck, and began his first mycological collections with Peck's assistance (3). Shear corresponded regularly with Peck through the coming years and the elder mycologist would continue to have a major influence on Shear's professional career. Peck helped identify and name the fungi that Shear collected from New York and later from Nebraska and Washington, DC (30).

After graduation from Albany Normal, Shear taught school and tried his hand at bookkeeping (29). At one teaching post in Scarsdale, NY, he had the opportunity to visit nearby New York City where he met local botanists who encouraged his mycological interests. It was during this time that his first botanical note was published in the *Bulletin of the Torrey Botanical Club*. He also purchased a microscope "to examine the spores of most of the fungi I collected" and, following Charles Peck's advice, purchased his first mycological text, Plowright's *British Uredinae and Ustilaginea* (29). He actively collected the fungi of the region, began to work on his exsiccati, *New York Fungi*, and published popular accounts of common mushrooms as his first papers in mycology (30).

While teaching grammar school in Stockbridge, Massachusetts, Shear met Avis M. Sherwood whom he married on December 25, 1890. Four years later, the couple moved to Osborne, Kansas, to live with her parents, who had moved recently

from western New York. In Kansas, he taught a term of country school and collected sets of flowering plants to be sold to universities and herbaria. Before long, having studied Charles E. Bessey's *Botany for High School*, Shear wrote to Bessey about the possibility of study at the University of Nebraska. Bessey was one of America's leading botanical teachers as well as a prominent figure in the development of plant pathology in the United States. He knew of Shear's work, having favorably reviewed the first century of *New York Fungi* in the *American Naturalist*, so Bessey offered Shear an undergraduate fellowship of $250 for 10 months of study (29, 30). Shear feared that if Bessey knew that he was married with two children, "the good Doctor would have hesitated about giving me the appointment." But Bessey accepted the circumstance anyway. Shear would later recall as "the thing that I was most proud of perhaps, was the fact that Dr. Bessey had me listed on the Department letterheads as one of his assistants" (29). During his continuing undergraduate education in Nebraska, Shear became acquainted with fellow students such as E.A. Bessey, F.E. Clements, R. Pound, and A.F. Woods, all of whom would go on to noted careers in the plant sciences.

During his early years at the University of Nebraska, Shear became associated with the United States Department of Agriculture (USDA). The USDA was quickly becoming the center for agricultural research in the United States. Since the 1880s, it had nurtured agricultural science, including the study of plant diseases, with steadily rising budgets because of the Department's legislative mandate to provide aid to farmers by whatever means, practical or scientific. To meet this mandate, the USDA required a corps of trained scientists, a requirement that offered an industrious student like Shear a promising future. With Bessey's recommendation, Shear secured a two-year appointment during the summer months as a special agent for the USDA's Division of Agrostology. His mission was "to collect grasses, grass roots, grass seeds, and seeds of other plants which are recognized as having, or may have, forage value" throughout the West and Midwest (11). His supervisor was Frank Lamson-Scribner, USDA Agrostologist and, like Bessey, a plant pathology pioneer. Scribner was "very well pleased" with Shear's collections (12). Soon after Shear graduated with a B.S. degree in 1897, Scribner helped him secure a permanent appointment as assistant agrostologist for the USDA. Shear worked in this position for the next three years while he continued his studies at Nebraska for an M.A. degree.

THE TALENTED PLANT PATHOLOGIST

In 1901, having obtained his Master's degree, Shear followed his interest in fungi and transferred to a position as an assistant plant pathologist in the newly created USDA's Bureau of Plant Industry (BPI). The next year Shear was promoted to the position of pathologist in the BPI's Office of Vegetable Pathological and Physiological Investigations. Among his earliest and most significant investigations were those involving various diseases of the cranberry, Texas root-rot of cotton,

and black rot of the grape. His research in the laboratory, together with thorough field and greenhouse studies, particularly with cranberry diseases and cotton root-rot, provided etiological explanations for these diseases as well as effective control strategies.

At the request of the American Cranberry Growers' Association and the New Jersey State Agricultural Experiment Station, Shear began to investigate diseases of the cranberry in 1901. Continuous plantings for many years in the Middle Atlantic and some New England states, especially in the old cranberry bogs of New Jersey, had created conditions favorable for the development and dispersal of several fungal pathogens that were becoming of increasing economic concern for growers (13). One of the first objectives of Shear's research was to sort out the confusing etiology of cranberry diseases. His mycological skills took center stage. Growers, for instance, had used the term "scald" to refer to a single disease. Shear's mycological studies, however, demonstrated for the first time that instead of one disease, "scald" actually included three distinct and destructive diseases of the fruit—scald, rot, and anthracnose—caused by three different fungal pathogens, *Guignardia vaccinii* Shear, *Acanthorhynchus vaccinii* Shear, and *Glomerella rufomaculans vaccinii* Shear. Shear also discovered the etiology of a fourth major fungal disease of cranberry caused by *Exobasidium oxycocci*, which he called "hypertrophy" (15). Shear's life history studies revealed much about these fungi with respect to various spore forms, growth requirements, and reproduction.

With this knowledge about the causal pathogens in hand, Shear soon turned his attention to control. He collected and studied data on the effects of water supply, so crucial to cranberry culture, the benefits of the destruction of dead vines, and the possibilities of resistant cultivars. His major focus, however, was on chemical treatment, particularly with respect to the much-heralded copper sulfate and lime compound known as the Bordeaux mixture. Since the introduction of copper spray compounds in the mid-1880s, a revolution had occurred in the chemical control of certain plant diseases (8). His field experiments centered on preparation of the mixture, methods of application, as well as the frequency and timing of sprays. His work showed that the addition of resin-fishoil soap to the Bordeaux aided significantly in leaf coverage and adherence. Shear also demonstrated that at least five applications of Bordeaux mixture should be made during the season and that the interval between applications should not exceed 15 days. Results from his 1905 field trials indicated that with five applications, only 2.36% of sprayed fruit was destroyed at harvest compared with 92% of unsprayed fruit (14, 15).

Shear had provided information on fundamental biology of important cranberry pathogens and effective control strategies. For his studies of cranberry diseases, he received a PhD degree from George Washington University in 1906. He also had won the affection of the cranberry growers. When the American Cranberry Growers' Association celebrated its 40th Anniversary in 1909, organizers insisted that "as the man who worked out our most difficult problems, it is eminently fitting that you should be one of our honored guests" (9).

In 1902, Shear split his assignment on cranberry diseases to investigate a highly destructive root-rot disease on cotton occurring in Texas and other parts of the Southwest. The boll weevil may have been on everyone's mind in the region, but the root-rot disease, characterized by the sudden wilting and dying of cotton plants, had acquired its own share of attention. In fact, as Shear reported, "some planters have expressed the opinion that this disease is at present a more serious menace to the cotton crop of Texas than the boll weevil." It was estimated that Texas planters alone suffered between $2 and $3 million in losses annually (17).

Against the prevailing local opinion that the disease originated from the presence of alkali in the soil, Shear provided the scientific proof that a soilborne fungus, which he named *Ozonium omnivorum*, was the actual cause of the cotton disease (16). Under his direction, the USDA conducted three main lines of research over the next five years aimed principally at finding an effective control: the investigation of chemical applications to the soil; the selection of resistant cultivars; and experiments with cultural practices and crop rotation (17, 19).

Whereas the investigations of chemical soil treatments and resistant cultivars produced little tangible success, experiments with cultivation practices were bright spots. Shear's field experiments on growers' farms in Texas showed the value of crop rotation with cereals and grasses, as well as deep plowing in the fall in fighting the soilborne fungus. "The benefit ... is so great," he wrote in 1907 to Beverly Galloway, the head of the USDA's Bureau of Plant Industry, "that there can be no question about the profit to be derived from this method of treating land upon which cotton dies" (18). The successful experiments with cultivation practices basically marked the end of Shear's five-year focus on cotton root-rot disease. He would maintain an interest in the disease and the causal fungus throughout much of his career, publishing the results of fundamental life history studies in 1925 (28).

In 1906, Shear added the investigation of black rot of grape to his growing list of USDA plant pathology responsibilities. Black rot, caused by *Guignardia bidwellii*, had been a major thorn in the side of viticulturists east of the Mississippi River for nearly 75 years. The introduction of Bordeaux mixture in the mid-1880s, combined with careful life history studies on the black rot fungus by Frank Lamson-Scribner, was a boon for commercial grape growing (8). But as impressive as initial spraying results had been, black rot continued to cause heavy losses into the twentieth century. Scientists at the USDA placed the blame on "unsatisfactory results from spraying" due to problems of application, primarily sub par spraying equipment and faulty preparation of the chemical mixture (22).

Shear's main objective was to improve both the mixtures and the methods of spraying, as well as to demonstrate the best application practices to viticulturists. He also was asked to employ his expert skills as a mycologist to shed further light on the biology of the fungus in order to enhance fungicidal treatments. His experiments began in Pennsylvania in 1906, extended to New York and Michigan in 1907, and included New Jersey in 1908. Early on, Shear's life history studies showed that infections from overwintering spores on mummified fruit were a main source of initial inoculum. Consequently, he stressed that the removal and destruction of

all old grapes and mummified fruit should be the vanguard of an overall control strategy, and one that could reduce the need for a number of fungicide treatments. In addition to evaluating the most effective mixtures of Bordeaux and the best application procedures and equipment, Shear insisted that because the black rot fungus attacked all aerial parts of the grape, growers should cover carefully the entire plant surface—foilage, stems, and fruit. Moreover, Shear's grape-spraying experiments had demonstrated that smaller quantities of copper sulfate and lime mixtures could be used quite effectively, thus reducing costs to growers. At the end of the field experiments, Chief of the Bureau of Plant Industry Galloway was pleased to report to Secretary of Agriculture James Wilson that the spray trials had shown "conclusively that the most serious epidemics of black-rot ... can be satisfactorily controlled by thorough and proper methods of spraying" (22).

Once again, Shear's plant pathology work in the first decade of the twentieth century highlighted his ability to lead a research program, both in the laboratory and field. His programs produced etiological discoveries about pathogenic fungi and advances to existing control measures. With this information in hand, Shear took it to the field and translated it rapidly into sizable practical benefits for agriculturists. Indeed, in taking on a destructive disease on its home ground, Shear proved remarkably skilled at communicating his science and traversing the treacherous waters of growers' expectations. These successful experiences as a plant pathologist would serve him well as he soon embarked on other avenues of professional leadership.

THE APS PIONEER

In the first decade of the twentieth century, plant pathologists began to express a desire for self-definition. Many, including Shear, felt this would be best accomplished by organizing a professional science society. This feeling was typical of the late-nineteenth and early twentieth centuries when science societies were being created at a brisk rate. Unlike general science societies of the mid-nineteenth century such as the American Association for the Advancement of Science (AAAS), these new societies were characterized by disciplinary specialization (1).

The yearning to organize along disciplinary lines was particularly evident among practitioners of sciences with a strong practical, economic basis such as plant pathology where scientists often felt unappreciated in societies geared to traditional sciences. This self-conscious attitude was bolstered by the rapid expansion of plant pathology by the first decade of the twentieth century; it was a boom time for financial support for agricultural sciences. Plant pathology was rapidly acquiring a sizable corpus of knowledge, a roster of prominent scientists, and a successful record of combating notable diseases.

Plant pathology was in a critical phase due to unparalleled growth, and Shear had great concerns about whether the burgeoning science could fulfill its responsibilities on a national scale. He worried about a lack of coordination and cooperation between pathologists in different states, regions, and countries. He had seen in his

travels that this lack of centralized oversight often led to needless duplication of effort and waste of resources. And, in the future, he felt that it was likely to stunt the potentially unlimited growth of the discipline (26).

Shear believed that a national system of coordination was needed, and he became one of the most active forces in the struggle to create the American Phytopathological Society. He believed that a professional science society was an essential tool for building national, and eventually even international, networks of communication and cooperation. Moreover, a society would create self-awareness among plant pathologists and help to define their roles and objectives. He felt that a society was a necessary element for the survival and continued success of plant pathology.

Several societies dedicated to botanical sciences had been created in the 1890s. Some were general in nature, like the Botanical Society of America, whereas others, such as the Society for Plant Morphology and Physiology and the American Mycology Society, expressed the trend toward specialization. Many influential botanists pushed for consolidation and, in 1906, these three societies were merged into a unified Botanical Society of America. There was, however, no effort to broaden the scope of the new society to encompass "newer" disciplines. This resulted in "the applied branches of botany being essentially ignored" (4).

Shear worked to fill this void. He was committed to creating a society that spoke more directly to the needs of his colleagues in phytopathology. As a pathologist with the Bureau of Plant Industry, Shear was positioned in the institution that dominated phytopathological research in the early twentieth century. No other institution in the United States could have given Shear the perspective to appreciate the needs and opportunities of plant disease research on a national scale.

In late 1908, Shear began to discuss with his BPI colleagues and experiment station pathologists the desirability of an exclusive organization for plant pathologists (7, 20, 27). Shear later recalled, "I first suggested the desirability of organizing the Phytopaths. with [William A.] Orton, [Merton B.] Waite, [William M.] Scott, [Erwin F.] Smith & [Haven] Metcalf. Meeting with a favorable reaction in most cases we arranged for an informal meeting of the Bureau Pathologists" (5). The significance of Shear's contacts can be shown easily with brief synopses of the work of each of the above figures: Orton was a pioneer in breeding for disease resistance, Waite discovered the role of insect vectors for bacterial plant diseases, Scott popularized lime-sulfur spraying for fruit tree diseases, Smith was possibly the finest plant pathologist in the world and a pioneer of phytobacteriology, and Metcalf was a leading forest pathologist who soon would do groundbreaking work on chestnut blight. It is not surprising that Shear wished to gather these scientists; obviously they were his close colleagues, but they also represented the core of their science. A vote of confidence from these men would arguably stand as a quorum of the finest pathologists in the United States and would hold great weight with plant pathologists at colleges and experiment stations around the country.

On December 15, 1908, Shear brought together 23 scientists, including 8 women, in W. M. Scott's spacious Washington pathology laboratory to discuss the possibility of forming a new society for plant pathologists. The prevailing

opinion on the new phytopathological society was that membership should be available to anyone working in plant disease research. Shear, Orton, and Donald Reddick of Cornell University, who happened to be in Washington and received an invitation to the gathering, were appointed to be an organizational committee, and they sent a letter to 130 plant pathologists across the country informing them of intentions to hold a formal meeting at the upcoming Baltimore convention of the AAAS. In the letter, Shear and his colleagues invited pathologists from across the nation to "take part in the organization of the proposed society which, it is believed, can exercise great influence in advancing the study of phytopathology in America" (21).

Those scientists whom Shear gathered in Washington differed in a significant way from those who had spearheaded earlier botanical societies. The older societies were constructed by botanists who, while they might have had some interest in plant diseases, did not have careers defined by phytopathological research. The Washington gathering, on the other hand, consisted of a sizeable number of the first generation of scientists who could truly be called "plant pathologists."

The AAAS convention in Baltimore was a momentous meeting in the history of American plant pathologists. Fifty-four persons met at Eastern High School on December 30, 1908, to discuss the creation of a society. Shear's organizing committee reported: "It is our opinion that an American Phytopathological Society, placed upon a broad and generous foundation, may be of invaluable aid in promoting the future development of this important and rapidly growing subject in America, and that its influence may be made of international importance" (27).

Still, the establishment of a new plant pathology society was not a *fait accompli*. Many influential botanists were skeptical. Some of them, such as George F. Atkinson from Cornell University, and Joseph C. Arthur at Purdue University, were men whose opinions were not taken lightly in the botanical and phytopathological communities. Decades earlier, Atkinson had done classic research on Shear's own topic of root diseases of cotton. Arthur was a founder of phytobacteriology, a renowned expert on rusts, and was considered by many to have been the first true plant pathologist in the United States. Both Atkinson and Arthur thought that a new society dedicated to phytopathology would be a "retrograde movement," and as such would be detrimental to the advancement of botanical unity and organization (23). These two certainly could not be accused of under-appreciating the economic value or scientific rigor of plant pathology.

The vigorous and unwavering commitment of Shear's cadre overwhelmed the opposition of consolidationists like Atkinson and Arthur. They maintained adamantly that the "aims and purposes of the proposed organization ... could not be attained without a separate society" (27). After an animated discussion, the report of Shear's committee in favor of a unique organization for plant pathologists was approved by a margin of three to one.

The organizing council of the nascent society was dominated, not surprisingly, by Eastern scientists—Lewis R. Jones, University of Vermont and the Vermont Agricultural Experiment Station, as president; Augustus D. Selby, the Ohio State

Agricultural Experiment Station, as vice-president; and as councilmen, J. B. S. Norton of the Maryland Experiment Station; and Benjamin M. Duggar of Cornell University. Shear was the only officer who worked for the USDA. He was chosen secretary-treasurer, a logical position as it kept the organizational and communications network firmly in his hands. Significantly, all the officers were relatively young men and, whether they worked at state agricultural experiment stations or the USDA, they were all full-time plant pathologists.

Even with these official positions in place, the final structure of the new society remained a matter for debate. Shear was more concerned that the new organization, whatever form it took, fulfill the needs of plant pathologists rather than simply being an exercise in disciplinary specialization. Therefore, he was willing to consider options. He wrote to Jones that "it was the opinion of Dr. [H.C.] Cowles, the secretary of Section G [AAAS], that an arrangement could be made which would secure for us practically all the advantages which we had hoped to secure by a separate organization" (23). Jones wrote from Vermont that he was personally hopeful that the AAAS Council might succeed in "some arrangement ... which will accomplish the most that we wish with the minimum of trouble" (6).

Ultimately, Shear opted for the risky choice of fragile independence over the safer route of association with a venerable old institution like the AAAS. He chose this course when he attended the April 1909 meeting of the AAAS Council where a resolution was made directing the sectional secretaries of the Association to arrange shortened programs and recommending that the papers presented in sessions be general in nature. Shear immediately understood that these regulations would restrict the sharing of information among plant pathologists, which he believed was the central purpose of their society. "There would be little advantage, so far as I can see," he wrote to Jones, "to us or to other botanical organizations in our carrying out the proposed arrangement to become a sub-section of section G" (24). Shear and Jones, in consultation with the other Council members, decided to proceed with the organization of an independent society.

Fifty members attended the first sessions of the APS held at the Harvard Medical School in December 1909 (25). The program consisted of 45 papers authored by 38 men and 3 women from 15 states, Washington, DC, and Ottawa, Canada. While scientists of the USDA's Bureau of Plant Industry may not have dominated the Council, they did contribute an impressive 19 papers, including 4 by E. F. Smith alone. Many who had harbored doubts about the new organization now agreed "that the large membership list, the numerous papers presented, and the great enthusiasm ... had thoroughly convinced them that the organization of the Society was fully justified" (7). A total of 130 individuals were accepted as charter members. The new officers demonstrated a slightly wider geographical range than had the initial Council. Frank L. Stevens, from the North Carolina College of Agriculture and Mechanical Arts, was elected president and Albert F. Woods, from the University of Minnesota, was the first vice-president. The councilors were A. D. Selby, L. R. Jones, and Herbert H. Whetzel of Cornell University. Shear continued as secretary-treasurer, a relatively thankless and glamorless

position, but one that clearly demonstrated his pivotal organizational role in the Society.

After the official establishment of the Society, the next critical issue was the creation of a research journal. Actually, Shear had been hard at work on that very issue for over a year. He began canvassing colleagues in 1908, asking them to "give me your idea ... whether the annual report would be sufficient or whether a periodical journal would be more desirable" (20). The possibility was discussed that APS would underwrite a phytopathological research journal published through the Bureau of Plant Industry (24). This proposal never came to fruition, perhaps because it failed to receive the early administrative support necessary from the BPI. It was also likely that the central founders of APS, like Shear, simply felt that a separate research journal was a necessary component to the success of an independent science society. Primarily through the efforts of Shear, Jones, and Whetzel, the journal *Phytopathology* was first published in February 1911. Shear contributed a review of *Diseases of Economic Plants* (1910) by F. L. Stevens and J. G. Hall, in addition to performing his extensive editorial duties. With the establishment of the journal, *Phytopathology*, Shear and the other creators of APS had erected the final structure of a mature and fully functioning scientific society.

The American Phytopathological Society represented Shear's vision for the professional organization of plant pathology. He fostered this vision throughout his career, serving as APS President in 1919. Shear continued to play an active role in plant pathology until his retirement from the USDA in 1935. He would enjoy many years in retirement before his death on February 2, 1956. Throughout his long career, Shear made many contributions to science, but it was his applied plant disease research and effective leadership in the creation of APS in the first decade of the twentieth century that constitute his enormous legacy to plant pathology.

ACKNOWLEDGMENTS

The inspiration for this paper came from Dr. C. Lee Campbell who was to serve as coauthor until his untimely death in July 1999. Dr. Campbell, an untiring champion of the American Phytopathological Society, admired Shear for his role as an integral figure in the formation of that Society.

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