WITH ONE FOOT IN THE FURROW

A History of the First Seventy-five Years of the Department of Plant Pathology at the University of Wisconsin–Madison

Edited by
Paul H. Williams
and Melissa Marosy

WITH ONE FOOT IN THE FURROW

A History of the First Seventy-five Years of the Department of Plant Pathology at the University of Wisconsin–Madison

Edited by
Paul H. Williams
Melissa Marosy
Department of Plant Pathology
University of Wisconsin–Madison

Kendall/Hunt
Publishing Company
Dubuque, Iowa

Copyright © 1986 by the Department of Plant Pathology, University of Wisconsin–Madison

Library of Congress Catalog Card Number: 85–81266

ISBN 0–8403–3790–6

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

Printed in the United States of America

A 403790 01

Contents

Preface

Conceived of necessity and born in conflict, the Department of Plant Pathology at the University of Wisconsin-Madison has been a dominant force in the development of the profession of plant pathology over the past seventy-five years. Since its beginnings in 1910 under the leadership of Professor L. R. Jones, the department has trained over 702 students in higher degrees, has contributed significantly to the stabilization and productivity of United States and world agriculture and forestry, and has provided important academic diversity and leadership within the life of the University of Wisconsin. This volume traces the history of the department from its earliest beginnings until the present, documenting virtually all facets of the department from the diverse perspectives of the many groups and individuals who have participated in its life over the years. The volume is introduced with a section which provides an historical overview and chronological framework of the departmental growth. Ensuing chapters are reflected in terms of the initiation and development of specific disciplines or activities.

Authors of each of the twenty-nine chapters of the volume were asked to seek all relevant historical information pertaining to the general areas they had been assigned and to provide an accurate, informative and interesting narrative of their subject. In particular, authors were asked to explore the roots or beginnings of their particular subject, and to provide insights into the intellectual, political and administrative initiatives that resulted in the inception and growth of their area up until the present. Authors were selected for their knowledge and representation of particular aspects of departmental life.

The title for this volume was coined twenty-five years ago by Professor J. C. Walker, as he and Paul Williams were walking down the rows of cabbage seeking "the perfect head". When Williams enquired of him how best to pursue his program into the future, he turned and said, "Well Paul, I'm not given to handing out advice, but if there is one thing, whatever direction you take, always remember to keep *one foot in the furrow.*" This statement has become the hallmark of our department, and in the final chapter of this book, Christen Upper has given us some thoughtful perspectives on Walker's advice.

In the preparation of this volume the editors and authors sought various kinds of historical information from many former students, faculty, and associates who spent time in the department. We would like to express our thanks to those who contributed this information. Because of the sheer volume of material received from our enthusiastic supporters and alumni we, of necessity, had to exclude a significant portion of what was provided. We have relied on the judgements of the chapter authors as to what information was used. However, we have maintained all of the resource information sent to us and will be placing this information, letters, photographs, recorded tapes, etc., in the departmental section of the University of Wisconsin Archives.

Over the years, the department has recorded the portraits of virtually all of its graduating students and faculty. We have included in this volume a picture of all those students who sat for a portrait before leaving. To those whose pictures are not recorded in the volume, we apologize, and hope that you or your family will send the department one for its records. We have also included a portrait of those faculty who received tenure at the University of Wisconsin and whose primary appointment was in the department. In addition to the student and faculty portraits are various photographs of historical interest used to support narratives within the chapters.

This volume is not a definitive work in the sense of being a thoroughly researched historical treatise with accurate documentary codefication and analytical insights. Rather, it is an attempt to gather a view of ourselves and our past after existing within the University of Wisconsin for seventy-five years. What we have produced is a potpourri of perspectives from current and emeritus faculty members, staff and students. The former students who read this book will undoubtedly see reflected in the style and contents of the individual chapters, the faculty and staff as they may have known them.

In the production of the book we have been fortunate and privileged to have drawn on the historical resources within the memory of Professor J. C. Walker, who joined the department as an undergraduate in 1912. Besides providing us with a title for the book, Professor Walker, now age ninety-two, has been of great assistance to numerous authors by providing them with information for their chapters. In April 1985 Walker made a special trip from Sun City, Arizona, to Madison to spend time interviewing the faculty, staff and students.

We would like to acknowledge the support of a number of persons in the production of this book. Professor Robert Patton organized the support needed to produce the photographs and illustrations. His staff specialist Russell Spear, together with Steven Vicen, provided invaluable photographic skills and many long hours in the production of the photographs. Judy Gosse, a word processor in the department, has been responsible for typing the text through its many revisions.

The department is also indebted to the J. C. Walker Fund and the J. W. Brann Memorial Fund at the University of Wisconsin Foundation for providing support that has initiated the production of this book.

Paul H. Williams
Melissa Marosy
Madison, July 15, 1985

PART 1

Chronology of the Department

L. R. Jones

CHAPTER 1

Beginnings, L. R. Jones, 1910–1925

J. C. Walker

Dr. Harry L. Russell, professor of agricultural bacteriology in the College of Agriculture, became dean in 1907. Up to that time any attention to plant diseases was given by the Department of Agronomy or that of Horticulture. Russell was born and grew up at Poynette, Wisconsin, a few miles north of Madison. He attended the university from 1884 to 1888 and continued graduate studies at John Hopkins University. He returned to Wisconsin in 1893 as assistant professor of bacteriology in the College of Agriculture. He advised in the establishment of the first pea canning plant which was located at Manitowoc in about 1894.

At the southern edge of Racine, extending about ten miles to Kenosha, a vegetable-growing industry was building up. Chief crops were onion, cabbage and potato. Dr. J. J. Davis, a homeopathic physician in Racine, botanized in his spare time, in that area. He noted that the cabbage crop was seriously affected with disease. He wrote to Dean Henry at Madison and to the U.S. Department of Agriculture (USDA) in Washington, D.C., about it. Henry sent Russell there to investigate and the USDA sent Erwin F. Smith. They had had some contact while Russell was at John Hopkins. Smith, however, was a decided loner. They worked on farms about a mile apart, but had nothing to do with each other. The disease they were both studying was later known as black rot. Russell made a preliminary report in August, 1895, at the annual meeting of the American Association for the Advancement of Science (AAAS), the proceedings of which were published in 1896. Smith published the first complete description of the disease in 1897, in which he named the causal organism as *Bacterium campestre*. Russell's complete report did not appear until 1898. I cite this incident because it was the first series of plant disease investigation in Wisconsin.

In 1909, the State Horticultural Society endorsed a legislative bill which appropriated money for research on pest and disease control. President Van Hise opposed the bill for fear it would set a precedent for legislative dictation of university instruction, but to secure its defeat he had to promise that the university would undertake the work within its regular budget. In 1907, W. D. Hoard of Fort Atkinson, Wisconsin, publisher of Hoard's Dairyman and a regent, wrote Dean Russell that he had told the regents that he favored the establishment of a Department of Plant Pathology within the College of Agriculture.

Two courses in plant pathology had been initiated in the Department of Botany, College of Letters and Science, in 1901. A general course was taught by Professor R. A. Harper, chairman of the department. One on timber tree diseases was given by Professor C. E. Allen. In 1909 Dean Russell included in his budget four new departments including a Department of Plant Pathology. It is not clear just when L. R. Jones was approached regarding the headship. But R. A. Harper, while agreeing that Jones was the proper selection, insisted that plant pathology should be located in his department. A considerable controversy arose, headed by E. A. Birge, dean of the College of Letters and Science. Birge arranged a meeting with Russell in President Van Hise's office, where he repeated his demand. Van Hise supported Birge. Russell reported by saying, "Well, the only thing for you to do, then, is to get another dean." After more heated discussions, Van Hise decided to let L. R. Jones, who was already on the campus, remain in the College of Agriculture. As a gesture of appeasement it was arranged that the two general courses in plant pathology would be listed in botany as well as in agriculture, and, for a time at least, Jones was listed as a nominal member of the Department of Botany.

BACKGROUND OF LEWIS RALPH JONES

L. R. Jones was born on a farm near Brandon, Wisconsin, on December 5, 1864. This village, which is not far from Ripon, was settled earlier by people from Vermont, who, like many others at that time, were moving west. Jones' mother was of the family Knapp. She was a teacher in an elementary school in the area. His father was of Welsh parentage and grew up in a Welsh community in Kenosha County not far from the Illinois border. As a young man Jones' father was somehow attracted to the Brandon community, where he acquired a farm. For some years this community had no name, but when it was learned that a new railroad was to pass through the area it was an occasion for a "town meeting" to decide on a name whereby the railroad company could be petitioned to make a regular stop. One man in the audience rose to suggest that since most of the people living there had come from Brandon, Vermont, it was pertinent to give this new village the same name.

By the time Lewis Ralph, who was fourth in a family of four boys and one girl, reached high school age, there was a high school in the village. Jones often referred to the principal whom he greatly admired. It was he who saw unusual promise in L. R. and encouraged him to go to college. In the yard of the present high school is a large granite boulder to which is attached a plaque in memory of this principal. L. R. Jones had much to do with providing this memorial. He and his first wife are buried in the cemetery nearby.

Ripon College was not far away. It was distinguished as having on its campus the one-room schoolhouse in which the Republican party was founded in the 1850s. Jones matriculated there in 1884. After two years he entered the University of Michigan, where he majored in botany under Professor Spalding. Probably because of need for money, after one year he interrupted his college course to teach science for a year and a half at Mount Morris Academy in Northern Illinois. Returning then to Ann Arbor, he completed his bachelor's degree in 1889. During his senior year, he was invited to attend a doctor's examination. The candidate was none other than Erwin F. Smith. Starting his training at Michigan State University in East Lansing, Smith began his graduate training at Ann Arbor, but before completing his doctorate took a position with the USDA. His first years there were spent investigating the peach yellows disease. By 1889, this had advanced to the point where he submitted his results as his doctor's thesis. I believe this was the first of a life-long acquaintance between these two men.

In 1889, Jones accepted a position at the University of Vermont as botanist of the experiment station and professor of botany in the university. For the next twenty-one years, he performed an outstanding record of teaching and research. He found in Vermont a group of amateur botanists who were accustomed to botanize together. He told me that he realized that these people knew much more about systematic botany than he did. Therefore, he helped to organize the Vermont Botanical Society and acted as its secretary for a number of years. Typical of these amateur botanists was a man by the name of Frost who had a shoe repair shop in a village of southern Vermont. Professor Jones described him to me in this manner. On a stool near the one on which he sat at his work was an open Latin grammar, which Frost studied as he worked on his shoes. He needed acquaintance with Latin, of course, in naming new species. The onion smut disease was discovered in the Connecticut River valley in 1869. Frost was the first one to describe it. He named the fungus *Urocystis cepulae* Frost in 1877. An unnamed specimen collected in 1834 was later found in Persoon's herbarium in France. No doubt, the fungus had been transported from Europe to New England, where it became the major disease of the onion crop.

While at Vermont, Jones earned a high spot in botany and plant pathology. He served as president of the Botanical Society of America. He participated in the founding of the American Phytopathological Society (1908) and served as the first president and as editor-in-chief of *Phytopathology*. He helped organize and served as president of the Vermont State Forestry Association; he started the first state forest nursery in the United States to distribute seedlings to farmers. He was the first state forester of Vermont. There is today a state forest named for him in recognition of his efforts in this direction.

Late blight was the major disease of potato in Vermont. The newly discovered Bordeaux mixture was tested and found to be effective. The second disease of importance on potato was described as early blight (*Alternaria solani* (Ell. & G. Martin) Jones & Grout) in 1896. William Stuart in horticulture was beginning to assemble foreign potato varieties with the objective of improvement through breeding. He transferred to a similar position in the USDA about 1905 where he continued his program. Jones became interested in the possibility of disease resistance to blight and was sent on a survey of European countries with this in mind about the same time. He brought back some material for Stuart and found varieties in general in Europe more tolerant than those in the United States.

During his busy career, he found time to study carrot soft rot, which was an important storage disease. He described the organism as *Bacillus carotovorus* in 1901. Van Hall in Holland described another soft rot organism in 1902 as *B. atroseptica*. These are still recognized as distinct pathovars and as *Erwinia carotovora* pv. *carotovora* and *E. carotovora* pv. *atroseptica*, respectively. Jones made a thorough study of bacterial soft rot and his was the first study of pectolytic enzymes secreted by bacterial pathogens. He spent one semester in Washington in E. F. Smith's laboratory and presented this work as a doctorate thesis at the University of Michigan in 1905. He published this research in 1909 in *Vermont Agricultural Experiment Station Technical Bulletin* 147.

THE AUTHOR'S BACKGROUND

I matriculated at the University of Wisconsin in the autumn of 1910, a few months after Jones' arrival. I registered in the College of Letters and Science. Botany and zoology were still contained along with physics, geology, and medicine in Science Hall. Construction of the new biology building, later named Birge Hall, was just getting under way. I took beginning zoology in the second semester of 1910–11 in Science Hall. In the fall semester of 1911–12, I took beginning botany in the new biology building. Lectures were by C. E. Allen. E. M. Gilbert was my quiz instructor. By that time, I had transferred to the College of Agriculture and was assigned to L. J. Cole, head of the new Department of Experimental Breeding, the name being later changed to Genetics. My uncle, Dr. D. J. Davis, a graduate of the University of Wisconsin in 1898, head of pathology and later dean of the University of Illinois College of Medicine in Chicago, had told me that a new Department of Plant Pathology had been established at our university and suggested that I look into it as a possible career.

While taking lectures in agricultural chemistry in 1911 in Agriculture Hall, I noticed that occasionally a slim, curly-haired, middle-aged man came through the front of the room and disappeared through another door. This was my first glimpse of L. R. Jones. Later, I learned that plant pathology was housed in two small rooms just above the dean's office in Agriculture Hall. It seems that the only access to these rooms was via this large lecture room.

In the beginning of my junior year (1912), I was required to select my major department. I told Professor Cole of my desire to interview L. R. Jones with the possibility of majoring in his department. By this time, the new Horticulture Building was finished and plant pathology had moved into the second floor. The agronomy wing which is there now did not appear until about 1931. Nearly half of the second floor at the west end was occupied by a large lecture room. Next to it was Professor Jones' office, and his secretary, Miss Alma Steinmetz, was housed in a narrow room across the hall. I made an appointment through her.

Professor Jones was very receptive and especially so when he learned that I came from a farm near Racine. Although my father had raised a few acres of cabbage each year for the preceding four or five years, we had not encountered any disease problems. However, I had heard in high school that something was going wrong with the crop along the "lake shore" as we were accustomed to refer to the intensive vegetable-growing area. I transferred to plant pathology and signed up for Plant Pathology 101 that autumn under L. R. Jones. In the second semester I took the methods course, which was given by J. C. Gilman, a graduate student and also a native of Racine. He assisted Professor Jones in his field work in that area. I soon learned that onion smut was also destructive in some of the fields on the lake shore. The formaldehyde drip system of control of this disease was developed by Selby of the Ohio Agricultural Experiment Station and reported in 1900. He used it in a locality where onion sets were grown in strips of about 10 inches wide consisting of as many rows. Professor R. E. Vaughan put on a demonstration in the Racine area in which the method was applied to single-row culture. I took records on this plot and repeated it during the next three seasons. This became a standard for at least forty years until R. H. Larson and I found that thiram applied to the seed with a methocel sticker was just as effective and much easier to apply. By 1914, Gilman had completed his M.S. degree and transferred to the Missouri

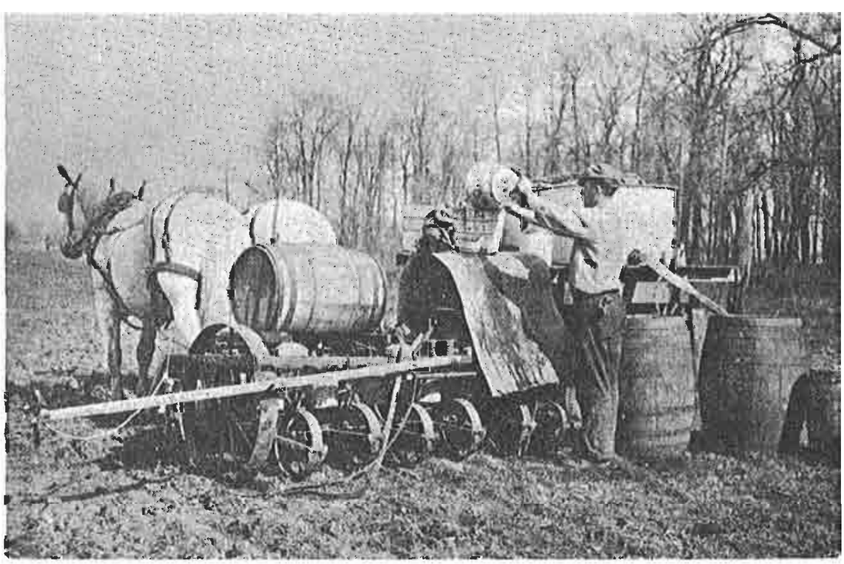


Figure 1.1 Formaldehyde drip treatment of onions for smut control. The subject of J. C. Walker's senior thesis.

Botanical Garden to complete his doctorate with B. M. Duggar, and I assumed his duties as research assistant to Professor Jones. I worked on onion storage rots for my master's and doctor's theses and worked with "Prof" on cabbage diseases.

THE CABBAGE YELLOWS DISEASE

Dean Russell emphasized to Professor Jones the importance of the cabbage problems in the Racine area, partly because of his experience with the black rot disease some 18 years earlier. Jones found (in 1910) hundreds of acres affected by the little known disease which he called yellows. He confirmed the disease to be the same as that reported by E. F. Smith in the Hudson River valley in 1899, and by others in northern Ohio and northern Illinois. He submitted *Fusarium* cultures from disease plants to H. W. Wollenweber of Germany who was then the foremost authority on that genus, and who was working in the USDA at the time. He named the fungus *Fusarium conglutinans* in 1913.

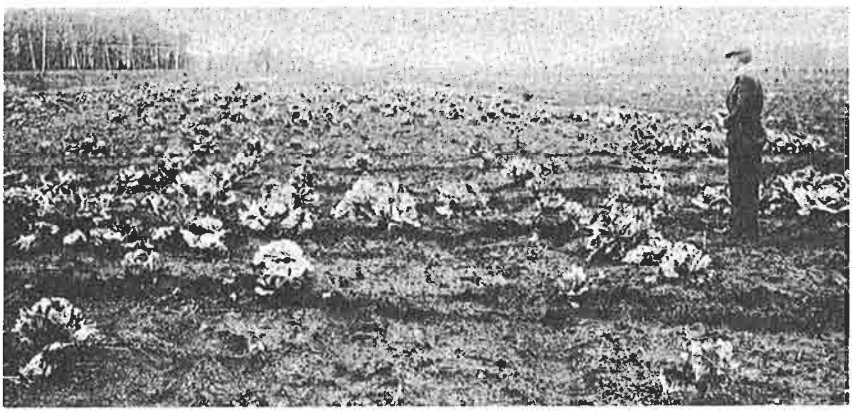


Figure 1.2 Jones found hundreds of acres affected by a little known disease he called yellows, 1910.

Figure 1.3 L. R. Jones making an early selection, with J. J. Davis, Racine County, 1910.

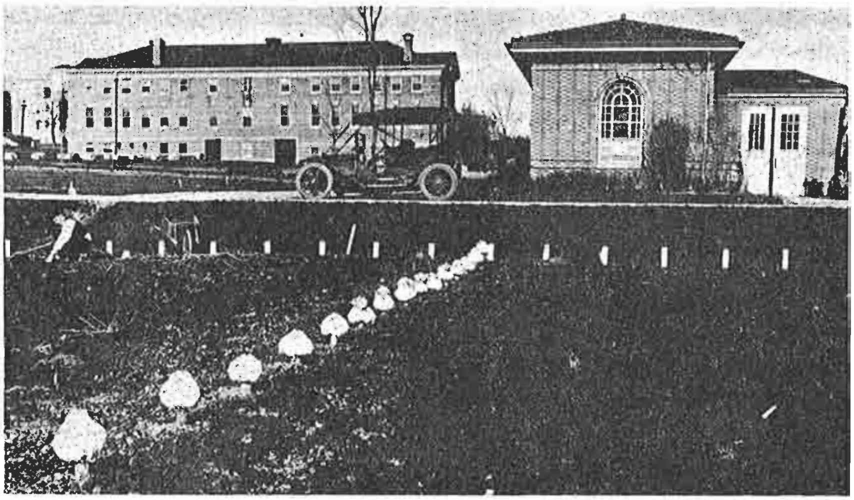


Figure 1.4 Yellows resistant cabbage selections for seed production, spring 1912, Madison.

Impressed by occasional healthy plants in fields almost completely decimated by the disease and aware of the recent success of W. A. Orton in developing cotton lines highly resistant to wilt, Jones saved a number of such plants and stored them in a commercial cabbage winter storage house. They went to blossom and seed when planted the next spring. They were allowed to be cross-pollinated by bees. The seed was saved separately from each seed plant. The first group of progenies showed fairly high percentages of resistant plants. Repeating the selection for two more generations he developed a highly resistant variety which was released in 1916 under the name of Wisconsin Hollander. This was the beginning of a cabbage disease program which has continued in the department up to the present writing.

It may be recalled that I pointed out earlier in this paper that Dean Russell had some opposition from President Van Hise and Dean Birge when he proposed a new Department of Plant Pathology in his college. Keeping in touch with Jones' progress he did not miss the opportunity to impress the president. I was stationed at Racine in the summer in charge of the plots beginning in 1914. In that year, we had arranged to have trial rows of the second generation of resistant lines included in several commercial fields. In some cases, most of the crop was destroyed leaving the resistant row in a striking position. Professor Jones sent word to me that Dean Russell was taking President Van Hise and the regents on a tour of the several branch experiment stations and would terminate this tour at Racine where they would visit his cabbage plots and demonstration fields. This visit was a great success. There is a picture of this group looking at a single resistant row in the midst of a decimated field in *Wisconsin Experiment Station Research Bulletin 38.* After a morning in the fields, they went to the old Racine Hotel for lunch to which a few leading farmers were invited. When called upon, President Van Hise gave a most laudatory speech praising the professor and his spectacular contributions.

Figure 1.5 What every good assistant wore to pollinate cabbage, 1912.

Figure 1.6 The first progeny of *Fusarium* yellows resistant selection Racine, 1913.

DR. J. J. DAVIS ENTERS THE PICTURE

Another important task to which Professor Jones was assigned soon after his arrival was concerned with Dr. J. J. Davis, a medical practitioner in Racine. I lived on a farm near Racine. From time to time in summer months, I would see in mid afternoon a horse and buggy tied to a tree along the highway about a quarter mile north of our house. From it, an elderly man would emerge, climb the fence, and walk with a short but steady pace across the field. I remember asking my mother whom this might be. She replied that it was Dr. Davis, who was searching for herbs. Incidentally, Dr. Davis' sister was one of my mother's intimate friends. It was years later that I took his course in parasitic fungi. Dr. Jones had told me that soon after he arrived in Madison, Professor R. A. Harper, head of the Department of Botany, knowing that Jones went to Racine frequently, asked him to look up Dr. Davis and see if he could be persuaded to give up his practice and join the Department of Botany as curator of the herbarium. This was at the time when the Department of Botany was preparing to move from old Science Hall to new quarters in the new biology building, Birge Hall.

Davis was an amateur mycologist. As I got acquainted with him, he told me that as a young man he became interested in collecting plants. One day, when he was near the harbor at Racine, the daily Milwaukee-Chicago boat had docked at the wharf. He noticed a man disembark carrying a vasculum. He introduced himself and inquired where the stranger was headed. The latter turned out to be Mr. Lapham, head of the Milwaukee Museum. He was about to walk back to that city and collect on the way. It was only *twenty-five* miles! Davis remarked about his interest in botany, including mycology. Lapham encouraged him to specialize on the parasitic fungi. This he did, and during his long ensuing life he became a recognized botanist throughout the world through his numerous lists of Wisconsin fungi which were published in the *Transactions of the Wisconsin Academy of Sciences*. He invited me to join the Academy while a graduate student, which I did, and I became an honorary member fifty years later.

Professor Jones told me about his first visit with Dr. Davis. He went to his house, which also served as his office, in mid afternoon. He waited until all the patients were taken care of and then approached the doctor on the subject of his visit. He said the doctor thought about it a few minutes, and then replied that he would take him up on his proposition. He said this practice of medicine was getting too tiresome anyway. So a very great stroke was made for botany and plant pathology. Dr. Davis was loved by all his associates and his students. In my day, his classes were made up largely of plant pathology students. It was a one-credit course which ran throughout the year. It met at 3:30 P.M. on Friday. During autumn and spring we set out on a collection tour at once and usually stayed out until dark. During the winter weather, we examined razor sections of our own specimens and of specimens which Dr. Davis provided. It was an unforgettable experience and one quite necessary as part of the background of a plant pathologist. To give you an indication of Dr. Davis' dry humor, I met him one noon at the foot of the main campus. It was raining. We were both headed for the University Club for lunch. I remarked that "this is good weather for ducks". He replied "Yes, indeed, especially for us young ducks". A few years later in late 1917, I had accepted a position with W. A. Orton of the USDA on a new project of diseases of fresh vegetables and fruits in market and transit. I was eating lunch at the University Club with Orton when Dr. Davis joined us. Orton told him that I had just accepted a place on his staff concerned with storage and market diseases. "Oh", Dr. Davis replied, "I don't call them diseases, I refer to them as putrefactions". Needless to say, he considered "parasitic fungi" as those which attacked growing plants. Dr. Davis was a chain smoker of low-priced stogies. The club kept a supply on hand for his exclusive use. He smoked them down to the bitter end. One day, as was his custom, he was reading the paper in the lounge of the Club after lunch. The cigar was now down to his lips. One of the younger members stepped over to him and said: "Doctor, pardon me, but I believe your chew is on fire". Dr. Davis had no beard, but he let his hair grow long around the back of his neck. This and the stogies were his defense against mosquitoes, which were usually more numerous than fungi on our trips. One day, a colleague of mine, C. N. Frey, who worked on apple scab with Professor Keitt, asked the doctor the name of a plant which was common in the woods. He received no answer. He repeated his question two or three more times at relatively short intervals. Finally the doctor replied: "Damn it, if you give me a little time, I will remember it for you". He was usually able to reel off the Latin binomial of any of the higher plants we encountered, and as I write now at the age of ninety-two, I feel very understanding and appreciative of these common lapses of memory. In 1912, I took general bacteriology under Professor W. D. Frost in the College of Letters and Science. The department was on an upper floor of South Hall. There was a member of the class who sat near the front whom I later learned was an octogenarian and, incidentally, the mother of Dr. Davis.

MORE BACKGROUND

In the spring of 1914, I finished writing my bachelor's thesis on onion smut. Everyone was required in those days to conduct enough research to write up as a bachelor's thesis or take a two-hour so-called thesis course. Professor Jones could not attend the 1914 June commencement, since he had agreed to visit the Department of Plant Pathology of the University of California that month. As he signed the approval sheet of my thesis, he suggested that I submit it to the Award Committee of the Science Club. The latter was a faculty club which preceded the honorary society, Sigma Xi. It was their custom to give a bronze medal to the best baccalaureate thesis in science. I took my thesis to professor W. D. Frost in bacteriology, who was chairman of the Award Committee. This was about a month before commencement. It was a busy month for me since I had onion smut notes to take at Racine and also plants to get ready for the cabbage yellows plots. There was a radical group (without long hair) among the agricultural seniors which determined that there was no rule or law requiring candidates to wear caps and gowns (rental for three hours was five dollars) at commencement. They succeeded in convincing everyone in agriculture concerned, so the only "ag" with a cap and gown was Ken Lehman, the cheerleader. (They still gave skyrockets at commencement.) The service was, as usual, in the old red gym. I appeared at the top of the hill, where the procession started, in plain clothes. Several "ags" ran over to me and informed me that I was to get the Science Award. I do not know who leaked (this was sixty years before Watergate). They insisted that I must wear a cap and gown, and that if I ran there was just time to get one at the Coop. So I ran and got one. As we walked in procession, all but the few informers looked on me as a deserter. To be less conspicuous, I sat next to Ken Lehman. When the time came, President Van Hise at the height of his weak voice said: "Will John Charles Walker please present himself?" I did and when I returned to my seat with the medal the "ags" had all forgiven me and gave me a skyrocket. My mother, who was in the audience, was greatly surprised and thrilled.

I refer to this commencement for another reason. As soon as Professor Jones was established in his new department, he let it be known that he intended to build a graduate department and a basic research program. All courses had numbers of 100 or more, indicating that they all received credit in the Graduate School. The first advanced degree given was in 1911 when the M.S. degree was awarded to George W. Keitt (more about him later). The first Ph.D. was granted to I. E. Melhus in 1912. He came from Iowa and had entered the Graduate School with a major in botany. As soon as Jones appeared, he transferred to plant pathology. His doctor's thesis was on white rust of crucifers, and was published as a Wisconsin Agricultural Experiment Station research bulletin. Later the same year, W. J. Morse, botanist at the University of Maine who had started graduate work with Jones in Vermont, was granted his Ph.D. A year later, H. A. Edson of the USDA, who had his undergraduate and early graduate work at Vermont, finished his Ph.D.

At the 1914 commencement, referred to above, plant pathology was especially conspicuous beyond the Science Club award. There were three Ph.D.'s with majors and one with a minor in plant pathology. The first three were G. W. Keitt, A. G. Johnson, and M. P. Henderson. We will say more about Keitt and Johnson later. Henderson's thesis was on black leg of cabbage which, with yellows under control, was rising rapidly as the number one cabbage disease in the lake shore area. He went first to the pear station near Medford, Oregon, where fire blight was a major threat. He later headed up botany and plant pathology at Brigham Young University, Provo, Utah. The minor, E. M. Gilbert, was a mycologist who also participated in instruction in the mineral course in plant pathology (101) for many years.

The high point in this commencement was that of honorary degrees. Professor Jones had apparently presented the name of Erwin F. Smith to the Honorary Degree Committee. Their favorable action was approved by the faculty. These candidates sat on the platform with the president and regents. Each was accompanied by a faculty member when called to receive his citation. Ordinarily, Professor Jones would have escorted Smith, but knowing of his commitment in California, he had apparently asked Dean Russell to substitute for him. This brought the two mild opponents together. On his return from California, Professor Jones told me that he was greatly pleased that Dean Russell and Erwin F. Smith were brought together on this occasion. Professor Keitt arranged a get-together of staff and students with Professor Smith that afternoon in the seminar room in the department. We had heard that Smith was very jealous about results as they came to light in his laboratory. They were to be kept secret among his staff until publication. This accounted for his attitude toward Russell many years earlier when they were working on black rot at farms only a mile apart near Racine. When I shook hands with him he recognized me as the one who had received an award that morning. He began to ask me about my work on onion smut. Then he hesitated and asked me if I had published. When I replied in the negative he said emphatically: "Then I don't want to hear another word about it until you do". Whereupon he hurried away and our conversation was over.

ENVIRONMENT IN RELATION TO DISEASE

When Jones came to Wisconsin, he had apparently decided to initiate a basic research program which emphasized the relation of environmental factors to development of plant disease. His immediate contact with such important soil-borne pathogens as those of cabbage yellows and pea wilt may have had a part in his deciding to study soil temperature first. W. H. Tisdale was given the problem of studying flax wilt incited by *Fusarium oxysporum* f. sp. *lini*. Equipment with which to control soil temperature was nil, but Tisdale demonstrated that he could grow healthy flax in heavily infested soil by using a glass jar to contain the soil and keeping the jar in a sink in which the tap water was allowed to run continuously in a small stream. This was enough to emphasize the need of controlled equipment.

This led James Johnson, who headed the tobacco research in a county (Dane) which was among the first dozen in the nation as to tobacco acreage, to build the first Wisconsin soil temperature tank. Johnson was really a full time member of the Department of Horticulture, but he also assumed the responsibility for tobacco disease investigations as well. In this, he was supported for many years by funds furnished directly by the USDA. Some years later, he became a part-time member of the Department of Plant Pathology. At the time of Jones' arrival, the root-rot disease of tobacco was the major one in Wisconsin. A major phase of control was carried out in the seed beds which were frames like those of cold frames, over which cheesecloth was stretched instead of glass. Since the disease usually got its start in the bed before transplanting, the practice was established early of sterilizing the seed bed before sowing seed. This was done with the aid of an iron pan inverted over the bed into which steam under pressure from a thrasher engine was introduced. If seed was sown too soon after sterilization, root injury resulted. This problem of injury due to sterilization of soil was the subject of Johnson's doctor's thesis. He showed that soil steamed to a point sufficient to kill all organisms was likely to contain sufficient free ammonia to be toxic to higher plants. When such soil was allowed to stand for one or two weeks, most of the toxicant was destroyed by reinfesting organisms not pathogenic to tobacco.

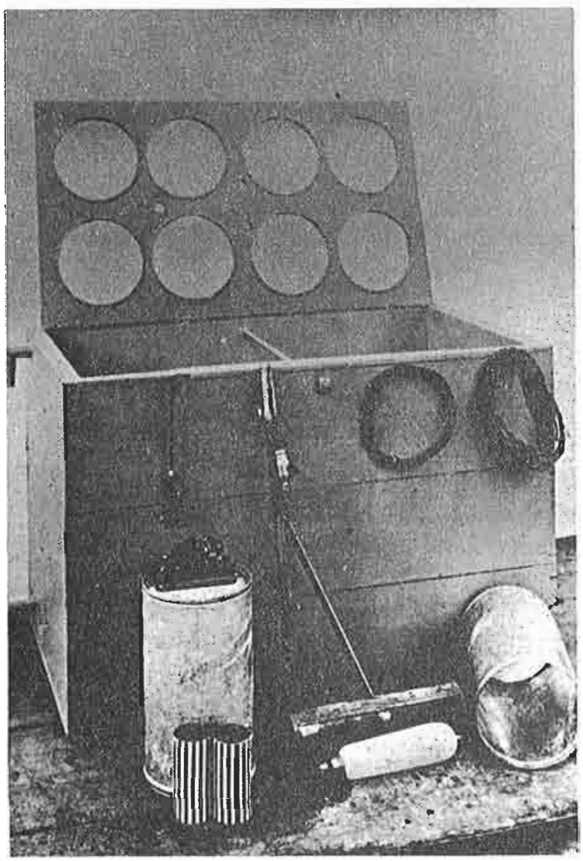


Figure 1.7 Early model of the Wisconsin soil temperature tank.

The soil temperature tank contained water into which metal soil containers were inserted. A heating unit with a thermostat controlled the temperature of the water which, in turn, controlled the soil temperature in the containers. Johnson's work with root rot showed that the disease was most severe in cool soil temperatures, the optimum being about 18 °C. At higher temperatures (ca 25 °C) the plants remained healthy. This explained the common observation by growers that root rot was much more severe in cool summers than in warm summers, and that it appeared early in unsterilized seed beds.

The first work on cabbage yellows with regard to soil temperature was done by Gilman in 1912 to 1914. With very crude equipment, he showed the disease to be favored by high temperatures. W. B. Tisdale, brother of W. H. Tisdale, studied this disease later in Wisconsin soil temperature tanks. He showed that little or no disease developed in soil at 16 °C, while the optimum was around 28 °C. This explained the fact that the disease was more destructive in the corn belt

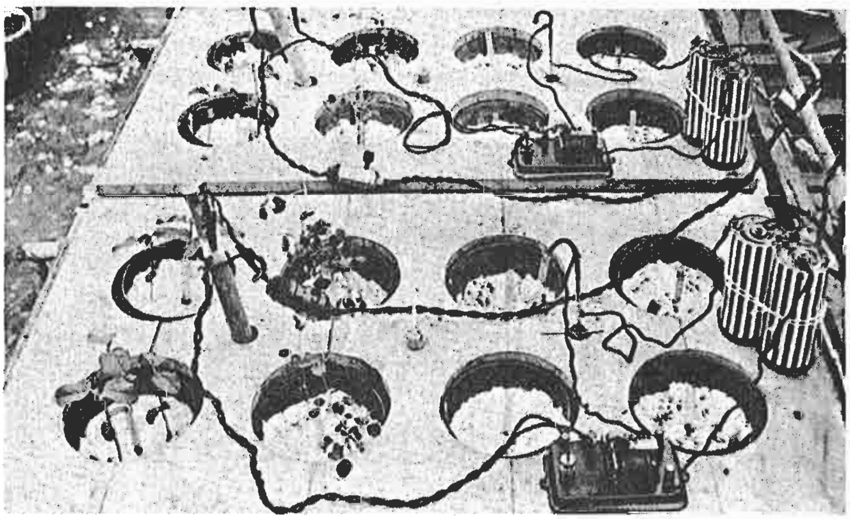


Figure 1.8 Wisconsin soil temperature tanks.

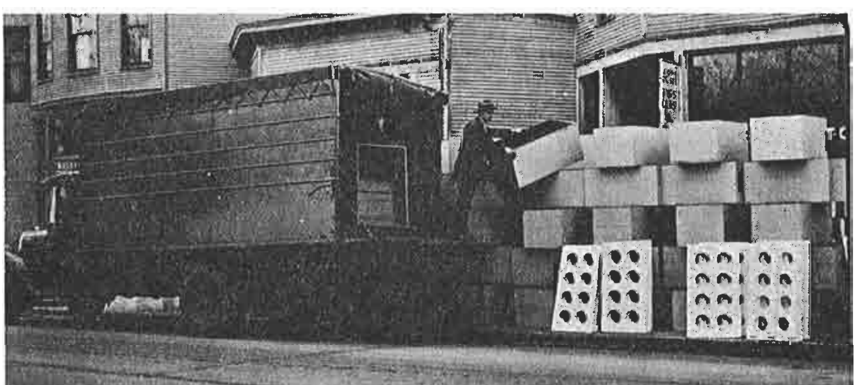


Figure 1.9 Wisconsin soil temperature tanks being loaded for shipment to the plant pathology greenhouses.

than in such areas as northern Wisconsin. Studies were made on many diseases with the use of the Wisconsin soil temperature tanks. Those reported up to about 1925 were reviewed by Jones, Johnson, and Dickson in *Wisconsin Agricultural Experiment Station Research Bulletin 71*. Many more papers appeared after that date on this subject.

Along with soil temperature, attention was given to air temperature and air humidity. Dickson took the lead in developing this equipment. Four greenhouses were built to maintain fairly constant temperatures of 6°, 20°, 24°, and 28°C during the fall, winter, and spring months. Chambers with humidity control and more precise control of temperature were contained in each house. Keitt used these extensively in studies of apple scab and cherry leaf spot, the two most important fruit diseases in Door County. An extremely important piece of research of immediate practical value was that on potato mild or crinkle mosaic.

The production of certified seed potatoes had become an important industry in northern Wisconsin. Professor J. G. Milward of horticulture and Professor J. W. Brann of plant pathology were in charge of this program. One perplexing problem was that crops of certain varieties grown in the southern states in midwinter from Wisconsin certified seed tubers often had very high incidence of mild mosaic, although little of the disease had been seen in the seed fields the previous season. Johnson, using air temperature control chambers, showed that temperature had a profound effect upon the expression of symptoms. C. M. Tompkins, working under Johnson's direction, showed that relatively short daily exposures of infected plants to 23°C were sufficient to mask the symptoms. This explained why many of the diseased plants in inspected fields were overlooked in warm midsummer weather, while their offspring showed severe disease in cool southern midwinter conditions. This finding resulted in modification of the inspection system wherein field performance was supplemented by winter trial plots in the South and by greenhouse planting at Madison in the winter.

MORE ABOUT JONES' ACTIVITIES

L. R. Jones gradually turned over the vegetable disease problems to J. C. Walker. In his last ten years before retirement in 1935, he was concerned primarily with diseases of ornamental plants. At this time, the very popular China aster was gradually losing ground as a home garden plant and one of the florists' cut flowers. Two diseases were most prominent. These were the *Fusarium* wilt and the virus disease known as aster yellows. The latter had been studied extensively by L. O. Kunkel of Boyce Thompson Institute and later of the Rockefeller Institute. He showed the virus (mycoplasma-like organism) persisted in various weeds and was transmitted from them to asters by a leafhopper. Jones had as his assistant Mrs. Regina Riker, who had taken her doctorate in plant physiology under J. B. Overton. They showed that asters could be grown successfully under cheesecloth, the cost of which was economical for commercial production of flowers. The experience with control of cabbage yellows was applied very successfully to the aster wilt. Several successful resistant lines were produced and turned over to seedsmen.

In 1926, Professor Jones was invited, with Mrs. Jones, to visit the Pineapple Research Laboratory in Hawaii at the invitation of Professor Dean who was director. He had moved to this position from the presidency of the University of Hawaii. Upon Jones' return, he went almost directly to Cornell University for the International Congress of Plant Science, which had been organized by Professor H. H. Whetzel, head of plant pathology at Cornell. By previous arrangement, a special dinner meeting of Jones' former and present students and associates was held, at which the portrait which now hangs in the departmental library was presented to the department.

It was accepted for the department by Professor Keitt. Later in the autumn of 1926, Mrs. Jones died suddenly of a heart attack. They had no children. Professor and Mrs. Riker kindly moved into his home and made life much happier than if he had continued to live alone.

In about 1929, he married Anna Mae Clark, professor of biology at Hunter College in New York City. She was a native of Vermont and attended a preparatory school there with Calvin Coolidge. She graduated from the University of Vermont and majored under Professor Jones. Incidentally, Mrs. Calvin Coolidge also attended that university and was active in the same church as Professor Jones. Needless to say, the Jones' were special guests at the White House on more than one occasion during the Coolidge administration. At age sixty-five, Jones turned the chairmanship of the department over to Professor Keitt and went on to half-time salary until his final retirement at age seventy in 1935.

This is as good a time as any to discuss the graduate training which occupied a great deal of Jones' time and energy during his twenty years as head. When I entered the Graduate School in 1914, there were about a dozen graduate student majors in plant pathology. The general course (PP 101) was given in the fall semester, as was the methods course (PP 102). A little later, three special crop disease courses were organized: fruit diseases under Keitt, field crop diseases under Dickson, and vegetable crop diseases under Walker. Jones gave the weekly lectures in 101; the laboratory, two meetings per week, was given first by Gilman, then by Carsner, then by Gilbert, next by Backus, and finally by Pound. I took over the lectures beginning in 1935 and continued in this until 1961. The weekly seminar throughout the year was conducted by Professor Jones until about 1928, when Professor Keitt took over this course.

The number of graduate students gradually increased until in some years it was above forty. Many students came from foreign countries. Wisconsin shared with Cornell and Minnesota the distinction of being the first departments in which major emphasis was given to graduate training in plant pathology. The accompanying chart is taken from the *Wisconsin College of Agriculture Stencil Circular 189,* published in 1937, two years after Professor Jones' retirement. It illustrates the location of former students of the department at that time. They were located in forty states and the District of Columbia, and in fifteen foreign countries. There was a total of 155, most of whom had received the Ph.D. degree. A census of M.S. and Ph.D. degrees taken at the time of this writing showed that from 1911 through 1985, 278 M.S. degrees and 538 Ph.D. degrees were granted to 702 majors in the department.

Professor Jones performed many extra departmental duties. He was a member of the National Academy of Sciences. He served a year as chairman of the Biology and Agricultural Division of the National Research Council, during which time Biological Abstracts was started. He was a member of the organizing committee of the Boyce Thompson Institute. He served on President Franklin Roosevelt's Science Advisory Board. He received honorary degrees from the Universities of Vermont, Michigan, and Wisconsin.

In 1930, he served as chairman of the Section of Mycology and Plant Pathology of the International Botanical Congress at Cambridge, England. He was the only American botanist at this occasion upon whom the honorary doctorate was conferred by Cambridge University. In the same year, he visited Puerto Rico as an advisor on agricultural development. In 1931 and 1932, he traveled extensively with similar purposes in Japan, Korea, China, and the Philippine Islands. In 1939, he was an honorary president of the Third International Microbiological Congress in New York City.

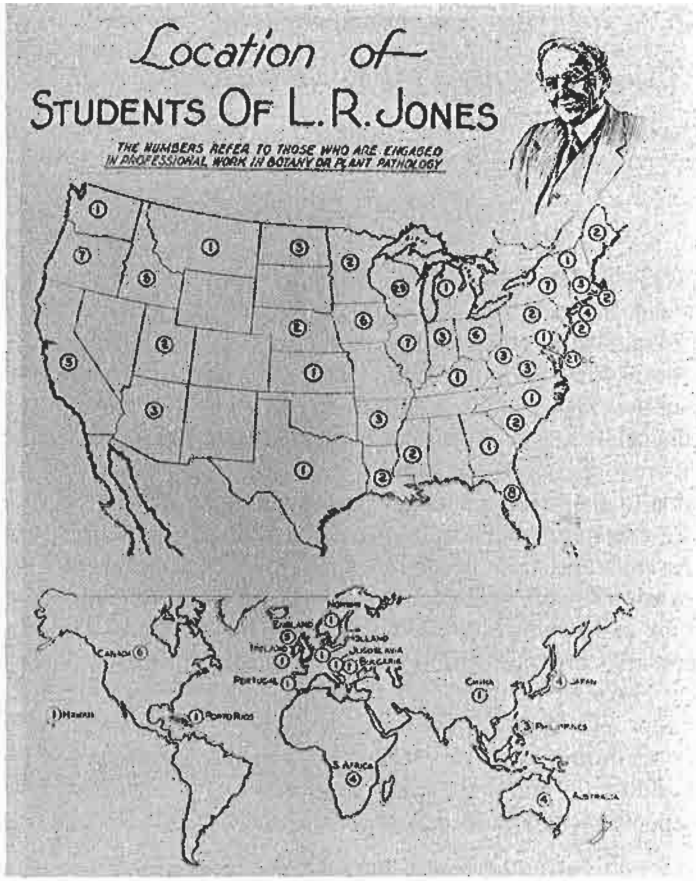


Figure 1.10 Location of students of L. R. Jones in 1937.

His last three years were spent in Vermont during the summer and in Flordia during winter months. He passed away in his sleep the day before Easter Sunday in 1945. His burial was at Brandon, Wisconsin, his birthplace.

CHAPTER 2

The First Generation, 1925–1940

J. C. Walker

Professor Jones was faced with the task of building a staff. Additional funds were not easy to come by. In addition to what he could ease out of Dean Russell, who proved to be a hard taskmaster, he solicited the interest of some of the leading pathologists in the U.S. Department of Agriculture (USDA). He was most successful in the beginning with his former Vermont student, W. A. Orton, who was in charge of the Office of Cotton, Truck and Forage Crop Disease Investigations. Through him, he received financial support for his cabbage and onion disease project and the pea disease problems, especially that of *Aphanomyces* root rot. Fred R. Jones was supported by federal funds, later giving attention to and making outstanding contributions to the diseases of forage crops. In this, he discovered the bacterial wilt of alfalfa and contributed generously of his time and interest to the alfalfa improvement program headed by R. A. Brink in genetics. This led eventually to the release of Vernal, a winter-hardy, wilt-resistant variety which now occupies a great percentage of alfalfa acreage in the upper midwestern United States and contiguous Canada.

Another cooperative program with the USDA was with H. B. Humphrey (uncle of one-time U.S. Vice President Hubert H. Humphrey), who was in charge of cereal disease research in the Office of Cereal Crops and Disease Investigations. A. G. Johnson, who took his Ph.D. in 1914, was added to the staff in that year. He received support from Humphrey's budget and built up research with the addition of graduate students, including J. G. Dickson. In 1919, Johnson accepted a full time appointment with the USDA in Washington. Dickson was appointed in his place in that year.

I took a wartime position with W. A. Orton in October, 1917. I presented my Ph.D. thesis in 1918, receiving my diploma at commencement in June of that year. By this time, we had been in World War I for several months. Students and faculty were being drawn upon in increasing numbers. By 1918, the commencement exercises were transferred to the Stock Pavilion. The number of candidates for the Ph.D. degree was reduced to twelve. One-third of these were plant pathology majors. They were James Johnson, S. P. Doolittle, E. W. Roark and myself. Roark went into service almost immediately and after a few weeks died from food poisoning in an Army camp in Minnesota. Doolittle went into service next and was attached to a special research unit at Yale University until the end of the year. Some months earlier, I received a copy of a telegram from the secretary of agriculture to my local board at Racine requesting that I be placed in a deferred class because I was needed in an important food research program.

FRUIT DISEASE RESEARCH TAKES SHAPE

G. W. Keitt enlisted as a lieutenant in the chemical warfare service. He served for about two years, the last half of which was in France where he was in charge of instruction of our troops in one entire Division on protection against gas attacks by the enemy. He retired in 1919 as captain. The following is from an account of his life written for *The Wisconsin Pathogen* in 1970 by Donald M. Boone.

Keitt was born on his father's farm in Newberry County, South Carolina, on June 11, 1889. His father had returned there to farm in 1882 after having taught modern languages at his alma mater, Virginia Military Institute. In 1901, when George was twelve, the family moved to Clemson, South Carolina, where his father reentered academic life as a professor of English at Clemson College.

George Keitt entered Clemson and graduated in 1909. During his college career, he was editor-in-chief of *The Chronicle,* class orator, intercollegiate debater, winner of the Norris Medal for general excellence in scholarship, editor-in-chief of the yearbook *Taps,* and senior class historian. Following graduation with a B.S. degree in agriculture and chemistry, young Keitt worked for a year as special agent for the USDA in the Georgia peach orchards. It was during this period that he became interested in diseases of plants and decided to seek advanced training in plant pathology. He came to the University of Wisconsin in 1910 where he became one of the first graduate students in the newly organized Department of Plant Pathology. The M.S. and Ph.D. degrees in plant pathology were conferred on him in 1911 and 1914, respectively. He was appointed lecturer in plant pathology in 1913 and by 1920 had moved through the professional ranks to the status of full professor. Professor Keitt succeeded L. R. Jones as chairman of the department in 1930 and continued in this capacity for twenty-five years. Under the leadership of these two men, the Department of Plant Pathology became one of the chief world centers for graduate training, research, and extension work on plant disease. Dr. Keitt was a visiting professor at Harvard University in 1957–58.

Keitt's research included studies on epidemiology of fruit tree diseases, aerial dissemination of plant pathogens, stone fruit viruses, chemical control of plant diseases and the nature of parasitism and disease resistance. He was one of the pioneers in the use of eradicant fungicides and antibiotics for control of plant diseases and was a codiscoverer of the antibiotic antimycin which has been used widely in this country and abroad in basic physiological research. Perhaps he is known best for his genetic approach to the study of pathogenicity, applying many of the techniques used with the saprophytic neurosporas to a combined study of the genetics, nutrition and pathogenicity of the apple scab fungus, *Venturia inaequalis.* He was author or coauthor of over 200 scientific papers. Although his main research efforts were directed to basic studies, he also concerned himself with the practical problems of growers, and orchard fruit production benefited greatly from his activities.

Keitt's leadership was largely responsible for the formation of the National Cooperative Research Committee on Stone Fruit Viruses, of which he was made chairman. He was instrumental in formation of the NC–14 Regional Committee on Stone Fruit Virus Diseases and the Interregional Committee on Stone Fruit Virus Diseases and served as the first chairman of these groups.

For many years, Keitt taught a course on diseases of orchard fruits and early in his career taught courses on research methods and fungicides. He was deeply interested in the history of plant pathology, conducting seminars on the subject and contributing a chapter on it in one of the volumes of *Plant Pathology, an Advanced Treatise,* 1959. He translated the classical paper of Prevost on the "Immediate Cause of Bunt or Smut of Wheat" from French into English. This translation is available as one of the series, *Phytopathological Classics* published by the American Phytopathological Society.

Keitt was a fellow of the American Association for the Advancement of Science and a member of many other scientific and scholarly organizations including: The American Phytopathological Society, the Botanical Society of America, the Mycological Society of America, the American

Society of Naturalists, the Society of Experimental Biology and Medicine, the Wisconsin Academy of Sciences, Arts and Letters, the American Association of University Professors, Sigma Xi, Phi Sigma, Gamma Alpha, and Phi Kappa Phi. He served as vice president of the American Phytopathological Society in 1934 and as president in 1937, and as a member of the Editorial Board of the Botanical Society of America from 1935 to 1944. Among other honors, he was elected a fellow of the American Phytopathological Society, received the Certificate of Merit of the Botanical Society of America, and was awarded an honorary D.Sc. degree from his alma mater, Clemson University, in 1937. In 1951, he was one of twenty-four "overseas guests" of the British Association for the Advancement of Science invited to speak at their centennial meeting.

Professor Keitt participated significantly in the development of the University of Wisconsin, whose student body increased from about 4,000 to 30,000 during his tenure. He served twenty-four years in committees which could be described as the "cabinet" of the dean of the Graduate School of the university and was elected member and chairman of the University Committee. During his term, the University Committee presented its report on faculty personnel policies on appointments, reappointment, promotion, and tenure that had very significant influence on the University of Wisconsin. He was appointed as the first chairman of the Faculty Division of Biological Science organized in 1943.

In 1914, Keitt assumed responsibility for lectures in the methods course and later organized the course in fruit diseases and continued to teach it for many years. His leadership in development of air temperature control experiments was noted in the previous chapter.

RESEARCH ON FIELD CROP DISEASES

Dickson organized the program on cereal and forage crop diseases. He developed the course in this area and wrote the textbook entitled *Diseases of Field Crops,* which passed through two editions. He was closely associated with R. G. Shands and Hazel Shands in agronomy who carried on the breeding programs in cereal crops, including those for disease resistance. F. R. Jones was a USDA appointee who was concerned primarily with diseases of alfalfa. Earle Hanson joined the staff in 1946 and was concerned with clover and sweet clover diseases. D. C. Arny, appointed in 1943, was associated closely with Dickson in cereal disease pathology. The details of Dickson's many contributions are given in Chapter 10 on Field Crops.

VEGETABLE DISEASE RESEARCH

Vegetable disease problems were turned over to me as Jones approached retirement. I returned from the market pathology program in 1919, becoming an instructor in that year, and an assistant professor in 1920. I retained a part-time appointment with W. A. Orton's office in the USDA until 1944, carrying their programs on cabbage and onion diseases during that time. In 1922, I was sent to Europe for six months by Orton to study onion culture and diseases in Spain, onion seed growing and diseases in the Canary Islands, and cabbage and cauliflower diseases and seed growing of these crops in the Netherlands and Denmark. General surveys and visits to major research centers were also made in France, Italy, Germany, and England. The report on this trip was published in *Plant Disease Survey.*

Problems with the cabbage diseases continued for the next forty-five years until my retirement, when they were turned over to Paul H. Williams. Previous to that, much assistance was provided by graduate students and especially by R. H. Larson and G. S. Pound who continued on the staff: Larson, until his death in 1962; Pound, until he became dean in 1964. Others who played major roles in the cabbage program were F. L. Wellman, L. M. Blank, M. E. Anderson, and A. A. Cook. Wellman, followed by Larson, did pioneer work with clubroot. This has expanded in recent years under Williams.

Early in the breeding program, some interesting events occurred. As farmers acquired the new variety Wisconsin Hollander, the question of seed production came to the fore. We recognized that resistance was not complete since, in the first year in which a large acreage in the lake shore area was planted, an unusually hot summer ensued; during this time, a high percentage of plants showed symptoms of yellows, which were, fortunately, relatively slight in most cases. As the summer ensued and the average temperature declined most such plants recovered from any signs of disease. I had fortunately asked a few farmers to permit me to include a row of plants of a susceptible variety in their field and in these rows a high percentage of plants succumbed early.

In view of the fact that resistance was then considered only "relative", farmers were advised to save healthy heads and produce their own seed. This was done, but in the first substantial production the black leg disease ran rampant. Thus, we knew that all seed had to be treated. The only known method was the mercuric chloride treatment. While it was suspected that the black leg fungus would invade seed coats, it was not appreciated how much until the next year when a black leg epidemic ensued even after treated seed was used. In the meantime, I investigated hot water treatment and found it to be much more reliable though much more cumbersome.

The kraut manufacturers in Racine and Kenosha counties were not slow to remind us that Wisconsin Hollander was really not a kraut type and was so late in maturity as to satisfy only a small percentage of the kraut need. We had recognized this and had selections under way with All Seasons and Brunswick varieties. These were introduced as Wisconsin All Seasons and Wisconsin Brunswick, respectively. Selections were still started in three midseason varieties, namely Copenhagen Market, Glory of Enkhuizen, and All Head Early. Highly resistant lines were eventually introduced as Marion Market (named for Marion, Virginia, where the parent type heads were selected), Globe, and All Head Select.

These seemed to fit the kraut packers' needs for the time being at least. However, a new breakthrough appeared. Of the All Head Early selections, only three plants survived the winter storage. I brought them to Madison and set them out in a safely isolated location. However, two plants died before blossoming, leaving only one plant. We knew from experience that a cabbage plant is self-incompatible, i.e., it will not ordinarily set seed with its own pollen. Some years later, it was determined at the University of California–Davis, that seed set could be secured by opening buds prematurely and placing pollen from older blossoms on the pistils. This became known as bud pollination. However, this plant had a heavy seed set without bud pollination. When this sample was placed in the Racine trial plot the next year, it was a surprise in two ways. The plants were exceedingly uniform, more so than in any other selection. Secondly, it was 100 percent healthy, a degree of resistance we had not hitherto observed. Looking back at this now, after accumulating several years of experience, it is evident that this mother plant was an exception in that it was self-compatible, not self-incompatible. This would suggest that its ancestors might have been so for several previous generations. In any case, it had become homozygous for high resistance which was just what we were looking for.

This lucky find became the basis of all future cabbage improvement. By crossing plants of the progeny with nearly completely susceptible progenies we found resistance to be completely dominant. Moreover in the F_2 generation, there was segregation at the ratio of three resistant to

Figure 2.1 The Racine-Kenosha vegetable laboratory.

one susceptible. When F_1 plants were backcrossed to susceptible plants, the progeny had one resistant to one susceptible plant. These data were proof that we had found a single dominant gene for resistance to yellows. This was the first case discovered of single-gene resistance in ***Fusarium*** wilts. It was later found in tomato wilt and pea wilt.

M. E. Anderson then made a thorough study of this type of resistance with that in Wisconsin Hollander. In this he grew seedlings under controlled soil temperatures in Wisconsin soil temperature tanks. At 24°C constant soil temperature, all seedlings of Wisconsin Hollander succumbed while all plants of the monogenic resistant type survived. This showed that the two resistant types were distinctly different and it provided a means of distinguishing them in selection work. After this, all new varieties of yellows-resistant cabbage released at the University of Wisconsin were of the single-gene resistant type. In fields of this type, there was no tendency of symptoms to appear even in unusually hot weather.

When one has resistance dependent on only one gene, we were soon to learn, there is likely to appear a mutant of the pathogen which is virulent on the resistant type. L. M. Blank collected isolates from throughout the country and published in 1934 that he found them uniformly nonpathogenic on single-gene resistant lines. For over seventy years the resistance has been effective in most cabbage regions. Only in 1985 in California has virulence on the dominant monogene been reported.

The production of earlier varieties raised the problem of seed production. It was obvious that the method used for Wisconsin Hollander would not do because of the poor storage qualities of these varieties. This led to a study of seed production which had recently become established in the Skagit River Valley of northwestern Washington. The winter climate there is mild enough to permit overwintering *in situ* in the field, the winter temperatures providing the necessary conditions to induce flowering. I visited the area around Mt. Vernon, Washington, in 1919. Several seed producers had growing headquarters there, especially for cabbage, turnip, rutabaga, and table-beet seed. The winter is too severe for cauliflower, which is grown for seed chiefly in the coastal range higher altitudes in central California. What impressed me at once was the climate. The summer is very dry from the end of May to September. Cabbage was sown in seedbeds, according to variety, about June 1; transplanting was in July or early August without water. This seemed incredible with no rain. However, this alluvial delta soil retained enough water from winter rains to carry the crop through until fall rains began. By that time, cabbage was approaching early heading stage. The aim was not to produce hard mature heads, but only enough to carry the plants through the mild winter.

This succession of events appealed to me at once as ideal to check or prevent establishment of black leg in the seedbed and in the transplanted crop. I arranged to make comparative sowings of infected seed at Madison and Mt. Vernon in 1921. While there was general spread in the seedbed at home there was none in the seedbed at Mt. Vernon when I visited it in 1921. These results were published in *USDA Bulletin 1029,* 1922. This appeared to be the ideal place to produce cabbage seed, and it has been ever since. The July and August climate was also unfavorable to infection of the seed fields. For the most part of the next five decades this has been the case, with only two or three exceptions.

Onion was an important crop in southeastern Wisconsin. The acreage was about evenly divided between bulb onions and onion sets. The latter were produced by sowing about fifteen times as much seed per acre as for the bulb crop so as to induce the crop to mature with very small bulbs. This crop was used for production of "green onions" in home gardens in the north and for an early bulb crop in the south. Red, yellow and white bulb varieties were grown for sets. A red globe-shaped variety was the chief one for the bulb crop at that time.

The disease I chose for my doctorate was known as onion smudge. It was first described by Berkeley in England in 1851. He named the fungus *Vermicularia circinans,* assuming that the black pin-point sporulating bodies were pycnidia. In 1907 Voglino, in the University of Torino, Italy, pointed out that the fruiting body was an open acervulus and transferred it to the genus *Colletotrichum* (*C. circinans* (Berk.) Voglino). Berkeley noted in his paper in the *Gardener's Chronicle* that he found the disease only on white bulb varieties while colored bulb varieties growing alongside were free. This also was the case when I began to study it. It appeared as bulbs were approaching maturity and continued as a very slow decay in storage. Its chief importance was in reducing the market appearance of white varieties. This was probably one reason why growers avoided white varieties for the bulb crop. As bulb crops were later grown so as to mature in dry climates, as in the Pueblo area in Colorado, white varieties came out very clean and commanded a higher price.

After I worked out the relation of the organism to the host tissue, I turned to the nature of the disease resistance. Quite accidentally I noticed that when a bit of dry outer colored scale was placed in a drop of water containing the conidia that they started germ tubes normally, but the germ tubes soon ruptured or dissolved at the growing tip while the protoplasm of the spore accumulated in a naked mass on the exterior. It did not matter whether red or yellow scales were used. Germination was normal when white scale tissue was used. Since I looked after the pathologium and greenhouse at this time, I carried on my research at a desk in the former. It so happened that Professor Jones came along at about this time. I told him I had a real find. "Would he like to take a look through the microscope?" He said he would, but warned me that what he saw might determine whether or not I received a Ph.D. He was duly impressed, but had no suggestions. I fooled around with it without any results. I knew that I needed a chemist, and an unusual one at that.

Ten years went by with no progress. Finally, in 1927, one of my first graduate students came to me and said he had his thesis problem about done (it was on another onion pathogen, *Alternaria* *porri*) and would like something else to do. This was Herbert R. Angell. He was a native of Jamaica, where his grandfather was a wealthy English sugar plantation owner. He had enlisted in World War I with the West Indian troops and served four years chiefly in North Africa and Italy. After his discharge, he matriculated in the agricultural college of the University of Montreal. Four years later, he came to Madison and entered the Graduate School in 1924 (see Angell's perspective in Chapter 27). He was an expert photographer and with Fred R. Jones taught Gene Herrling in this craft.

I advised Herbert that I had an honest to goodness problem which had been waiting for a genius for some time. I pointed out that in the final analysis, it required the best analytical organic chemist in the country, but before that, there were some preliminary steps to be taken. I suggested that he get in touch with Karl Paul Link, a young biochemist in our Department of Biochemistry who had only recently returned from two years on a postdoctorate, one year of which was with the world's most accomplished microanalytical chemist of his time in the University of Zurich, Switzerland.

He and Angell were soon at work. I suggested that since this was a new exploration, it would be best to have plenty of raw material on hand. It was late autumn and winter would soon set in. By that time, the onion set growers would be screening the stocks for shipment. This meant that masses of white scales and of colored scales would be piling up. Herbert set out with our Ford (Model T) half-ton truck and came back with sacks of onion scales. These were, by mutual agreement, deposited in the basement of the Biochemistry Building where water extraction was the first procedure. Naturally, it took time and patience to follow the various exploratory tests. The three of us soon had a teamwork plan whereby Herbert did the extracting and Karl applied the steps of chemical treatment. At each step, it was necessary to know whether the disease resistant principle was still active. Herbert brought the samples to my lab and I set up a spore germination test which was read the next morning. Things moved along well until a dish of clear liquid was obtained which was still highly toxic. By methods of those days, it was necessary or at least highly desirable to get the substance to crystallize before the next analytical step was taken. However, this material was obstinate; it would not crystallize.

Now two disturbing events took place. If the one who has had the patience to read this far is a young plant pathologist, he should take special notice. The bales of onion scales in the warm basement of biochemistry by this time were exuding more and more of the characteristic odor of rotten onions. Professor E. B. Hart, chairman of the department, was getting fed up (or "stunk up"), as were probably some others in the building. He told Link that those plant pathologists better take that junk over into their own basement. This was easier said than done. We had been "poor relations" on the second floor of the Horticulture Building since 1912, and J. G. Moore, head of the latter department, was decidedly gruffer than E. B. Hart. The next thing that happened was that Link did not show up for several days. The truth of the matter was that a chemist friend of his, son of our erstwhile professor of inorganic chemistry in the General Chemistry Department, had been a postdoctorate in Europe with Link and had just arrived home. He called Link and they went out on the town that evening, along with some special European brew which he had brought back. The result of this reunion was that Link stayed in bed under his wife's care and guardianship for several days. So the onions continued to stink. But note this! When he did return, the stubborn unknown had crystallized beautifully. What it needed was to be left alone for four days. It was then only a short time until protocatechuic acid was identified. The next day or two was the biochemistry seminar, during which Karl wrote a note to be passed on to Professor

Hart announcing the new discovery. No complaints about the onion stench from then on. After all, Professor Hart spent the first hour of every day in animal barns filling his lungs with the characteristic odor of cow manure, etc., but he was used to that!

By 1914, the vegetable canning industry, which had started before 1890, was expanding rapidly in the state. By that time, about 100,000 acres of peas were canned annually. Other crops, in order of importance, were sweet corn (diseases handled by Dickson, et al.), string bean, cucumber pickles, red beet, cabbage as sauerkraut, lima bean, and carrot. By 1914, the pea crop was in serious disease trouble. The chief diseases were *Ascochyta* blight, bacterial blight, and root invader problems still uninvestigated, but later described as *Fusarium* wilt and *Aphanomyces* root rot. The first one to concentrate on pea diseases was R. E. Vaughan. His major thesis problem as a graduate student was the *Ascochyta* blight. Among other contributions he pointed out the merits of Idaho-grown pea seed in which the crop grew in a relatively dry climate, unfavorable to *Ascochyta,* a foliage pathogen dependent upon rainfall for dispersal and infection, with the result that Idaho-grown seed was practically free from the pathogen. The industry rapidly followed his advice, which resulted in this becoming a minor disease except where reasonable rotation was neglected. Bacterial blight, first described in Colorado, responded well to the shift in seed growing also. Vaughan was appointed Extension Plant Pathologist for Wisconsin in 1914.

As World War I ensued, Fred R. Jones was allowed to shift his attention temporarily from alfalfa to pea disease. M. B. Linford, coming from Utah State University at Logan, started graduate work about this time. He was given pea wilt as the subject of his doctor's thesis. He described the causal organism as *Fusarium orthocerus* var. *pisi* (now known as *F. oxysporum* f. sp. *pisi* (Linford) Snyder and Hansen). I set up trials on naturally infested soil in Wisconsin with a world collection of varieties in 1929. This showed that some varieties were resistant (i.e., a large percentage of plants survived where susceptible varieties succumbed completely), some had various percentages of resistant plants, while some were completely susceptible. Resistant varieties and resistant individuals in segregating varieties practically always were not acceptable for canning needs. E. J. Renard, working for his doctorate in genetics and agronomy, led the way to produce acceptable resistant varieties by crossing and backcrossing. B. L. Wade, working on his doctorate in genetics with a minor in plant pathology, showed that resistance to wilt was controlled by a single dominant gene. Later W. C. Snyder described a more slowly developing disease which he called near-wilt, due to a second race of *Fusarium oxysporum* f. sp. *pisi.* D. J. Hagedorn and W. W. Hare, who conducted field trials with near-wilt, discovered a variety which contained plants resistant to near-wilt. Hare and D. G. Wells showed that resistance to near-wilt was controlled by another dominant gene. The first variety developed which was homozygous for resistance to wilt and near-wilt was introduced as Delwiche Commando.

Charles Drechsler, who received an M.S. at Wisconsin and a Ph.D. in mycology at Harvard University, was assigned by the USDA to collaborate with Jones; after much work, he isolated the organism responsible for pea root rot. It was described as *Aphanomyces euteiches* Drechsler in 1925. Although this disease has since been the subject of much research, its control through disease resistance has not been accomplished. The only practical control is avoidance of soils which are heavily infested. R. T. Sherwood and Hagedorn (the latter received his Ph.D. in 1948 and was appointed to an assistant professorship in plant pathology and agronomy in that year) worked out a method of assaying soils in the greenhouse for degree of infestation. This discovery was the basis for these two men receiving the Campbell Award. Hare and Hagedorn both served in armed forces in World War II. Soon after his return, Hare accepted a position in his home department at Mississippi State University. Hagedorn continued in charge of pea diseases and pea breeding. Eventually he became a full time plant pathology staff member, the continuation of pea breeding being in agronomy under Professor Earl Gritton. Hagedorn has continued ever since a very prolific program on pea diseases. Much of what we know about the several viruses affecting peas comes from this work.

Other canning crop problems arose. Snap beans were on a decided increase in central Wisconsin where a virtual underwater lake at about sixty feet below the surface was discovered. This permitted the use of irrigation by overhead sprinkling systems. Early potatoes and snap beans responded very rapidly to irrigation on this sandy soil with relatively low fertility. The development of the mechanical bean harvester also led to increase in acreage of this crop. The two important seed-borne pathogens, those of anthracnose and bacterial halo blight of bean, were relegated to a minor position when it was shown that Idaho-grown seed was quite free from them. The chief plaque in the 1930s was the seed-borne mosaic virus. W. H. Pierce, who had grown up at Twin Falls, Idaho, center of the dry bean industry, after receiving a B.S. and an M.S. degree in plant pathology at the University of Idaho, came to the University of Wisconsin in September, 1930, to continue graduate work toward a doctorate. I put him on the mosaic problem at once. He soon demonstrated that there were two distinct bean viruses concerned. One of these was seed-borne and was referred to thereafter as "common bean mosaic virus" (CBMV). The other was not seed-borne and depended on weed hosts as a means of overwintering. It was referred to as bean yellow mosaic virus (BYMV). Both were transmitted primarily by aphid. CBMV was the most important on the canning bean crop, and western-grown seed, although free of anthracnose and halo blight organisms, was rather generally infected by that virus. Some twenty years earlier this virus had been destructive on dry bean, chiefly red kidney varieties, in New York State. The same condition was soon recognized in Michigan, the chief producer of white "navy" or "pea" beans. A field bean resistant to CBMV was developed by Spragg in Michigan from a single pea bean plant. It came into commercial use about 1916. In 1929, I was told by Willis Crites of Sioux City Seed Company of a similar situation in Stringless Green Refugee. This was then the favorite canning bean variety in the Midwest. Ralph Corbett, who was in charge of that company's headquarters at Billings, Montana, had observed a single healthy plant in a heavily infested field of about four acres of Stringless Green Refugee. He saved the seed therefrom and planted most of it the next season (1930) in the same field with the same variety. As in 1929, all plants showed severe symptoms of mosaic, except the progeny from the healthy plant of 1929, consisting of 100 plants or more. They were all free from mosaic. We were given seeds from this row of plants in 1930. With it, Pierce started a breeding program by crossing this with Stringless Green Refugee. After about three backcrosses, he came up with two lines of Stringless Green Refugee type, highly resistant to mosaic, and differing somewhat in time to maturity. These were named and released as Idaho Refugee and Wisconsin Refugee. The first of these soon took over most of the acreage in Wisconsin.

Pierce kept records of behavior of F_1, F_2, and backcross progenies. Resistance was dominant and segregation fitted only loosely into a single gene pattern. Meanwhile, Melvin Parker, majoring with Dr. Brink in genetics at the University of Wisconsin, studied the inheritance of field beans. When crossed with susceptible, resistance was recessive and segregation in F_2 and in backcross progenies suggested resistance to be controlled by a single recessive gene. After Pierce returned to Idaho, he crossed resistant Refugee with resistant dry bean. The F_1 progeny was resistant, but in the F_2 generation susceptible individuals appeared. This indicated that two types of resistance occurred. It was not until Mohammed Ali, a graduate student from Egypt (not the prize fighter) majoring with Dr. Brink and minoring in plant pathology, took up the problem, that this matter was straightened out. For the details, the reader is referred to my textbook, *Plant Pathology,* 3rd edition.

With the important common mosaic taken care of and with introduction of resistance to it into numerous varieties, this disease was relegated to a minor position. Continuous cropping in central Wisconsin led inevitably to root rot diseases and bacterial brown spot. These still required major attention, but fortunately at this writing, Hagedorn and his associates have made substantial progress in producing resistant lines.

Over the years, the acreage of red beets increased as that of sugar beets declined in the state, for economic reasons. Wisconsin with New York and Oregon became a leading producer of red beets. This crop, like string beans, fitted into the operation of the pea cannery, since they came to maturity after the latter crop was over. We heard little about red beet diseases until internal black spot appeared. I remember a seed salesman coming to me and describing this trouble. Soon I heard that the U.S. Food and Drug Administration had condemned two carloads of Wisconsin canned beets in the Cincinnati market, declaring them unfit for food because of this disease. It resembled in some respects the heart and dry rot of sugar beet which had pestered this crop in Europe for several decades. First one and then another fungus was cited as the inciting agent, but each, in turn, was disproved. Finally in 1931, Brandenburg, a German plant pathologist working for his doctorate in Holland, noted that sugar beets grown in boron deficient liquid nutrient showed the heart rot symptoms. The application of borax to soils where it occurred rapidly cleared up the trouble. As we encountered the internal black spot in red beets, the symptoms suggested heart rot of sugar beets. In the spring of 1938, I visited several beet canners asking each of them to have their fieldman show me fields of beets where the trouble was expected from previous experience. I had a bag of borax with me, and like Johnny Appleseed, staked out a few rows in each case and dribbled a little borax along the rows of beets which had only recently emerged.

Well, the dribble trials were quite convincing, and I presented them to the canners, pointing out that they were only preliminary. The immediate question was what shall we do next spring. I told them that I could make no official recommendation on such meager evidence, but man to man I would if I were them require every beet farmer in his contract to broadcast 40 pounds of borax per acre before final preparation and sowing. When my recommendation reached New York, where they had similar troubles, the Cornell savants disagreed with me. They said 40 pounds of borax per acre would injure the crop beyond repair. Their extension service gave orders to county agents that they could recommend no more than five pounds of borax per acre.

It so happened that I had agreed to attend the International Congress of Horticulture the next summer in Europe. The beet harvest had barely started when I left. It was all over when I returned. The graduate students working closely with me on this problem were William T. Schroeder and James P. Jolivette. When I returned they greeted me with broad smiles and told me the borax treatment had worked and internal black spot was licked. But I said maybe the environment was unfavorable for the disease. "No," they said, "we have a perfect control. One canner refused to follow your advice and he had plenty of black spot. Moreover, the New York canners had plenty of trouble with their five-pound application." Jim worked out an excellent thesis studying the effect of boron deficiency on the histology of the growing plants. He used beets and cabbage as the principal crops in his study. Unfortunately, as a Wisconsin National Guard reserve officer, he soon joined the U.S. Army and was killed in battle as General MacArthur's troops were driving the Japanese out of the Philippines. He is buried in our National Cemetery in Manila.

By 1946, cucumber scab or spot rot had become a major limiting factor. The disease was until then considered a minor one. It occurred chiefly in cool summer regions as in Maine. As our acreage moved north, it became more destructive. It was especially serious because the fungus was most destructive on young fruits, the stage most valuable for pickling. We showed by controlled experiments that it was most destructive at about 17°C while at 21°C and above lesions were rapidly cicatrized by host tissue reaction. This explained why the disease was never observed in the latitude of Madison. A resistant garden variety had been developed in Maine some years earlier and introduced as Maine No. 2. It was highly resistant when tested in Wisconsin. By crossing with standard pickle varieties such as Chicago Pickling, it was determined that resistance was controlled by a single dominant gene. A suitable pickle variety resistant to scab was soon developed and released as Wis. SR7. In the meantime, a mosaic-resistant pickle variety was introduced by the Ohio Experiment Station as Ohio MR17. We crossed this with Wis. SR7 and developed a double resistant variety which was introduced as Wis. SMR 18.

DISEASES OF ORNAMENTAL PLANTS AND TREES

A. J. Riker took his undergraduate work at Oberlin College. He then spent two years in the Department of Botany in the University of Cincinnati where he took an M.S. degree. He then entered the armed services during World War I. Upon his discharge, he entered the Graduate School at the University of Wisconsin, majoring in plant pathology. The crown gall disease was one which had received much attention in Erwin F. Smith's laboratory where the causal bacterium was described in 1907. Smith described the bacteria as intracellular. Riker took crown gall as his thesis problem and continued his studies with numerous associates after gaining his degree in 1922. He spent the next year as a postdoctorate fellow in Europe. Returning to the Wisconsin department in 1923, he became a permanent staff member. He proved that Smith was wrong in claiming that the bacteria were intracellular. He presented irrefutable evidence that the bacteria were intercellular. He and his associates described, in addition to crown gall (incited by *Agrobacterium tumefaciens* (E. F. Smith and Townsend) Conn.), two other related species. One of these, described in 1942, incited the hairy root disease on apple trees and is known as *Agrobacterium rhizogenes* (Riker et al.) Conn. The third disease known as cane-gall appears as small protuberances or elongate ridges on fruiting canes of *Rubus* spp. The inciting organism is *Agrobacterium rubi* (Hildebrand) Starr and Weiss. Associated with Riker as doctorate students in his extensive crown gall program were E. M. Hildebrand, W. M. Banfield, S. S. Ivanoff, W. H. Muir and A. C. Hildebrandt. Riker was also responsible for building up a program on tree diseases. One of his first extensive programs was on oak wilt. He and associates described the causal oragnism. J. E. Kuntz continued an intensive program on this disease after he joined the staff in 1946 (Chapter 9).

DISEASES OF TOBACCO

James Johnson was a member of the horticultural department in charge of all tobacco research. In Chapter 1 an account was given of his building of the first Wisconsin soil temperature tank. This was in connection with his consideration of tobacco root rot. With the encouragement of L. R. Jones he took charge of all the tobacco disease work. Since tobacco mosaic was a major disease and since little was known about it, he became a devout student of the nature of plant viruses. I remember Wendel M. Stanley (who was the discoverer of the virus molecule) referring to Johnson with the highest of respect for his work on viruses. Eventually Johnson became a nominal member of the Department of Plant Pathology and a number of students from there conducted their Ph.D. research under him.

EXTENSION

The Smith-Lever Act, passed by Congress in 1914, opened the way for extension specialists in various fields of agriculture. R. E. Vaughan, who had come from Vermont soon after Professor Jones, was one of the first extension specialists in plant pathology. His appointment in 1914 was followed by relatively rapid expansion of the county agricultural agent system. J. W. Brann spent part of his time in plant pathology extension. This continued until both Brann and Vaughan retired (Chapter 6).

CHAPTER 3

The Second Generation, 1940–1964

Glenn S. Pound

In the preceding chapters, Dr. Walker has presented detailed developments of the early years of the department. In this chapter it would seem appropriate for me, a representative of the "Second Generation", to give an appraisal of the "First Generation" leaders as well as to characterize the structure and programs of the department as the second generation began to assemble at Madison about 1940. But first something should be said about the academic matrix that was the University of Wisconsin, for the departmental history must be measured within that context.

THE UNIVERSITY OF WISCONSIN—A UNIQUE ENVIRONMENT

Few universities, if any, can match the University of Wisconsin in the kind of academic environment it has offered its scholars. The Department of Plant Pathology has profited by and helped to build the great traditions that characterize the University of Wisconsin.

Perhaps the greatest of these traditions has been the unparalleled emphasis on the individual professor and his unfettered freedom to seek and teach the truth. From the very outset of an appointment as an assistant professor, one is a member of the graduate faculty and is privileged to teach graduate courses and direct graduate research.

No one is tied to another in regard to promotions in rank or adjustments in salary. There are no quotas for the various ranks, in departments or colleges. Rather, there is an orderly progression of growth and maturity for each person. As a result, Wisconsin has a faster track than many institutions and this is stimulating to development.

Professors have always been free to establish collaborative relations with colleagues in other departments anywhere in the world. Interdisciplinary research and teaching at the University of Wisconsin were widely practiced from early years and it was unnecessary for the University of Wisconsin to create an administrative unit to bring about interdisciplinary programming as many universities did in the 1960s (e.g. a new College of Biology at the University of Minnesota, a new Division of Biology at Cornell University) when molecular biology was recreating unity in biology.

Agricultural research at the University of Wisconsin had an unusual orientation to science and at the same time was highly developmental. Dean Russell had a strong belief that the College must have a strong dimension of science if it was to solve agriculture's problems. As pointed out elsewhere, plant pathology was one of his chosen instruments to establish this principle.

Also, recounted in Chapter 23 on *The Wisconsin Idea* are details of how meticulously the professors and farmers worked in partnership (e.g., in L. R. Jones' very first experimental thrust at cabbage yellows control, he asked local farmers to "assist" him in selecting resistant plants of good type). This engendered a sense of mutuality between the college and the people of the state and a public trust on the part of the university that created much of Wisconsin's reputation.

Administration at Wisconsin, at all levels, has been dedicated to servicing and implementing programs. It has worked from the bottom up rather than from the top down. A high-handed administrator does not last long at Madison.

Another significant factor in professional development at Wisconsin has been the tradition that a person is not asked to carry a teaching load that would preclude full and fast research development.

THE DEPARTMENT AND THE STAFF IN 1940

The department as conceived and structured by L. R. Jones was mature and full blown when I became associated with it in September, 1940. There were fifteen staff (including U.S. Department of Agriculture [USDA] personnel) and twenty-two graduate students. The staff consisted of:

Prof. G. W. Keitt, chairman
Prof. J.G. Dickson
Prof. J. C. Walker
Prof. A. J. Riker
Prof. R. E. Vaughan
Prof. James Johnson (salaried in horticulture)
Prof. B. M. Duggar (primarily botany)
Prof. E. M. Gilbert (primarily botany)
Prof. G. H. Rieman (primarily genetics)
Asst. Prof. John Brann
Asst. Prof. R. H. Larson
Instructor—John McLean
Instructor—Otis C. Whipple

USDA—Fred R. Jones
USDA—Paul Hoppe

For all practical purposes, the department consisted of Keitt, Dickson, Riker, Walker, and Vaughan, for all of the others did not participate in budget and policy decisions of the department. One can readily see that staffing for a second generation was in order, for otherwise there would be a serious lack of leadership when the senior members retired. Plant pathology at Wisconsin has been careful, and indeed successful, in spreading its leadership. It has operated under the assumption that retirements need not mean loss of programs or momentum even though they do mean loss of leadership.

Persons familiar with the department in 1940 will quickly notice that Prof. M. P. Backus is missing from the staff roster. This is because the department paid part of the salary of E. M. Gilbert who taught the laboratory section of Plant Pathology 101 from 1920 to 1937 when he was replaced by Backus. The Departments of Botany and Plant Pathology never got around to altering the budgets until 1943 even though Backus began teaching PP 101 in 1937.

It was common practice in the early years of the department to use the title of instructor for a student who had completed the Ph.D. degree and was waiting for a job opportunity or for a student who had completed all course work and could profit by a full-time appointment. Two instructors were on the staff roster in 1940. Otis Whipple had received his Ph.D in 1938, following which he directed the program of the vegetable field laboratory in Kenosha County. He died of a cerebral hemorrhage while on a field trip to Kenosha in the spring of 1941.

John McLean finished his degree in the spring of 1940 and remained on for a few months in charge of the potato seed certification. In late 1940 he took a similar job in Colorado and left the department.

Two other persons should be mentioned at this time who were to receive post degree appointments of instructor. These were James Jolivette and Berch Henry. Jolivette finished his degree in 1941 and Berch Henry finished in 1942. Both became instructors and soon went into military service. Jolivette was killed in 1945 in the Battle of Luzon. Henry took another job upon discharge from the Navy. It is not clear what the department's intentions were about these men. They had both done well in research and might well have remained at Wisconsin had different conditions prevailed.

The graduate students in 1940 were:

J. O. Andes	James P. Jolivette
Deane C. Arny	Leonard M. Josephson
Sam Baritell	J. Duain Moore
Donald W. Chamberlain	Robert F. Patton
John B. Carpenter	Glenn S. Pound
Robert W. Fulton	Ralph Rawlings
George Gries	J. Ralph Shay
Richard H. Gruenhagen	William T. Shroeder
Woodrow W. Hare	Paul G. Smith
Berch W. Henry	Edward Spoerl
William J. Hooker	Elmer C. Stevenson

Robert W. Fulton had finished his Ph.D. degree earlier in the year but was staying on in a postdoctoral capacity. W. B. Allington, who had finished his degree in 1938 under James Johnson, was still in Johnson's program as a postdoctoral student.

Of these twenty-two students, five (Arny, Fulton, Hare, Moore, Pound) were to receive professorial appointments and all but Hare remained at Wisconsin for their careers. In addition to these, Albert C. Hildebrandt, James E. Kuntz, and Donald J. Hagedorn began their graduate studies in 1941–42 and received their degrees in 1945, 1945, and 1948, respectively. Hagedorn's studies were interrupted by military service while Kuntz and Hildebrandt were permitted to remain at Madison during the war. These three were also to become career staff members.

It is most unusual for a single department to draw such a heavy complement of staff from the same experience and time frame. Two factors were obviously at play: (1)The "Big Five"[1] were at their peak and the department was at a point of selecting understudies to assure continued leadership in their respective areas; (2) immediately after WW II, land grant colleges across the country greatly expanded staffs with increased federal and state appropriations. The Bankhead-Jones Act of 1935 required the states to match the federal Hatch appropriations so there was a strong force of expansion. The nation had gone through a number of years of greatly reduced training, so manpower was short. The choice of those with known performances and potentialities was perhaps exercised more freely than might otherwise have been the case.

This 1940 cluster of students, as a group, cast a tremendous professional influence. In addition to the eight who received professorial appointments at Wisconsin, three others became departmental chairmen or deans at other institutions. George Gries was chairman at Arizona and later dean of graduate studies at Oklahoma State University; Ralph Shay and E. C. Stevenson were heads of botany-plant pathology and horticulture, respectively, at Purdue University and later at Oregon State.

1. The reader will note references to "The Big Five" and/or "The Big Four". The latter were Keitt, Dickson, Walker, and Riker, all professors of plant pathology. James Johnson, who was a bona fide plant pathologist but attached to the Department of Horticulture, was the fifth member of "The Big Five". His program was so central to plant pathology that he was considered part of the department, although not administratively.

Woodrow Hare's tenure as an assistant professor at Wisconsin was very short, because he was a most "southern southerner" and he could not resist the call to return to his native Mississippi State University.

The Department of Plant Pathology in the 1940s was a federation of fiefdoms. The "Big Four" (Keitt, Dickson, Walker, Riker) had their individual areas and almost total control of them. Each communicated directly with and made commitments to prospective students. Each decided when their students were ready for their exams[2] and who the examiners would be. Each placed his own students in jobs, helping each other with support letters as needed.

The department quite literally ran itself. Professor Keitt was a very efficient chairman of this loose administrative structure in that he was very busy with his own program, he was basically congenial and placid, and he was quite content for the other three to share in the administrative load by running their own programs and by carrying one key responsibility each. For example, Riker looked after the library, Walker took care of general supplies, and Dickson managed equipment repairs. Budget resources other than salaries were allocated to broad categories such as labor, travel supplies and expenses, and equipment repairs. The departmental budget was managed as these fund kitties and was not allocated by projects.

The Big Four differed markedly in style and principle. They had a certain amount of infighting but on things that counted they closed ranks and pulled together. They exhibited unbroken loyalty to the college administration and to the profession. When a student was being recommended for a job he could count on as strong a letter from one professor as another. When a job opening was known, the group decided which student would best fit the need and only that student was recommended. In my long experience with the department, I never felt that any factor was placed above creating the best fit between the student being recommended and the institution being served.

When recommendations went forward for appointments, promotions, or salary adjustments they always went with unanimous recommendations. In my later years at Wisconsin when I was dean of the college, I was proud to witness the unusual ability of the department to manage its internal affairs without friction.

THE BIG FIVE—CHARACTERIZATIONS

It would seem appropriate to record in this place a brief statement of the leadership role each of the Big Five had in building this great department.

George W. Keitt

Professor Keitt was the logical choice to assume the chairmanship following L. R. Jones. He was the most senior of the five, being the recipient of the first advanced degree (M.S.) given by the department. Upon receipt of the Ph.D. degree in 1914 he immediately became the leader of the section of fruit diseases. He developed true eminence in his programs of epidemiology, chemical control, stone fruit viruses, and the genetics of pathogenicity in the fungi. In the classroom his most conspicuous interest and expertise were in the history of our profession.

2. This is well illustrated by my own experience. In the spring of 1942, I was generally preparing for my preliminary examination but with no date known. I had an 8–10 A.M. class in Birge Hall on Monday and when I went to my mailbox in the Horticulture Building at 10 A.M. Clara Sleicher, the departmental secretary, rushed out and said to me, "Do you know that your prelims are tomorrow morning at 8 A.M.?" I had only twenty-two hours and the first thing was to get a hair cut, for in 1942 you went into a preliminary exam with all the "spit and polish" of a marine.

Professor Keitt was the ultimate gentlemen, being always kind, friendly, gracious, and dignified. He was never high-handed in his administration. His work day was generally nine to four o'clock with a reasonably long lunch break.

Professor Keitt was by nature a procrastinator. He constantly lived with deadlines. He neither cherished nor despised departmental administration and dealt with it when he had to. His work schedule philosophy was reflected in the fact that his students generally spent at least one year longer in their graduate tenure than the students of Walker or Dickson. Outside the department he served the university best in committee leadership roles in the Graduate School administration.

James G. Dickson

A. G. Johnson was another of Jones' early Ph.D.'s (1914) and was added to the staff immediately to develop a program in cereal diseases. He immediately developed cooperative programs with the USDA which resulted in his transfer to Washington D.C. in 1919. James G. Dickson was one of his students (joint with botany) at that time and he was appointed to the department staff in 1919 to replace Johnson, although completion of his degree was not until 1921.

Dickson was extremely energetic and ambitious. He rapidly developed a multifaceted program to cover both cereal and forage crops. He carried a large complement of graduate students throughout his career and he trained many excellent students who were later to have great impact on our profession.

Dickson was a paradox in that he carried on extensive cooperative relationships with the USDA, with colleagues in agronomy and genetics, and at the same time effectively alienated their personal support. He had a great proclivity for wanting to be "right and out front" with judgements and actions and many times this led him to be caught off base.[3] He was always covetous of the opportunities to assist in judgements and thus played closer to the chairman than the other professors did. In spite of these personal traits, he was always cooperative, and the number and quality of his graduate students attest to the success and eminence of his career.

John Charles Walker

Of the Big Four, Walker was the toughie. He spoke with the greatest candor and never pussyfooted around with issues: because of his candor and his ability to quickly come to terms with an issue, he exerted unusual influence with his colleagues.

Walker generally had the reputation among the graduate students of being tough, uncommunicative, and downright unpleasant. His personal traits did, indeed, invite such judgements. He was extremely disciplined in the use of his time. While he was amenable to hearing a good story, a bit of gossip, a passing comment, he rarely initiated such conversations and never allowed them to become protracted.

3. I recount such an activity of Dickson's that almost became a serious problem of relationships. In 1950, one of my students was simply not developing well, and after repeated efforts to save him I finally advised him to terminate his studies with a Master's degree. He took a job in industry but at the same time somehow had Dickson searching for opportunities for him.

Upon return from one of the southern states Dickson informed me that he had found an opportunity for this student to be a student there and do research which could later be transferred to the University of Wisconsin from which the degree would be given. I replied, "Jim, I will have none of this. You have gotten us into a mess, and you have got to get us out." He did reverse himself and the incident never created the least problem in our continuing relationship.

His life was his work. He worked as he walked, and as he vacationed, and as he participated on exams. He worked as if every day was his last. And unlike his colleagues, he did menial work in the greenhouse, the laboratory, and the field.

Plant pathology, to J. C. Walker, ultimately meant control of plant diseases. He is our profession's best example of combining basic and applied research. He became an unusual resource to the vegetable seed industry, the vegetable canning industry, and to the farmers of Wisconsin and the nation. Few, if any, have contributed so much to the economics of food production.

The academic dimension of Walker's life was equally illustrious. He organized his research around projects designed to control diseases but into these projects he built in objectives designed to obtain the most fundamental information of the disease process. There were no limits to the extent of his probes for fundamental information. The research of his laboratories brought great international recognition and acclaim to him and the department. He is truly one of the great historic leaders of plant pathology.

A. Joyce Riker

Riker (one of Keitt's early students) started off as a staff member in different format. Except for his salary, his support was extramural. There is no indication in the records as to why this was so. By the time he received his degree (1921), the original staff plans of L. R. Jones (i.e., positions to cover fruit diseases, field crop diseases, and vegetable diseases) were complete in Keitt, Dickson, and Walker. Jones himself was giving the attention to ornamentals that seemed to be required. There was no cry for attention to forest trees so there would seem to have been no justification to support a position for Riker. This would be further suggested by the fact that it was nine years before Riker produced his first student with a Ph.D. and twelve years until he produced his second Ph.D. Obviously, his program support was skimpy.

Be that as it may, throughout Riker's career support for his program came from such extramural sources as nurseries, the Wisconsin Department of Natural Resources, the Research Committee of the Graduate School, the United States Forest Service, the National Science Foundation, etc. Except for the strong program in forest pathology which he developed in his later years, he did not have the agricultural dimension to his profession that his colleagues had.

Long before grant support permitted scientists to attend so many meetings, Riker was a seasoned traveler. Garnering support for his program required it, and much of his professional reputation rested upon "committee" work. I think it fair to conclude that his personal research did not qualify him for his membership in the National Academy of Science but his wide acquaintanceship with NAS members did.

Aside from Riker's early work on the crown gall disease which established him in the profession, perhaps his greatest contribution was his leadership in developing a strong, multidisciplinary program in forestry. His contributions were restricted to the graduate program, for the undergraduate degree in forestry came after his retirement. Riker's forest tree disease program led to staff positions for James Kuntz, Robert Patton, Jack Berbee, and Eugene Smalley, perhaps the strongest research group on tree diseases in any university.

James Johnson

James Johnson, although a *bona fide* plant pathologist throughout his career, had his appointment in the Department of Horticulture. The story goes that when he received his degree in 1918, L. R. Jones had no position for him in plant pathology, but since he was too good to lose he arranged for an appointment in the Department of Horticulture. Beginning in 1943 he did begin an appointment, without salary, in plant pathology. His students (e.g. C. S. Reddy, Karl Koch, C. M. Tompkins, Isme Hoggan, T. J. Grant, W. B. Allington, Armin Braun, Robert Fulton, Howard Heggestad, James Guthrie) were all bona fide students of the department by virtue of the chairman of the department signing student records with Johnson.

Johnson's contributions to plant pathology were monumental, and doubly significant when one considers the isolation in which he lived. He was truly one of the historically great pioneers in plant virology. His niche in history centers around his early attempt at plant virus classification and his belief and espousal that viruses were organismic. In this he was indeed prophetic! One of his proudest possessions was a letter of commendation from Professor Whetzel of Cornell University written in response to Johnson's bold idea that viruses were living things.

Johnson also made historic contributions to virus literature in his discovery of latency of the potato mosaic disease and of the relation of air temperatures to host expression of disease.

In addition to his plant virology research he carried the leadership of research on control of tobacco root rot and was one of the pioneers in Wisconsin's contributions to the role of environmental factors in disease incidence and development.

ASSEMBLY OF THE SECOND GENERATION STAFF

I have chosen to describe the assembling of the "Second Generation" staff around the crops organization of the department. This was before the era of molecular biology and the department was organized on a crops basis. The era of emphasis on more basic subject matters of biochemistry, genetics, physiology, and cell biology were to come later. The 1940s was still in the era of descriptive pathology and students were trained primarily as taxonomic mycologists and physiologists.

Students began to scatter, with or without degrees, after Pearl Harbor. Some had Reserve Officer Training Corps or National Guard reserve commissions and left for military service immediately. Some were able to finish their degrees before being drafted. Some draft boards granted exemptions from military service because of the importance of food production. All of those who were granted exemptions were required to give maximum attention to food production needs.

VEGETABLE CROPS PATHOLOGY

By the time the draft board got around to my number, a serious food situation had developed that dictated a war-time assignment for me in the production of cabbage seed for lend-lease shipments to England and Russia. When Hitler's armies overran the lowlands of northern Europe in 1940 they cut off our supplies of vegetable seed from imports. A seed-growing industry had been developed in the Puget Sound area of Washington, but it had received virtually no servicing from research agencies, and plant diseases had built up to devastating proportions. Furthermore, the winter of 1942–43 had been so severe that practically the entire crop had been lost. Both England and Russia were heavy consumers of cabbage so demands for seed were great.

J. C. Walker made a trip through the west coast seed-growing areas in March and April of 1943 at the request of the USDA and participated in plans to establish an emergency research program in cabbage seed production. He essentially volunteered my services to the program. The pressure was so great for this program to be launched that a portion of my thesis was mailed to him and read by him in the hotel in Sacramento. The commencement exercise in the Field House was on May 21, and my wife and I left that afternoon for Mt. Vernon, Washington, before I had received a formal appointment. I was to work for four months before receiving my first salary check.

Washington State University and the USDA agreed to cooperate in the development of the Northwest Washington Vegetable Seed Laboratory to be located in an old building on the county fair grounds at Mt. Vernon, Washington. I was to develop the pathology program as a USDA employee, and Washington State was to provide a horticulturist, who was to be director of the station, and an entomologist. I was the first to arrive. I worked out of the county agent's office and received a microscope and Ford car transferred from USDA labs at La Jolla, California and Corvallis, Oregon, respectively. I rented a greenhouse of 700 square feet from a florist.

Dr. Walker had described the disease situation in Washington as serious epidemics of *Mycosphaerella* ringspot and *Sclerotinia* stalk rot. Upon my first field trip I changed the diagnosis to an indescribable incidence of cabbage mosaic, the subject of my thesis dissertation. I could not have felt more at home!

The cause of the serious virus problem was readily apparent. Seeds were sown in plant beds in early June and transplanted into rows for seed production in September and October; they would be cut for harvest the following July and August. Thus, the seedlings were exposed to uncut seed plants for approximately two months. During this period, severe infestations of aphids built up in the seed fields and plant beds. The seedling plants were literally 100 percent infected when removed from the seed beds, for the beds were adjacent to maturing seed fields. This cycle had to be broken, and the obvious way was to get the seedsmen to relocate their plant beds to areas beyond the flight of aphids. To prove the point, I established an experimental bed forty miles up the Skagit River.

In the Spring of 1944, I made such a recommendation to the seedsmen. I was opposed in this by the horticulturist director of the station on the grounds that I had not been there long enough to make such a bold recommendation. I was very confident of the move, however, and took the war emergency seriously. I stood by my recommendation, and in one season the virus problems of both beet and cabbage were under control. An illustration of the effectiveness of the program was that average seed yields per acre over the entire area increased by 100 percent in one year. The area people were ecstatic and treated me with unusual respect, only deepening my problem with the director of the station.

After these problems were brought under control, I let Walker know that I felt too isolated, professionally, to stay there long. He placed me in touch with C. M. Tucker of Missouri, relative to a staff position there. I visited Columbia in December of 1944, but ultimately declined any interest in the job because it had a dimension of extension responsibility to the Dutch elm disease. I communicated with R. G. Goss of Nebraska relative to the job vacated by James H. Jensen who had gone to North Carolina. This did not develop into anything of interest.

In early 1945 (February 28), I received a brief note from J. C. Walker telling that J. P. Jolivette of the Madison staff had been killed in the Battle of Luzon. After what I thought was a courteous lapse of time (some four or five months), I wrote Walker and asked if I might be considered for the Jolivette job. To our great delight, I received an immediate reply saying that he had already advanced my name and had tentative administrative approval. On October 25, 1945 I received a formal offer from Keitt. We returned to Madison April 1, 1946, where I resumed research on cabbage and other vegetable crops as an assistant professor of plant pathology.

My entry into plant pathology had, indeed, been a baptism of fire, but one that aided very materially in my professional development.

On the first of April, 1946, I experienced one of the great traditions of the University of Wisconsin, namely, that no one tells a professor what to do. Walker and I traveled to the campus together on that first day of my new job. He took me into the office across from his and simply said "Well, Glenn, here it is." Neither then nor any day thereafter did he ever talk with me about what I should work on. I was on my own, to sink or swim.

Russell H. Larson

Larson obtained his Ph.D. degree in 1934 and had a very credible thesis which dealt with the mode of tissue invasion of cabbage by the club root organism. He disproved an earlier report by L.O. Kunkel that the pathogen invades stem tissue without wounds. Larson was kept on the staff as a research associate, instructor, and assistant professor. By the time I became associated with the department, he was entrenched in a permanent position, but with no opportunity for full rank. His problems, whatever they were, were personal and not professional. He was a skilled and diligent technician and became one of the best potato pathologists in the business. He and his students brought great elucidation to the complexes of potato viruses by characterizing differential host reactions group by group. Among his students were Richard Ladeburg, John Darby, Eugene Gasiorkiewicz, Raymond Webb, Don MacLachlan, Eugene Easton, Dean Robinson, A. Juergen Hansen, John Shaw, Javier Cervantes, German Kollmer, Lloyd Seaman, and Charles Walkinshaw. He was singularly effective in ridding the potato industry in central and southeastern Wisconsin of disease problems by espousing the cause of disease-free seed and crop sanitation.

In later years (1944), while keeping an academic appointment, he became the chief USDA vegetable pathologist in a long-time cooperative program with the University of Wisconsin. Prior to this year, J. C. Walker had been the chief USDA vegetable pathologist at Madison. This adjustment between Walker and Larson was appropriate from the standpoint of Walker's leadership in the department, but it also served to stabilize Larson's career.

When I was moving into the chairmanship of the department in 1954, I was uneasy about having a very productive researcher on the staff who could not look forward to becoming a full professor. I talked to Walker about the matter and he replied, "I have tried and have been unsuccessful. I would appreciate anything you can do." With some trepidation I approached Keitt, and his reply to me portrayed the graciousness of his character. He said, "It was a problem for me. If you think it will be no problem for you, I will not oppose it." The door was opened and the recommendation for an associate professorship was approved immediately. In the spring of 1961, we recommended promotion to a full professorship, but before the announcement of the promotion, Larson lay on his deathbed, a victim of lung cancer. So that he might not be denied knowledge of his promotion, I obtained a letter from the dean and carried it to his hospital room. This last meeting with him made me know that right had been done.

Henry M. Darling

In 1914, W. A. Orton of the USDA traveled in Europe to survey programs for producing disease-free "certified" seed potatoes. His report gave great impetus to seed certification programs in this country. Wisconsin developed an important program in this area under the leadership of J. G. Milward of the Department of Horticulture and John Brann of Plant Pathology. In 1939, this program responsibility was transferred to the Department of Plant Pathology under the leadership of John McLean, an advanced student of Walker and John Brann.

McLean finished his degree in 1940 and took a job in Colorado. Coming into the picture at this time, as a part of the overall disease-free potato seed program, was a university-owned and operated farm that would provide disease-free foundation stock for the producers of certified seed. This operation, together with the state inspection service, constituted a major responsibility. To develop this program, the department, in 1941, hired H. M. Darling from the Potato Experiment Station of Mobile, Alabama.

Darling was a recent graduate of the University of Minnesota where he was a student of Professor Carl Eide, Minnesota's chief potato pathologist.

The Potato Seed Farm at Three Lakes, Wisconsin became a very elite operation. By using greenhouses with controlled air temperatures and by growing stock in the winter in Alabama (both methods capitalizing on virus disease technology developed by C. M. Tomkins and James Johnson), tuber index lines were rapidly developed.

Although the Seed Farm and Seed Certification were run as separate programs, they were coordinated in an effective way by Darling, and Wisconsin became a leading supplier of disease-free stock (Chapter 11).

Darling's program is discussed further below in relation to nematology.

Earl K. Wade

In 1947 John Brann, who had managed the department's potato disease extension programs since 1916, retired. Earl Wade, who was a former vocational agriculture instructor from Antigo, Wisconsin, joined the Potato Seed Certification program upon his release from the Army in 1945. He became increasingly interested in potato disease work and under a leave of absence did graduate work at Madison. When R. E. Vaughan retired in 1949, Wade was appointed assistant professor in charge of general extension. While continuing as a potato specialist, he also carried the full load of the department's extension responsibilities until Gayle Worf's appointment in 1963.

Wade was never presumptuous in involving research personnel in support of his program. His quiet and sincere manner did solicitation for him. He was respected for his knowledge, diligence, and effective working relationships by all who knew him.

Edward Jones

In 1949, Ed Jones was named instructor as a senior student working on the Potato Seed Foundation Farm. He stayed in this role until 1953 when he completed his degree and took a job at Cornell University to establish a Potato Foundation Seed Farm for the state of New York.

Donald J. Hagedorn

D. J. Hagedorn did an undergraduate degree at the University of Idaho. He had an early interest in pea research, since his father was a grower of pea seed in the Spokane area and was associated with Dr. Merle Stubbs (1935 Ph.D. with J. C. Walker) in the Crites-Moscow Seed Company. It was natural, therefore, that Hagedorn come to Wisconsin for his Ph.D. and to associate himself with J. C. Walker. This he did, in 1941. He finished a master's degree in early 1943 and departed for the army. He returned to Madison after discharge from the army and completed his degree in 1948.

Woodrow W. Hare announced his decision to return to Mississippi in 1947, just as Hagedorn was finishing his thesis. Hagedorn immediately began an appointment as assistant professor of agronomy and plant pathology.

This position was joint between the two departments, since agronomy had historically carried responsibility for pea breeding and plant pathology had covered pea diseases, including disease resistance. This approach had worked very well and the Delwiche-Walker team had served the industry with distinction.

As time approached for Walker to retire, it was in the interest of both Hagedorn and plant pathology for him to shift full time to plant pathology. This permitted him to assume leadership for green beans, which had become a very important crop for Wisconsin. He has trained a large number of students and has been an unusually devoted and effective cooperator with the canning and freezing industries.

All who know him will remember the meticulous care with which he organized his office and his research. Every paper clip or rubber band had an assigned space and was kept there.

Glenn S. Pound—The Department's Third Chairman

In September 1953, the American Institute of Biological Sciences (AIBS) had its annual meeting at the Madison campus. I had committed myself earlier that year to assume the secretaryship of the American Phytopathological Society (APS) which was meeting with AIBS, and that meeting constituted an apprenticeship for me. Toward the end of the meeting, J. C. Walker informed me that Dean Anderson of North Carolina State University would like to visit with me about the possibility of assuming the chairmanship of plant pathology at N.C. State, following James H. Jensen who was leaving to become provost at Iowa State University. I visited with Anderson later that day and left the meeting with him honored, but emotionally disturbed. My professorship was developing quite well, and I was not eager to go into administration; in fact, I guess I was a bit scared to. That night, the students of J. C. Walker had a party at Walker's home during which Walker strongly encouraged me to go to North Carolina and look the situation over. Within a few days I did travel to Raleigh and spent three days in intense visitation there. In two or three days after returning to Madison I received a phone call from Dean Anderson offering me the job.

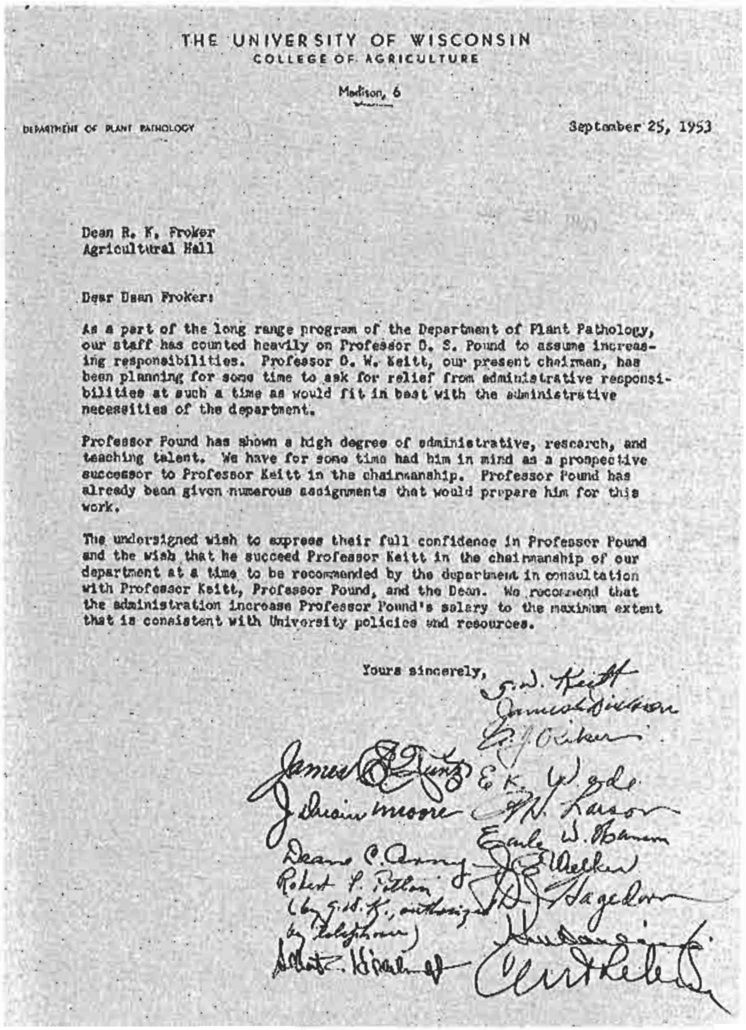
Upon my return to Madison, I reported details of my visit to Keitt. I shall never forget the seeming eagerness with which he heard my report. He reached across the table and handed me a letter, saying "We have also been busy while you were gone." The letter he handed me was a letter addressed to Dean Froker and signed by all members of the department. This letter stated that the department wanted me to assume the chairmanship at Wisconsin at whatever time was mutually agreed upon by Keitt and me. As usual, such a change carried a salary adjustment.

The decision for me was quite easy following receipt of that correspondence for I simply could not walk away from that expression of confidence. It was agreed that I would assume administration of the budget and spend that year, in essence, as an apprentice. The record shows that the change was made in 1955, but in actuality I assumed the role of chairman in 1954.

The transfer of administrative duties could not have been smoother. Keitt was, as always, a perfect gentlemen. He never looked over my shoulder. He never sought to influence me about any issue. He was available and present if I needed him, but otherwise he stayed in his office, administering the large research grant he had from NSF for studying the genetics of *Venturia inaequalis*.

The assumption of the chairmanship meant that additional help would be needed to relieve me of some teaching and research responsibilities. It was agreed that upon Keitt's retirement in 1959, his position would be used to shore up the vegetable disease section.

Robert Shephard was just finishing his Ph.D. with me and was one with rare research potentiality. I presented his name to the department, and he was enthusiastically added to the staff.


THE UNIVERSITY OF WISCONSIN
COLLEGE OF AGRICULTURE

Madison, 6

DEPARTMENT OF PLANT PATHOLOGY

September 25, 1953

Dean R. K. Froker
Agricultural Hall

Dear Dean Froker:

As a part of the long range program of the Department of Plant Pathology, our staff has counted heavily on Professor G. S. Pound to assume increasing responsibilities. Professor G. W. Keitt, our present chairman, has been planning for some time to ask for relief from administrative responsibilities at such a time as would fit in best with the administrative necessities of the department.

Professor Pound has shown a high degree of administrative, research, and teaching talent. We have for some time had him in mind as a prospective successor to Professor Keitt in the chairmanship. Professor Pound has already been given numerous assignments that would prepare him for this work.

The undersigned wish to express their full confidence in Professor Pound and the wish that he succeed Professor Keitt in the chairmanship of our department at a time to be recommended by the department in consultation with Professor Keitt, Professor Pound, and the Dean. We recommend that the administration increase Professor Pound's salary to the maximum extent that is consistent with University policies and resources.

Yours sincerely,

Figure 3.1 Department's request for Pound to be chairman.

He was to cover the department's responsibilities to the vegetable crops grown on muck soil. Unfortunately, Shephard had a son with an illness that was complicated by the frequent respiratory infections favored by the northern climate, and he left Wisconsin for Davis, California in 1961.

G. S. P.—Politics in APS

After I had served for three years as secretary of APS (1953–1956), I came close to being a victim of a political upheaval in the society. In force in those years were rules whereby a person designated to serve as president would be elected to the position of president-elect the previous year and then, without further election, automatically assume the presidency. Also in force was a rule that if a person was nominated for two positions (e.g. vice president and president-elect) his name would be placed on the ballot for the position for which he received the greater number of votes.

Paul R. Miller (USDA, *Plant Disease Reporter* editor), who was vice president in 1956, would naturally be a nominee for president-elect. A letter and telephone campaign developed to dump him by getting behind someone else. This was led by the department at Cornell (particularly Frank Ross) and by W. C. Price (Pittsburg). I was their chosen instrument. I actually received a letter from Cornell asking me to go along with being nominated for president-elect. I was alarmed at the implications. Had I let it happen, I would have been associated with a messy situation and would have had no way to explain that I was an innocent victim. Because of the ruling that a person's name entered the ballot for the position for which he got the most votes, the obvious strategy was to get more votes for vice-president than for president-elect. I turned this task over to Earle Hanson, for he was the department's unofficial contact with other departments for such matters. It was a common practice for the large institutions to check signals relative to the leadership posts for APS. The strategy worked for us and backfired against the revolters. I followed Miller through the presidency. I never learned the real basis for the revolution, but suspect that it centered around editorial problems of *Phytopathology* (Price had been editor-in-chief) and the *Plant Disease Reporter.*

In 1956, APS met with the American Association for the Advancement of Science in Atlanta. At that meeting, I called the council's attention to the upcoming fiftieth anniversary of APS and suggested that some appropriate celebration be observed. President J. H. Jensen, later in the meeting, asked me to chair a committee to plan and stage the fiftieth anniversary. This was one of the most enjoyable professional assignments I ever had. The general program committee and all the sub-committees worked very well together in planning, raising money, and staging the convention. The success of the 1958 meetings over which Paul Miller presided as president must have been bitter medicine for those who had sought to dump him.

G. S. P.—Going International

I experienced a very marked letdown after the 1958 meetings and felt that I needed some "renewal" experience. I wrote to J. G. Harrar of the Rockefeller Foundation (he was a member of the Fiftieth Anniversary Committee) and inquired about possible support for a summer in Europe to assess the research and organization of agricultural research institutions. The Foundation graciously supported an eight-week travel assignment during May and June of 1959. This was a great experience. The Rockefeller Foundation sponsorship and the recently completed APS anniversary paved the way for unusual treatment for us. The trip also probably opened the door for two decades of intense international involvement.

In 1960, I was invited to join the Board of Consultants of the Rockefeller Foundation for their agricultural sciences programs. In this assignment, I traveled extensively in Latin America, the Orient, and Africa. In Africa, I was asked specifically to look at University College (later to become the University of Ibadan) in Ibadan, Nigeria and a paper organization for a university for western Nigeria (the University of Ife) which was to meet the political demands of the Yoruba tribe. I advised the foundation to make their investments at University College, because it was an established and going institution. Furthermore, it did not make sense for two agricultural facilities to develop only fifty miles apart.

The University of Ife applied for developmental assistance from the U.S. Agency for International Development (USAID). Since Dean Oyanuga had obtained his Ph.D. in animal nutrition from Cornell University, they requested that USAID involve Cornell in an institutional development grant. Cornell turned the request aside. USAID next approached Wisconsin.

The University of Wisconsin had not jumped into the international field as rapidly and forcefully as some other universities, and President Harrington was pressing the College of Agricultural and Life Sciences to move. Consequently, in 1963, Dean Froker appointed E. E. Heizer (dairy science) as an associate director for international programs. Thus, when USAID approached Wisconsin, there was some sympathy toward a response.

Heizer put together a committee of six to go to Nigeria and study the feasibility of a ten-year program with the University of Ife. I was asked to chair the committee. We spent the month of April, 1964, in Nigeria. This was the most difficult professional assignment I ever had. USAID was pressuring the University of Wisconsin for involvement, but our committee was negative primarily because the charter law of the University of Ife made it possible for the Premier of the country to abolish the university, if he chose to do so. Our report to the college faculty upon our return recommended University of Wisconsin involvement, if the Nigeria law was changed. After about four months of heated negotiations the matter was resolved and a contract was signed.

The Department of Plant Pathology played a major role in the development of the University of Ife (Chapter 24). J. D. Moore, J. E. Kuntz, J. G. Berbee, D. C. Arny, and E. W. Hanson all had residence assignments there. In addition to their regular professor duties, J. D. Moore served as dean of the faculty of agriculture and Earle Hanson as chief of party. Because of my involvement in setting up the program, I remained close to the project after becoming dean of agriculture.

G. S. P.—Dean of Agriculture

In the early summer of 1964, Dean R. K. Froker resigned after a long tenure as dean of the College of Agriculture. The Nigeria study had thrown me into contact with President Harrington and Vice-president Clodius. The tough stand that was taken on Nigeria relative to changing the charter law of the University of Ife, together with an expressed willingness to become involved in Nigeria, undoubtedly played a role in my being named dean. I had only one very brief interview with Harrington and Clodius at which I was told that they wanted to name me dean on August 14, 1964. Because of the political activities of the farm organizations, I was asked to make no revelation of the appointment except to my wife. The farm groups did, indeed, become active. The Farmers' Union lobbied for Professor Willard Cochrane of the University of Minnesota. The Wisconsin Farm Bureau pushed the name of Henry Ahlgren. I kept out of sight as much as possible and spent most every day in early August in my cabbage plots. The appointment was approved by the Board of Regents, and on September 1, I moved my office to Agriculture Hall.

Before leaving the department, I felt it necessary to set in motion the selection of a new chairman. In order not to place any senior member of the staff under a disadvantage, by having him chair the department deliberations, I asked Jack Berbee to serve as chairman *pro tempore*. He did an excellent job of leading the department to a consensus, namely that Arthur Kelman of North Carolina State University be offered the chairmanship. J. E. Mitchell was requested to serve as chairman until Kelman could take over. Mitchell and I both got on the phone and extended the offer to Kelman so that he would know that the appointment would have the dean's approval.

Luis Sequeira

As a replacement for Shephard, several candidates were looked at, and Luis Sequeira was the one the department desired. At the APS meetings at Green Lake, Wisconsin, in 1960, I interviewed Sequeira and invited him to visit the department. He was on an eighteen-month study leave at that time, stationed at North Carolina State University, and had a full salary by the United Fruit Company. He arrived for his visit at Madison in mid January 1961 (temperature about $-15°F$ and he with a borrowed overcoat).

Our chances did not seem very good. Not only was the shift from a tropical climate to the Madison climate a serious decision, but Sequeira felt morally obligated to return to the United Fruit Company since he had been on their salary for his study leave. I obtained the name and address of the president of United Fruit and addressed a letter to him asking him to give Sequeira freedom to choose to come to us if that should be his choice. I tried to point out in the letter the great need we had of him. The company did grant Sequeira the privilege of a free decision and on August 1, 1961, he joined the University of Wisconsin.

Sequeira is a good illustration how Wisconsin's great traditions work. When he visited with me about the responsibilities of the Wisconsin job, he had serious reservations about becoming bogged down in a lettuce breeding project. My comment to him was, "At the University of Wisconsin no one tells a professor what to do! He chooses his own area of work. We only ask that you provide service to this broad area of vegetable production. You do not need to become bogged down in a breeding project, but I would advise you to not rule out breeding for resistance as a part of your program." With these assurances of freedom of movement Sequeira quickly developed a research program in lettuce diseases that was truly classical in its findings, and some difficult disease problems were quickly brought under control by both breeding and non-breeding technology. In addition, Sequeira, in the tradition of the history of the department, developed a laboratory research program of great significance in nature and scope, particularly in plant bacteriology.

Paul H. Williams

It is appropriate to record the conditions under which Paul Williams was appointed. In 1961, the department was beginning consideration of a replacement for J. C. Walker who was to be seventy years of age on July 6, 1963. Paul Williams was finishing his degree with me at that time, and we were all aware of his unusual breadth and depth of both interest and knowledge, and of his most winsome personality. At a staff meeting a full year before completion of his degree, I presented his name to the Executive Committee. It was unanimously approved that he be notified that a year hence he would be offered an assistant professorship. Immediately after the meeting, I encountered Paul in the men's room, and it was there that he received the communication! This was a bit irregular, to say the least, and was not without some risk for such an advance notice could have affected the development of some students, but not Paul. We had obtained the services of a growing young man and had thwarted competition from other universities. Our offer to Paul included a request that he spend some time as early as possible at another institution. Thus after completion of his degree, he studied with R. C. Staples of Boyce Thompson Institute.

Paul Williams has indeed kept one foot in the furrow, as the title of this book suggests. He has been very adept at fundamental laboratory research and at servicing the needs of our state and national agriculture, particularly in the area of crucifer and cucurbit crops.

FRUIT CROPS PATHOLOGY

J. Duain Moore

J. D. Moore came to Wisconsin as a graduate student in 1939 with experience in greenhouse and nursery culture both from family background and his undergraduate education at Pennsylvania State University. He became a student of Professor Keitt, and his interests naturally placed him in the apple and fruit research of the Peninsula Field Laboratory at Sturgeon Bay. He developed real expertise in chemical control of the apple scab disease and epidemiology of *Venturia inaequalis*.

Although he began his graduate work in 1939, he did not finish his degree until early 1945 due to extended requirements of war food efforts. About the time of his degree, virus diseases of stone fruits became increasingly recognized and troublesome. Moore delved into the virus complexes of sour cherry and became a national leader of a vast interstate study of stone fruit viruses and virus diseases. He remained with this program until 1975 when he was requested by the college administration to become director of the experimental farms of the college.

Robert W. Fulton

Fulton completed his degree in 1940 and remained at Wisconsin in various research capacities, but particularly in research on virus diseases of tobacco. In 1955, he joined the staff of the department as an assistant professor to lend his expertise in plant viruses to the stone fruit virus program. After a few years, it became evident to all that dividing his time between Madison and Sturgeon Bay restrained productivity, particularly in graduate student training. He was shifted, therefore, to a full-time professorship at Madison and was unencumbered with field responsibilities so that he could engage totally in basic plant virology.

Curt C. Leben

Curt Leben completed his degree in 1946 under Professor Keitt. He remained in a postdoctoral capacity and ultimately served a few years as an assistant professor before joining the research staff of the Eli Lilly Company in 1956. He was pioneering in a new area of research, namely antibiotics functional against fungi. He discovered (with Keitt) the compound Antimycin A that has been widely used as an enzyme inhibitor in biological research and as an eradicant of unwanted fish in streams and ponds.

Clifford C. Ehlers

As Dewey Moore became increasingly burdened with the stone fruit virus program, he had to have relief in some measure at Sturgeon Bay, particularly in the chemical control of apple scab. Cliff Ehlers, upon receipt of his degree in 1957, entered an assistant professorship for this purpose. He developed a conflict of interest in engaging in commercial orcharding that reduced his value to his own program. He shifted, therefore, to an area extension position and left the staff of the department.

John E. Mitchell

Jack Mitchell completed his Ph.D. degree in 1948 with a major in biochemistry and a minor with A. J. Riker. He was an undergraduate at the University of Minnesota and did an M.S. degree at Louisiana State University with C. E. Edgerton before coming to Wisconsin.

During WW II and the postwar years, he was associated with the government's biological warfare program at Fort Dietrick, Maryland.

In an effort to reshape the department programs as the Big Five approached retirement, and to maintain the major thrusts of the department, it was deemed necessary to build additional leadership in the area of chemical control and soil microbiology. J. E. Mitchell was chosen as the one who could do this.

The appointment of J. E. Mitchell to a tenure position in 1956 constituted a problem in that most of his research time had been spent in the biological warfare program at Fort Dietrick and the results were classified. It was difficult, therefore, to prepare adequate documents for the faculty biological division. We solved the problem, however, in obtaining the services of Vice-president

Ira Baldwin who had been a consultant to the Fort Dietrick program and who knew Mitchell's program. His communication to the divisional committee solved the problem.

From the beginning of his appointment in the department, his overt cooperative spirit and the soundness of his judgments dictated against an unencumbered research career. We were faced with developing plans for the new building that was authorized about the time of his appointment, and he skillfully chaired this effort. Similarly, he masterminded the physical transfer into the new building. As chairman of the department, I depended on his counsel very greatly. In a critical transition year of 1964–65 he served as chairman of the department, and served another term as chairman from 1975 to 1980.

He is mentioned in the context of the Fruit Crops Pathology section because it was that area that triggered his appointment.

Donald M. Boone

Don Boone completed his Ph.D. thesis in 1949 under Professor Keitt. His research was in the genetics of pathogenicity of *Venturia inaequalis* which was unfolding rapidly at this time due to the advent of grant support from the federal foundations. After getting his degree, he stayed in the program as a postdoctoral fellow until 1956 when he became an assistant professor. The primary design of his professorship was to cover research needs with the small fruit crops, particularly strawberry and cranberry. Wisconsin was rapidly developing cranberry acreage, and the crop had received almost no attention since the days of the 1920s when Neil Stevens would come up from the University of Illinois to study the cranberry false blossom disease.

Boone continued the fungal genetics program for several years and contributed significantly to the body of knowledge in this area. He also developed a comprehensive program on the nature and control of fruit rots of cranberry. Following his retirement in 1984, Boone has continued to serve the cranberry industry as an important consultant on disease control and production, both in the United States and the Soviet Union.

FIELD CROPS PATHOLOGY

The programs dealing with grain and forage crops had always been closely coordinated with agronomy and with the USDA. Through most of his career, J. G. Dickson had been salaried part-time by the USDA and enjoyed considerable program support from them. Both R. G. Shands and Hazel Shands did joint degrees with agronomy and plant pathology (under Dickson) and both remained at Wisconsin for their careers. H. L. Shands was employed by the university while R. G. Shands was a career USDA scientist. Between them, they covered the breeding and disease resistance needs of oats, wheat, and barley. They were extremely devoted to their research and very productive.

Fred R. Jones, Oliver F. Smith, and J. Lewis Allison

As Wisconsin had developed its dairy agriculture and still had large numbers of horses, it had used red clover as its major forage crop. By 1950, clover was being rapidly replaced by alfalfa to the extent that the state soon had 3 million acres in alfalfa. The Department of Plant Pathology did not have sufficient staff leadership for the forage crops and encouraged the USDA to station research scientists in the department.

F. R. Jones, who completed his Ph.D. in 1917, had remained in the department as a legume pathologist salaried by the USDA. In early years, he worked on problems of the canning pea, but after WW II, he became deeply involved in alfalfa research and made very significant contributions to the discovery of the relation between bacterial wilt and winter killing in alfalfa. This research, in cooperation with R. A. Brink of genetics, led to the development of the Vernal cultivar and to the control of bacterial wilt. The Department of Soils carried on an intensive program of liming of soils; these interdisciplinary efforts all contributed to the rapid replacement of red clover by alfalfa.

Oliver F. Smith came to the department in 1930, working with Dickson with a joint major in agronomy. After his Ph.D. in 1934, he joined the USDA-state co-operative red clover disease resistance program with J. Torrie in agronomy and remained until 1940.

J. Lewis Allison was established in the department in 1941 by the USDA. He also carried an academic appointment. His primary emphasis was to be on the diseases of clover. He was offered a position of increased responsibility at the USDA National Research Center at Beltsville and left Wisconsin in 1946.

Earle W. Hanson

The USDA transferred Earle Hanson from Minnesota to Wisconsin to continue the work on red clover and sweet clover. He soon became a joint appointee with the university and developed a strong program of graduate training. He was a special reinforcement for the field crops section in that he did his Ph.D. with E. C. Stakman and had several years experience in the cereal grains.

From 1964 to 1974, the department was deeply involved in the development of the University of Ife in western Nigeria, and Hanson contributed to this program as a resident staff member and as chief-of-party. This is discussed in more detail in Chapter 24. Upon his return to the department about 1970, he devoted full time to extension problems of field crops. Douglas Maxwell had joined the staff in 1968 to lead the research on forage grasses and red clover diseases in collaboration with Richard Smith of the USDA in agronomy.

Paul E. Hoppe

Paul Hoppe began graduate studies at Madison in 1925 under Dickson and became an employee of the USDA to work on diseases of corn. Something happened in his personal relationships with the USDA, and he never finished his master's degree and never received normal advancement. His major contribution, perhaps, was in working out seed treatment technology to prevent seed rot in corn. His "rag doll" cold test technique for determining the efficacy of seed treatments was classic. From the personal side, friends of Paul Hoppe will always remember him for strong cigars, his enthusiasm for bass fishing, gladioli, sports, and for his blind loyalty to political conservatism.

Deane C. Arny

Arny arrived at Madison as a graduate student in 1939. He was an undergraduate at the University of Minnesota where his father was a professor of agronomy. At Wisconsin, he did a joint thesis between agronomy (H. L. Shands) and plant pathology (J. G. Dickson). Thus, his heritage and graduate training equipped him well for a career in cereal pathology. His assistant professorship, which he began in 1944, was joint between the two departments. He maintained this dual role until adjustments were made following Dickson's retirement when he became full-time in plant pathology.

At the time of Paul Hoppe's retirement, the USDA was in a position of forced retrenchment and the position in corn pathology was lost. Deane Arny covered for the department in this area. As important as corn was to the state, one would think that more budget resources would have been allocated to disease research. It was only because nature has given corn special treatment in regard to diseases that this could be so.

Arny also participated in the Nigerian program (Chapter 23).

Art Hooker, Leon Wood, Richard Durbin, Maurice Kauffman

In the later 1950s, H. C. Murphy, project leader for small grain diseases in the USDA, was encouraged to station a plant pathologist in the department. The first of three such appointments was Art Hooker, who had finished his degree in 1951 with J. G. Dickson. Hooker had a strong background and much promise as a researcher. The department was elated to have him on the staff and even though salaried by USDA, he was assured full professorial development.

The USDA soon entered a period of severe non-competitiveness in salaries. Hooker became unhappy with the prospects of his future. The department, together with the college dean, pressured the USDA for special salary treatment for Hooker. In fact, Ted Byerly, head of the Cooperative State Research Service, and the chief of crops research in the Agricultural Research Service, came to Madison and visited with Dean Froker and me about the matter. This experience will always be my number one negative experience with the federal bureaucracy. We lost a top researcher to the University of Illinois in 1958.

Hooker was replaced by Leon Wood, a transfer from South Dakota. He never successfully separated himself from South Dakota and returned there to an extension program after only two or three years.

Murphy was a strong supporter of research and, in discussions with him about a replacement for Wood, he was encouraged to broaden the position to permit a full dimension of fundamental research. It was in this context that Richard Durbin joined the department in 1962. Since his program is discussed in Chapter 21, only mention of his appointment is made here.

Also in the late 1950s Maurice Kauffman was appointed by the USDA to work on grass diseases at Madison with E. Neilsen and D. C. Smith of agronomy. He was an extremely affable and mild-mannered person, but his church had a stronger hold on him than his profession, so he left Wisconsin to become an agricultural missionary.[4]

FOREST PATHOLOGY

The founder and developer of the forest pathology program in the department was A. J. Riker. For many years this program was in close cooperation with the USDA's Forest Products Laboratory, which was founded in 1910 in the old Mining and Metallurgy Building on the engineering campus. In 1937, the new Forest Products Laboratory was occupied.

Through the years, one or more pathologists on the laboratory staff were carried as "lecturers" in the department. Among these were Audrey Richards, Ralph Lindgren, and Ted Scheffer.

Development of a forest pathology program by Riker was a normal extension of his earlier research in the crown gall-hairy root complex of orchard and nursery crops. Strong support for research on forest trees and tree nurseries was given by the Wisconsin Conservation Department (later the Department of Natural Resources).

4. In my years with the department, I experienced some five or six students who could not separate their profession and the call of their church. None of them was truly successful as a scientist!

John E. Thomas

One of the earlier staff positions built into the department for forest pathology was for John E. Thomas in 1946, who was just finishing his degree with Riker. Thomas could not resist the call of his alma mater so he left Wisconsin for Oklahoma State University after only three years.

James E. Kuntz

James Kuntz completed his degree with J. C. Walker very soon after Riker and his associates had described the causal organism of the oak wilt disease that was sweeping across the Midwest at an alarming rate. He was appointed to the staff as an assistant professor in 1947 to continue studies on oak wilt. He developed an extensive program, embracing both natural stands and nursery plantings, and trained a number of good students. He was perhaps the nation's leading authority on oak wilt.

In the decade previous to his retirement, he became a national leader in diseases of walnuts, as the supply of black walnut diminished and the value escalated rapidly.

Kuntz was one of the participants in the Nigeria program.

Robert F. Patton

Robert Patton was added to the staff in 1951 to continue and advance a program on white pine blister rust. He had done a thesis under Riker and was one of the most promising intellects the department had seen. His research has centered on a search for resistance and on fundamental aspects of the disease process.

Keith Shea

Keith Shea (Ph.D. 1954) began as an assistant professor in 1954 to begin a program on poplar which was an important source of paper pulp in Wisconsin. He was attracted to a position at the Weyerhaeuser research laboratory at Centralia, Washington, in 1956.

John G. Berbee

Jack Berbee had received his degree under Riker in 1954 and had returned to Canada to work on forest tree diseases for the Canadian government. He was persuaded to accept an assistant professorship (vice Shea) at Wisconsin in 1957. His primary activity has been in developing fast-growing hybrid poplars for the pulp industry and attending the problems associated with forest tree nurseries. Berbee was one of the original team on the Nigeria project.

Eugene B. Smalley

In 1957, the department had an opening for a person to work on the Dutch elm disease, which at that time was moving through Wisconsin like a fire. In 1956, the legislature made a special appropriation to support two positions, one in entomology and one in plant pathology.

Several persons were interviewed, and the position was offered to Eugene Smalley who had just completed his degree with William Snyder and H. N. Hansen of Berkeley.

Smalley worked closely with Milwaukee and other municipalities. The Department of Natural Resources did not support the work, since elm was not a forest tree of importance. All aspects of the disease were studied. Seed collections were made from all over the world and resistant sources found. From such genetic stocks, several resistant varieties or clones were developed. In collaboration with Donald Lester, forest tree geneticist, 'Sapporo Autumn Gold' has been released.

Smalley not only became the leading authority on Dutch elm disease, but, pursuing his mycological interests, he developed a strong center of mycotoxin research.

David Houston

In the late 1950s, a serious disease problem occurred in the hard maple forests of northern Wisconsin. The etiology of "maple dieback" was unknown but it appeared to be of non-parasitic origin.

David Houston was a senior student with Kuntz, and he was moved into a staff position in 1959 to try to bring an answer to the problem. He finished his degree in 1961 and accepted a job in 1962 with the U.S. Forest Service in the Northeast.

Eugene P. Van Arsdel

During the period 1956–62, E. P. Van Arsdel was associated with the forest pathology group. He had finished his degree in 1952 with Riker and was interested in climatic and epidemiological factors of white pine blister rust. He was salaried by the U.S. Forest Service, and in 1962 he transferred to the Great Lakes Regional Laboratory at St. Paul, MN and later to Texas A & M University.

NEMATOLOGY

Gerald Thorne

In the previous chapter, J. C. Walker describes the potato rot nematode problem, and the bringing of Gerald Thorne to Wisconsin. The willingness of the Research Committee of the Graduate School to provide salary for a half-time appointment for five years made it possible for the establishment of a dimension of nematology. The USDA was encouraged to participate, and they placed Vernon Perry in the department. Henry Darling began an effort to shape himself for nematological studies. Ella Mae Noffsinger, an advanced student in nematode taxonomy, transferred to Madison and greatly supplemented the effort. Grover Smart, Joe Dickerson, Juan Heins, and Roger Anderson did their entire doctorate studies in the new program.

Vernon Perry was a very southern southerner, and when he received an offer from the University of Florida, he left Wisconsin. He was replaced by Gerald Griffin who, because of his religion, was as drawn to Utah as Perry was to the South. He returned to Utah after a short tenure.

Thorne, by this time, was facing retirement because of his age. The USDA program became another victim of forced retrenchment. The department decided to establish a full-time university-supported position in nematology and obtained administrative approval to do so. Kenneth Barker was just finishing his degree at that time with J. C. Walker, and the department offered the position to him. The year was 1961. Barker's development was very good, and he became an excellent nematologist. However, the manpower critical mass in nematology was so small that he experienced isolation. As a result, he accepted a position at his alma mater (North Carolina State) where nematology existed in full bloom.

The department next tried to hire Seymour Van Gundy from University of California–Riverside but did not succeed. The "one-man" nematology post again proved to be a liability. Over the years a succession of nematologists was brought to Madison to fill the void, including Clifford Blake from Australia, and Victor Dropkin, then with the USDA. In later years curricular needs to provide nematology to the students were carried out by Henry Darling with summer visitors including William Mai from Cornell University, David MacDonald from Minnesota, George

Bird from Michigan State University, and in 1983, Ann MacGuidwin, a student of Bird's from Michigan State. Continued ranking of the need for a full-time position as number one priority in the department's needs led to the hiring of Ann MacGuidwin in 1984 and to the restoration of a *bona fide* nematode research and teaching program after a twenty-year void. At the time of this writing it is simply too early to determine whether the departmental resources are adequate to sustain a critical mass for nematology to thrive.

ORNAMENTAL PATHOLOGY

Albert C. Hildebrandt

Hildebrandt received his Ph.D. degree with Riker in 1945. He stayed on for a number of years in postdoctoral research in which he was very active in tissue culture studies. He entered the budget as a part-time staff person in 1950 by assisting with the teaching of the historic Methods of Research course. It was a consensus judgment that he should have an agricultural dimension to his career and that ornamental crops and plants were sufficiently unattended that he should move in this direction. This he did, and well, until his early retirement in 1978 due to medical disability. He offered a course in this area.

PHOTOGRAPHY AND SPECIAL ASSIGNMENTS

Eugene Herrling

Every student and every professor in plant pathology at Wisconsin from 1919 to 1969 owes a monumental debt to Eugene Herrling. He began serving the department as a dishwasher while a student at Wisconsin High School. He learned photography from F. R. Jones and H. R. Angell and soon became so proficient in specimen photography that he was the department's indispensable man.

Herrling was the envy of other departments and other schools. He was so professional that the University Photo Lab used undue pressure to try to close down his operation.

In addition to specimen photography, he became a first-class draftsman and his touch was on every thesis and publication in the department.

PHYSICAL FACILITIES DEVELOPMENTS

The Department of Plant Pathology, until 1964, had been treated as a stepchild in relation to physical facilities for research. It had never had a building of its own. When the department was established in 1910, it set up shop in a large room on the second floor of Agriculture Hall directly over Dean Russell's office. This was a large open room, and Professor Jones, the graduate students, and the secretaries lived and worked in this open space. This room was not partitioned off into smaller offices until 1963–64 when Agriculture Hall was remodeled.

The Department of Horticulture in 1910 was in a building on Observatory Drive that bore its name over the front door. This was the building that was later to be named King Hall. In 1912, a new building was built for horticulture at the intersection of Linden Drive and Babcock Drive. As space was assigned in this building, plant pathology received all of the second floor and the east half of the third floor "loft". Until the move to Russell Laboratories in 1964, this third floor was very critical space for the department in that it provided the space for Eugene Herrling's

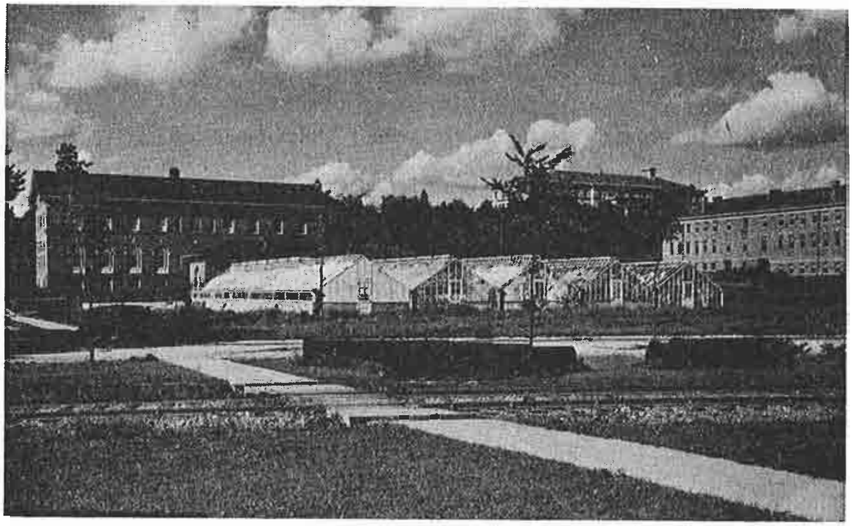


Figure 3.2 Horticulture Building and greenhouses, 1916.

photographic and manuscript services, for the dish washing facilities, and for the general supplies inventory. As poor as this space was in regard to location and work environment, it contributed inordinately to the department's general welfare.

The second floor of the Horticulture Building, as used in 1940, provided the departmental office, private offices for Keitt, Walker, Vaughan, Larson, Riker, and Brann, one office shared by F. R. Jones and J. Lewis Allison (USDA), plus four small to moderate research labs and three other small offices which were used for advanced student research labs.

Professor James Johnson, being officially a member of the Department of Horticulture, had his office-laboratory on the first floor of the Horticulture Building.

Space assigned to the department was not adequate for its size. Even so, growth in student numbers and in the stature of the department, both within and outside the university, continued unabated. Consequently, when a new wing (Moore Hall) was added to the Horticulture Building in 1931–32 for agronomy, plant pathology received much-needed expansion space. In fact, it received about one-third of the space of this new wing. The negotiations for this space must have created initially a difficult relationship between the two departments. Some thirty years later, when plant pathology was negotiating temporary use of the tower room of Moore Hall, Professor L. H. Graber (chairman of agronomy in 1932) vented unseemly wrath on Professor G. W. Keitt (chairman of plant pathology in 1932) in the presence of Professor D. C. Smith and me who were then chairmen. It was obvious that plant pathology had received space in 1932 that was against the wishes of agronomy.

The plant pathology space in Moore Hall included three large rooms on the third floor, one of which was the laboratory/lecture room for teaching, one for housing graduate students, and one for the departmental library. One other small room was used for storage of teaching materials, but beginning in 1946, it became the office of W. W. Hare and later D. J. Hagedorn, both of whom shared appointments with agronomy.

Directly underneath the third floor space, the department was given an identical amount of space on the second floor which was in the form of a large room for advanced graduate students,

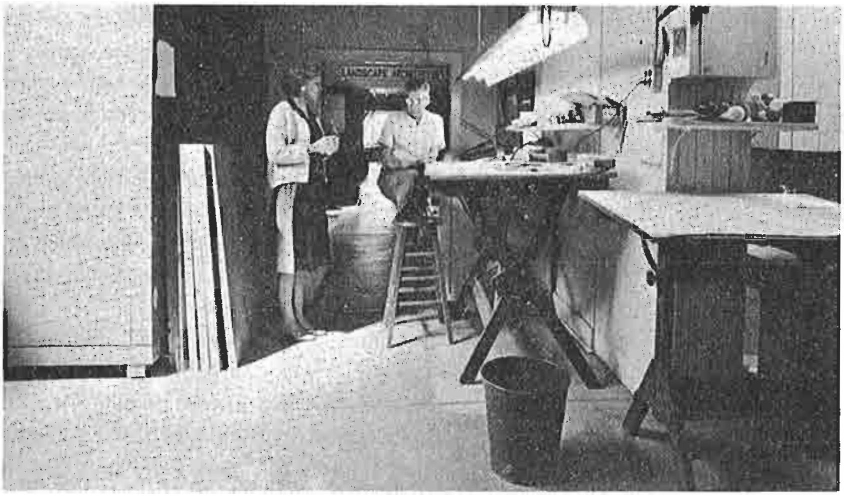


Figure 3.3 The third floor loft where Gene Herrling worked. Gene and Marleen Steinmetz in the picture. First walk-in cold room is at the left.

a media preparation room, the office of Professor J. G. Dickson, and a small research lab used by field crop personnel. H. L. Shands and R. G. Shands had offices on either side of Dickson, and Paul Hoppe (USDA-corn) had a desk in R. G. Shands' office.

This is as good a place as any to describe the philosophy that prevailed in those years of housing graduate students. Every student for an advanced degree was provided a desk and a very limited amount of cabinet space. There were temperature controlled incubators, transfer chambers, and a limited amount of "common" counter space in each lab.

First year students were housed together, regardless of their program or professor. In the second year, they usually moved downstairs to the advanced student lab. Again, they were housed together without reference to program or professor. The department simply did not have space whereby a professor could have a suite of rooms in which his students could be clustered about him. This forced exposure to cross fertilization of ideas has much to be said for it. Personally, I learned much by getting to know the problems of the others' research and of their approach to solving them.

The Barley and Malt Laboratory of the USDA had occupied the east hall of the basement of Moore Hall since 1932. In 1949, a new building was built for the Barley and Malt Laboratory on Walnut Street. In reassigning the space in Moore Hall, A. C. Hildebrandt obtained a remodeled room for his tissue culture research.

Thus the department lived and worked, from 1910 to 1964. During the 1940s and 1950s, the staff of the department doubled, the number of graduate students tripled, and extramural support of the department's research grew steadily. This explosive growth was simply absorbed into the already crowded rooms and hallways. Refrigerators and incubators moved into the hallways to make room for more desks. And the lush era of grants lay just ahead! The situation was deplorable.

In 1947, Floyd Andre, assistant director of the Wisconsin Agricultural Experiment Station, left Wisconsin to become dean at Iowa State University. He was replaced by Professor R. J. Muckenhirn, professor of soils. Muckenhirn became a great friend of the department and a fair and effective research administrator, but my first encounter with him about our space situation almost led me to leave Wisconsin. He remarked, "You may have to have your people do their research in shifts, some in the morning, some in the afternoon in order for all to have access to the labs." My comment was that one didn't do biological research in shifts, and we either had to scale up our facilities or scale down our programs. As I describe later, I got on a very firm planning track with Muckenhirn that ultimately produced results.

Agronomy, horticulture, and plant pathology almost yearly pressured the college administration for a new building. This took the form of frequent memorandums from the chairmen to the dean. The Plant Science Conference, organized in 1935 as a forum and voice for the plant sciences, lent its support for both new building space and new greenhouse space. Under the leadership of James Johnson, it was especially vocal about greenhouse needs.

In 1951, the Walnut Street greenhouses were built. J. C. Walker was a member of the Joint Faculty Committee that lobbied for the appropriation. I was chairman of a Joint Committee to recommend space assignment to the dean, a function that was accomplished with little discord. J. D. Moore was especially helpful in equipping the space for the department's needs.

The first major task that I undertook as chairman of the department in 1955 was to obtain data on space utilization from competitive schools that would give us added leverage for a new building. The results of that survey, which were submitted to Dean Froker and the graduate dean on November 30, 1955, showed how mediocre our physical facilities were compared to those at the University of California-Riverside, University of California-Davis, University of Minnesota, Purdue University, Cornell University, and North Carolina State University.

I remember so well the buoyancy of my spirit when I walked up to Ag Hall to present these statistics to Dean Froker and how utterly dejected I was when I left his office. As I was going over the tables and charts with him, he abruptly terminated our conference, saying that he had to go to another meeting. I felt then that we really had our work cut out for us. I was received much more understandingly by Conrad Elvehjem, dean of the Graduate School and chairman of the University Research Committee. The data were obviously studied by the college administration and were convincing enough that in 1956 the number one priority in the college's building requests was a new wing on the Horticulture Building for plant pathology and agronomy.

The department began to develop plans immediately but before a funding request was made for the new building something happened that resulted in ditching the plans and starting all over again. Governor Gaylord Nelson brought the State Building Commission to the campus to see first hand the needs for which the college had requested buildings. These included, in addition to the Plant Science wing, the Departments of Entomology, Forestry, and Wildlife Management.

Before the visit by the legislators, I wrote to all students and staff asking that they do two things on the day of the visit:

i) be present and working
ii) have the laboratories cleaned up as much as possible.

Everyone cooperated, and with the rooms literally filled with people and the hallways clogged with refrigerators and incubators our case was impressive, indeed. It should be recorded, perhaps, that some of the students did double duty that day. The facilities on the west end of the Horticulture Building could be reached by going up through the third floor as well as down the regular hallway. As I led the group from the agronomy end to the horticulture labs, I was amazed to see the same students we had just left. But, instead of getting the new wing we had worked toward, we were asked to share a much larger building (later named Russell Laboratories) with entomology, forestry, and wildlife management. This was actually an improvement for plant pathology, but it meant that agronomy lost its priority for a new building. It also meant that entomology, forestry, and wildlife management had piggybacked us to first priority.

Concomitant with developing detailed building plans (superbly done by a committee chaired by J. E. Mitchell and including Hagedorn, Hanson, Moore, and Patton) were efforts to carry on adequate communications with friends of the college to assure legislative appropriation for construction. Dean Froker was not aggressive in matters such as this and did not want to cross swords with higher administration or with the legislature. Therefore, I carried communications directly to a number of organizational representatives and only informed Dean Froker that he should not be surprised if a number of people showed interest in the building.

The extent to which friends helped is illustrated by the hearing before the Joint Finance Committee. The day before the hearing a select group, at the invitation of Mully Taylor (Trees for Tomorrow), met with me in a rented room in the Park Hotel to prepare statements to be read before the Finance Committee. At the hearing, the room was filled with friends ready to testify. When President Elvehjem entered the room he said to me, "I see you have a lot of friends here." When the president was called upon to comment on the university's needs, he made a few general remarks and then said, "There are a number of people here to speak on behalf of a College of Agriculture building. Mr. Chairman, I should like to yield my time to them." What a gracious thing he did! The building was approved.

R. J. Muckenhirn chaired the committee to develop plans for the new building. J. E. Mitchell and I represented plant pathology. I generally served as the watchdog of the department's interests, and Mitchell carried the detailed space development and utilization functions. The committee got along very well except for constant pressure applied by forestry for what I considered more than their share of space. This is well illustrated by what happened in 1961 when R. H. Larson (a USDA employee), for whom an office and laboratory had been planned, died. I was in Chile at the time of his death and upon my return I learned that the forestry chairman had requested that Muckenhirn transfer Larson's planned space to his department. I encountered Muckenhirn outside his office and told him, "If you move to grant this request, I shall take the matter directly to the Board of Regents. I might not win, but I believe I can." The matter never surfaced again.

Figure 3.4 Reconstruction of World War II temporary buildings. T–18 in background.

While plans were being developed for the new building, the department was assigned the space in T-18 (a temporary World War II building) which bacteriology released as it moved into the new bacteriology building. Since T-18 was on the building site for the new building, this usage was very temporary. Nonetheless, the department considered it a great pickup, and it moved three program groups (nematology, forest pathology, and cereal pathology) into the space. The department tried to be as self-sufficient as possible and did its own partitioning of the room with desks, cabinets, and some carpentry. While this was contrary to rules of the Buildings and Grounds Department, little would have been said had not Professor Dickson done a poor job of hanging an old used door. Buildings and Grounds let the job stand, but we were admonished, "Never again".

During the construction period, the programs in T-18 had to be moved again. Nematology went into the tower room of Moore Hall, forest pathology went to the basement of the Home Economics Building, and the old Kroger Grocery building on University Avenue served as a catchall.

Russell Laboratories were built on schedule and occupied in 1964. The very day plant pathology was scheduled to move (August 14, 1964) I was named dean of agriculture. I never got to occupy the eighth floor lab overlooking Lake Mendota that had been prepared for me.

The occupancy of Russell Laboratories ended an era during which the department had been established and matured to a point of being generally recognized as the world's leading center for graduate training in plant pathology. It marked the end of an era in which plant pathologists were essentially taxonomic mycologists, and their research largely descriptive pathology. The stage was now set for the department to lead strongly and abruptly into more fundamental areas.

Two items of equipment should be mentioned, since they played an unusual role in upgrading the department's research and in shifting emphasis from descriptive research to more fundamental physiological research. My thesis research had dealt with environmental factors of host growth on virus synthesis in plants. In those days, virus concentration measurements were only quasi quantitative, to say the best. In 1953, L. G. Weathers had done a thesis with me in which he purified virus preparation and estimated concentration by comparative ultraviolet absorbancies by a spectrophotometer. His results were quite spectacular. We had to do the virus purification with the bench Sorval centrifuge of biochemistry and to use their spectrophotometer as well.

I reported to Professor Walker that I wished to expand this kind of research and needed a centrifuge and supportive equipment. He carried my request to Dean Elvehjem who promptly approved the purchase of a new Spinco refrigerated ultracentrifuge. This was a marvelous piece of equipment that permitted many in the department to upgrade their research.

One day in 1957, following a trip to Texas, J. G. Dickson informed me that there were some surplus meat coolers on government inventory, and he could obtain two for the department, if we wanted them. As crowded as we were, we made room for one in the corner of Herrling's laboratory, and for the first time in its history the department had a walk-in cold room.

This facility lifted the quality of departmental research to a remarkable degree. It lead to the immediate germination of the oospores of *Albugo occidentalis* which Bob Raabe had been trying to achieve for months. It permitted Bob Shepherd and Tom Pirone to quickly purify and characterize the turnip mosaic virus and the cauliflower mosaic virus, respectively. This paved the way for the cauliflower mosaic virus to become the research model that it is today. The second meat cooler was set up adjacent to the old greenhouses for use in the apple scab program.

CHAPTER 4

The Transition 1960–1975

Paul H. Williams

Although there can be no clear-cut delineation in time as to when one era in the life of the department ended, and another began, the decade centering on 1960 marked the end of a period when the influence of the "Big Five" could be measured by their presence. Coinciding with this time were a number of critical events that represented the beginning of a transition period that can be characterized as initiating profound change in the life and future direction of the department.

THE SETTING FOR CHANGE

As Glenn S. Pound has indicated in the previous chapter, the department had reached its zenith in terms of numbers of graduate students enrolled and supporting faculty. The strong research and curricular orientation toward crops and commodities was reflected in the program strengths built around the Big Five: Dickson, Keitt, Johnson, Riker, and Walker. The second generation of faculty under the Big Five each had dynamic research programs and taught courses that supported the crop orientation of the department. Most of the research was done at field laboratories and mainly during the summer. At semester's end the forest pathologists left *en masse* for Wisconsin Rapids, Star Lake, and Lake Tomahawk. The vegetable students were ensconced at Kenosha and the fruit pathologists spent the summers at Sturgeon Bay.

It was not until the research students returned for classes in the fall that the pressures for space were felt. With ten to fifteen graduate students housed in the third floor tower room of Moore Hall, twenty-five to thirty in the "bull pen" on the second floor, eight to ten in the basement room and another fifteen across Linden Drive in the Army Hut, T-18, the department was literally bursting at its seams! The shear numbers of graduate students in the department, packed in at close quarters, created a tension that fostered an unusual camaraderie and interpersonal support. In the four years of 1959 through 1962, sixty-four Ph.D. and twenty M.S. degrees were granted.

Though burgeoning in numbers, the department was pathetically equipped for the kinds of research that was going to be called for in the decades to come. I remember well my arrival at the department in September 1959. Ascending to the main plant pathology office on the second floor of the Horticulture Building, I passed a shy and very young woman (Marleen Steinmetz) sitting in the shadow of a dominant yet friendly appearing woman at a large desk. I introduced myself, and enquired as to Professor Pound's whereabouts. The large woman lowered the bifocals on her nose, scrutinized me, leaned back in her chair and exclaimed "Why you're the one with bunny fur around his neck." (More will be said of this remark later.) "Professor Pound, Paul Williams is here from British Columbia!" Whereupon I was ushered into the presence of Chairman Pound, warmly welcomed, and escorted to the temporary building across the street known as T-18. There I was introduced to the students who would be my colleagues for the years to come. Kenneth Barker, Gayle Worf, Jack Rogers, John Cunningham, Rodney deGroot, and Tom Geary

Figure 4.1 A scene familiar to all students and faculty—the main office in the old building—circa 1959. Marleen Steinmetz and Audrey Dunlap.

all had desks surrounding mine. In the presence of these men, Pound proceeded to instruct me that it was my responsibility to maintain the equipment that he had placed in the laboratory as part of the vegetable program. He hastened to add that I was particularly fortunate to be in T-18, as accommodation and research space was relatively luxurious there compared to that in the rest of the department. We had our own army surplus field autoclave, an oven for sterilizing petri plates, and the only two pieces of analytical equipment in the building, a chain-o-matic balance and a Beckman pH meter, of which I was put in charge. In many ways, such spare beginnings were a blessing, for in these years we called upon our ingenuity to obtain the equipment and resources needed to get our research done. All of this was to change, however, in the next five years.

THE WINDS OF CHANGE—THE DEPARTMENT GOES "OUTSIDE"

Perhaps no other decision was more fundamental to the future shaping of the Department of Plant Pathology than the decision to go beyond the bounds of the University of Wisconsin in staffing for the future. Though the staffing of the second generation from the students of the Big Five had an element of expediency to it, it was also done out of necessity (Chapter 3).

By the 1950s the University of Wisconsin had the reputation of being inbred, and our department was no exception. It is a tribute to the collective wisdom of the faculty in the early 1960s that in preparing for the retirement and departure of Dickson, Riker, and Walker, they looked elsewhere for new faculty. This decision was first fully enacted with the appointment of Luis Sequeira in 1960 (Chapter 3) and was to continue, with a few exceptions, over the next twenty-five years.

Luis Sequeira

Sequeira brought to the department a broad based expertise in mycology and pathology gained under 'Cap' Weston at Harvard University and a strength in plant physiology with interests in hormone and phenolic research gained under Kenneth Thimann. In addition, he brought several years of experience in applied tropical plant pathology and industrial research gained while combatting banana disease problems in Central America. Sequeira's interest in the biochemical solution of problems regarding host-pathogen relations has resulted in his leadership in this area over the years. He has demonstrated a unique ability to maintain his research at the evolving edge of biological inquiry by keeping current with genetic, biochemical, and molecular technologies. At the same time Sequeira has continued in the early Wisconsin tradition of directing a significant portion of his research to applications of control of Wisconsin lettuce diseases and of tropical potato wilt (*Pseudomonas solanacearum*) by breeding for resistance. Sequeira's program has always attracted and supported large numbers of graduate students and postdoctoral scientists. Housed on the eighth floor of Russell Labs, it has been a veritable "hive of industry" and "melting pot" for ideas and student interactions. As a teacher, Sequeira has been largely responsible for the introductory graduate-level course on pathogen and disease physiology PP 601 and for courses on the physiology of diseases PP 708 and phytobacteria PP 518. He is well known for his excellence in the classroom (Chater 27). His intellect, energies, and professional contributions over the past twenty-five years have been aptly rewarded by the university in his position as the first J. C. Walker Professor in Plant Pathology in 1982 and in his election to the National Academy of Sciences in 1980.

Richard Durbin

The decision to appoint Richard Durbin as replacement for Leon Wood in the U.S. Department of Agriculture (USDA) oat pathology position represented an important change in the direction of research priorities both within the department and the USDA. Durbin was mainly interested in the physiology of disease and was encouraged to conduct basic research in this area rather than servicing what was to become the diminishing needs for support of the oat breeding efforts of the USDA and agronomy by the brothers, R. G. and H. L. Shands (Chapters 10 and 21). Durbin, together with the dedicated support of his professional assistant Tom Uchytil and the collaboration of colleagues and students, has developed an unusually productive basic research program on the mode of action of phytotoxins. With the support and encouragement of the department, Durbin has built and guided the USDA involvement within the department for the past twenty-five years in a growing symbiosis of research and student education that has been of immeasurable mutual benefit to both the USDA and the university (Chapter 21). In November 1964, Durbin became leader of the Pioneering Research Laboratory now known as the Plant Disease Resistance Research Unit.

Over the years Durbin has nurtured an important liason with Japanese physiological plant pathologists though the organization of United States-Japan scientific exchange conferences that were initiated in 1966 and have continued every five years since then.

Durbin brought experiences gained from his educational and professional backgrounds at the University of California–Berkeley and at the University of Minnesota that have contributed to the climate of change within the department.

Arthur Kelman

Again, it was the fundamental decision of the department to break with tradition and to seek the "very best" person from outside to replace Glenn Pound as chairman that has had a significant effect on the department over the past twenty years (Chapter 3). In Kelman, the department recognized a distinguished teacher, a dedicated professional plant pathologist and an outstanding researcher with broad interests in phytobacteriology and forest pathology. Kelman had obtained his Bachelor of Science in biology and chemistry in 1941 at the University of Rhode Island where he was strongly influenced to pursue graduate training in plant pathology by Professors V. I. Cheadle, H. Browning, and F. L. Howard. After service in a U.S. Army cryptographic unit on the Italian and European fronts, Kelman completed his doctorate at North Carolina State University under J. H. Jensen and L. W. Neilsen. During his graduate studies in 1947 he had spent a semester at Wisconsin studying with A. J. Riker and thus was familiar with the general tenor of the department to which he was returning as chairman. Kelman arrived in the department on July 1, 1965, eight months after the move of the department into its new quarters in Russell Laboratories.

In addition to administering to the growing complexities of the department in the mid 1960s, of which more will be said later, Kelman established a vigorous research program on the corn stalk rot bacterium which he had initiated in North Carolina. In the years following his arrival at Wisconsin Kelman maintained a close collaborative research program with Sequeira, on aspects of pathogenicity of *P. solanacearum* in potato. It was during this period that his theories on bacterial motility and virulence were formulated. His research with potatoes soon led him to investigations on storage rot losses in Wisconsin's potato crop grown in the irrigated central sands region of the state, and back to *Erwinia* with which he had been familiar in North Carolina (Chapter 14). Kelman's research on the etiology and physiology of vegetable soft rot has continued in the years following his resignation as chairman in 1975. Since then he has devoted a substantial portion of his energies to the professional needs of the International Society for Plant Pathology and to questions of national concern in the biological sciences through his active involvement in the National Academy of Sciences. Throughout his years as chairman, Kelman participated in the teaching of various courses. He has particularly enjoyed the introductory course Plant Pathology 300. Kelman's devotion to the department, to the university and to the profession of plant pathology were early recognized in his appointment in 1975 to the first named chair professorship in the department, the L. R. Jones Distinguished Professor, and his subsequent election in 1976 to the National Academy of Sciences. In 1983 Kelman received the American Phytopathological Society's highest award, the Award of Distinction. It is interesting to recognize that Kelman has been working on the same organism, *Erwinia carotovora,* that occupied the interests of L. R. Jones over seventy-five years ago!

THE MOVE TO RUSSELL LABS—SPACE, BEAUTIFUL, SPACE!

The long awaited move to Russell Laboratories occurred in October 1964. Within the period of a week an ant-like army of graduate students, faculty, and civil service personnel helped pack, transport and unload all of the cherished belongings and relics of the past into the seemingly limitless bowels of the basement and eight floors of Russell Labs (Table 1). Space, beautiful, space! How could we ever occupy all this space? Jack E. Mitchell and his committee had masterfully designed more than enough room for the faculty, their sixty graduate students, and the supporting professional staff. Students had individual well-designed desks and cupboard space in each faculty

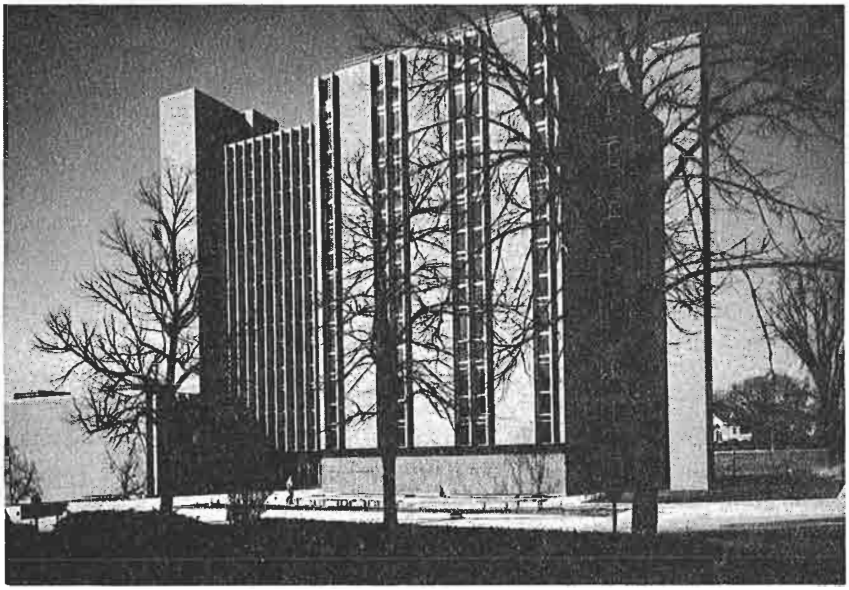


Figure 4.2 Russell Laboratories.

laboratory. In addition to a large general research laboratory designed more or less to the specification or needs of each program, individual faculty members had an office and smaller laboratory for an additional work area. The department occupied one of the twin towers of Russell Labs as well as approximately 65 percent of the basement. The other tower and remainder of the basement under the tower was entomology space. The low, two-story portion of the building was occupied by forestry (basement and first floor) and by wildlife management (second floor).

The Eighth Floor

At the time of the move to the new building, the eighth floor was occupied by Robert W. Fulton on the southern half with an office leading directly into his spacious laboratory. Next to his office were chemical and balance rooms. Across the main laboratory were cold preparation and analytical instrument rooms. The open laboratory space was occupied by large stand-up benches, with student desks on the south perimeter. In the planning stages, Pound was to occupy space on the eighth floor with a "fine lake view." Alas, his decision to accept the deanship precluded all this! Across the hall Sequeira had designed a state-of-the-art facility for physiological research. A large open central laboratory was flanked on the west and east walls by small separate rooms for specialized tasks. Two special darkrooms were designed and equipped for oat coleoptile assays for auxins, and at the opposite side of the laboratory was a specially vented facility to house large paper chromatography cabinets for the separation of phenolics and other growth regulators. Additional rooms housed radioisotope counting equipment and spectrophotometers and fluorimeters. Students were housed in the laboratory and in an adjacent office in the hallway. Sequeira had an office-laboratory suite along the corridor. Next to Sequeira's office suite was a similar laboratory-office suite reserved for the arrival of Arthur Kelman in July 1965. Kelman and Sequeira shared facilities on the eighth floor until 1978 when A. C. Hildebrandt retired, leaving space on the third floor to be occupied by Kelman and John H. Andrews.

The Seventh Floor

On the seventh floor was a series of smaller laboratories and offices housing the field crop and forage research of Deane C. Arny and Earle W. Hanson. Durbin's research in physiology occupied a large laboratory on the south side of the seventh floor, off of which a student office was located, and was shared with Arny and Hanson. Durbin's research occupied a double office-laboratory suite on the north side of the floor together with small instrumentation and analytical laboratories along the corridor. Paul Hoppe occupied a small office suite along the corridor. The floor also housed a series of temperature-controlled incubator rooms and a central autoclave, centrifuge, and ice-dispensing facility. Although no plans had been made for an electron microscope in the building, when one was purchased in 1966 it was housed initially in a laboratory suite next to the elevators on seventh floor.

The Sixth Floor

The fruit pathology programs of J. Duain Moore and Donald M. Boone were housed on the sixth floor together with Eugene B. Smalley's programs on elm diseases and mycotoxins. Boone and Smalley had transfer rooms, autoclaves, and incubator facilities to accommodate their mycological interests, while Mitchell, who was actively involved in the analysis of pesticide residues on fruit crops, occupied a large analytical laboratory on the northeast section of the floor. Moore, whose primary research activities on tree fruits took him to the Peninsula Research Station at Sturgeon Bay, was housed in a double office-laboratory suite on the north side of this floor.

The Fifth Floor

With its central position in the tower, the fifth floor was designed to house the departmental library, conference room, and small kitchen facility on the south side. The northern half of the

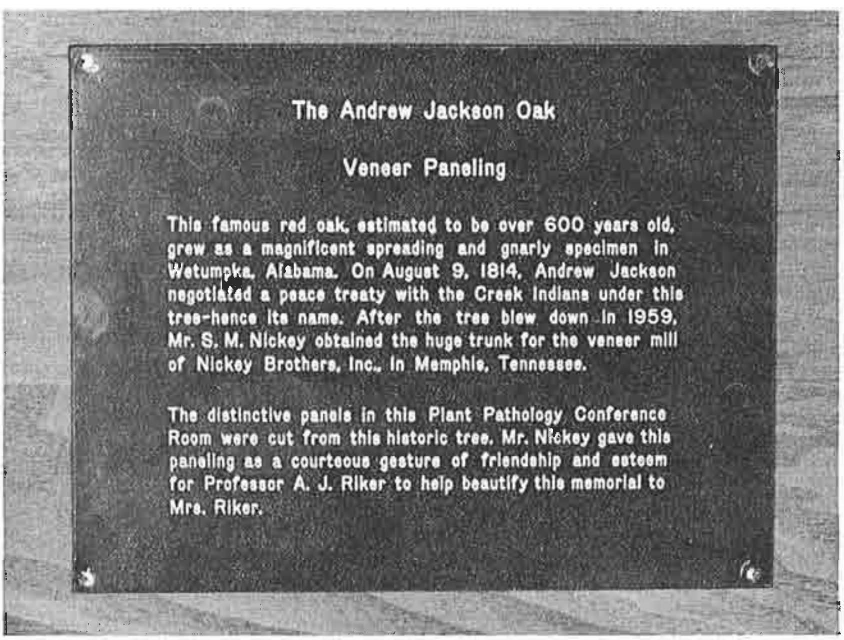


Figure 4.3 Oak paneling in the Riker Memorial Conference Room.

building was for the vegetable program of Hagedorn. Pound maintained an office, to which he occasionally escaped from Agriculture Hall, in the suite shared by Hagedorn. The conference room on fifth floor was comfortably and tastefully furnished through the generosity of A. J. Riker as a memorial to his second wife, Helen Burgoyne Riker, and is paneled with the unusually grained wood of the Andrew Jackson Oak from Tennessee.

The Fourth Floor

The fourth floor was also designed to house central department facilities: a general storeroom, a media preparation facility, a temperature incubator series, and a preparative cold room. In the old building these departmental facilities, along with the photographic facilities, had occupied the attic region of horticulture where Eugene Herrling had managed the stock room, drafting, and photography and Minnie Flood had washed glassware for over fifteen years. It was a great day for Minnie and her counterpart from T-18, Genevive Hauser, to move into the luxurious quarters on the fourth floor of Russell where a large automatic dishwasher and three self-timed autoclaves aided their duties. Minnie retired in 1965, having tasted the luxuries in Russell Laboratories for only a few months. Gene retired in 1969 to be replaced by his able apprentice Steven Vicen. At the time of this writing, both Minnie and Gene are flourishing in their retirements.

The fourth floor housed the nematology programs of Kenneth Barker, Gerald Thorne, and Henry Darling. Barker occupied a laboratory suite on the south side of the building with the large laboratory on the north adjacent to four office-laboratory suites, two of which housed Darling and Thorne. This facility was designed to support Barker's research in nematode-host physiology and Thorne's interest in morphological taxonomy, and contained complete soil washing facilities and extensive microscope tables. Darling, whose research interests centered on nematodes of potato, vegetables, and mint, also managed the Potato Seed Certification Program from his office on fourth floor (Chapter 11). Also on the fourth floor were office-laboratory suites for visiting faculty.

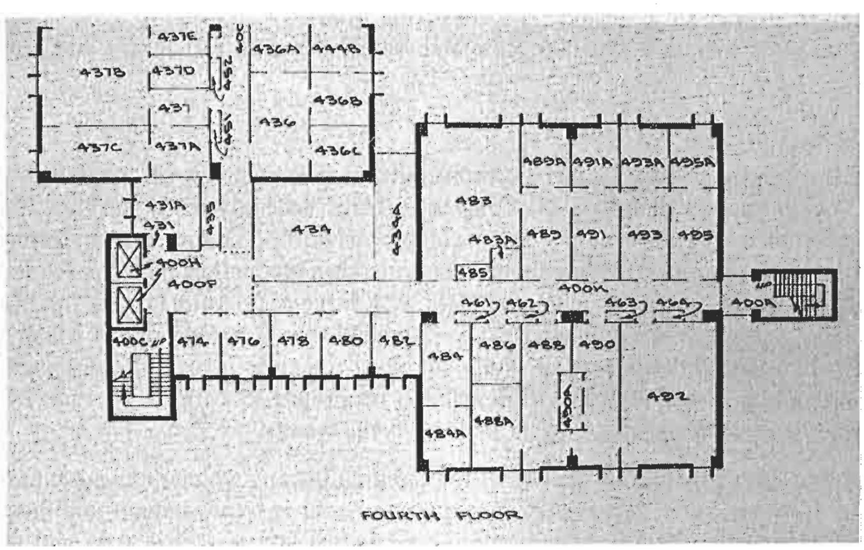


Figure 4.4 Floor plan of fourth floor Russell Labs.

The Third Floor

Space on third floor occupied what in essence was the legacy of A. J. Riker. On the north half was a large general laboratory housing students and shared by the forest pathology programs. Next to this were Patton and Kuntz in a dual office-laboratory suite and Berbee in a single office-laboratory combination. Across the hall on the south half of the building were the media preparation areas, tissue culture laboratories, culture incubation rooms, and microscopy room associated with A. C. Hildebrandt. Other students were housed in a hall office next to which was Hildebrandt's office-laboratory suite. A. J. Riker had an office suite next to Hildebrandt.

The Second Floor

On the south side of the second floor were the departmental offices housing the chairman, administrative assistant Audrey Dunlap, and desks for seven secretaries. Next to the main office was a large laboratory occupied by Paul Williams' students and directly across the hall were the greatly expanded departmental photographic facilities for Gene Herrling. The photo laboratory consisted of a large studio-drafting room, a dark-room with sinks housing enlargers, a second suite of two darkrooms with sinks, and a storage room. Next to the photo lab was a dual office suite housing Williams and Walker. Adjacent to this dual suite was the office-laboratory from which Earl K. Wade conducted his extension duties. Additional laboratory space for the extension program was in an office-laboratory suite along the hallway.

The First Floor

The first floor of the plant pathology portion of Russell Labs was assigned to teaching facilities. On the south half was the large lecture hall, Room 184, with 150 seats. Across the hallway was the plant pathology teaching classroom and laboratory, Room 185–187. This room contained cabinets for microscopes and the bottled specimens from the old teaching laboratory in the Horticulture Building, a sink, and two long laboratory benches with gas lines. An adjacent preparation room contained a sink, an autoclave, and sterilizing ovens. In addition to a teaching materials storage room, there was an herbarium room elaborately designed for storage and fumigation of specimens.

The Basement

Housed in the basement were twenty-two controlled environment growth chambers of varying sizes, a battery of ten dew chambers, dual tiled mist rooms, specially ventilated hoods for spraying hazardous chemicals, an extensive soil washing laboratory with soil sedimentation traps, numerous storage rooms, a small animal holding facility for antiserum production, a field specimen receiving room, a potting and soil storage room complete with large-scale autoclave, a volatile-chemical storage facility, and five large stainless steel walk-in cold storage rooms, one of which was a subzero freezer. In addition there were two fully equipped research laboratories designed primarily for soil microbiology and occupied by Mitchell and his program. Without question Russell Laboratories represented the finest facility of its kind in the country.

After due ceremony and dedication of the building, during which an historic narrative and slide presentation was given (University of Wisconsin Archives), the students and faculty quietly settled into their new surroundings anticipating the arrival of a new chairman, and with the realization that the beginnings of change were, indeed, in full swing.

TABLE 1
Major space allocations of faculty at the time of entering Russell Laboratories and at ten year intervals thereafter.

Floor #	Oct. 1964	1975	1985
8	Sequeira	Sequeira	Sequeira
	Fulton	Fulton	Ellingboe
		Kelman	Slack
7	Durbin	Durbin	Durbin
	Arny	de Zoeten	de Zoeten
	Hanson	Kemp	Leong
	Hoppe		
6	Boone	Boone	Handelsman
	Smalley	Smalley	Helgeson
	Mitchell	Helgeson	Upper
	Moore	Upper	Hirano
			Clayton
5	Hagedorn	Hagedorn	Hagedorn
		Arny	Rouse
		Slack	Maxwell
4	Darling	Williams	Williams
	Thorne	Maxwell	Smalley
	Barker	Darling	Parke
		Haley	MacGuidwin
3	Berbee	Berbee	Berbee
	Patton	Patton	Patton
	Kuntz	Kuntz	Andrews
	Hildebrandt	Hildebrandt	Kelman
	Riker		Jeffers
2	Wade	Wade	Worf
	Williams	Worf	Grau
	Walker	Grau	Stevenson
Basement		Mitchell	

THE ERA OF PHYSIOLOGICAL PLANT PATHOLOGY

The early 1960s was a period, nationally, in which enormous sums of federal dollars were being pumped into research both at federal and state levels. Spurred by the Soviet successes with Sputnik and Presidents Kennedy's and Johnson's commitments to establish the United States' preeminence in research, the federal granting agencies, the National Science Foundation (NSF) and National Institutes of Health, liberally supported much research in plant pathology. Many of our faculty received research grants from these agencies in the early 1960s providing for the staffing of their laboratories with research oriented specialists (Chapter 18) and graduate students and for the purchase of expensive research equipment. Much of this research was laboratory oriented and physiological or biochemical in nature.

Coinciding with the move to Russell Labs was the submission of a major equipment grant proposal to provide the necessary costly and sophisticated analytical equipment for physiological and biochemical studies on plant disease. In 1966 a committee of Durbin, Hildebrandt, Mitchell, Sequeira, and Williams received funds from the NSF with additional support from the Graduate School of the university and the College of Agricultural and Life Sciences for the purchase of spectrophotometers, electrophoresis apparatus, ultracentrifuges, gas-liquid chromatographs, a Zeiss photomicroscope and optical systems, respirometers, radioisotope counters, and an electron microscope. Fulton tells of the story of the electron microscope. Apparently the committee was favoring the purchase of an updated version of an RCA model similar to an early model housed in Paul Kaesberg's laboratory in biochemistry. The ordering procedures were well along when Fulton returned from his sabbatical leave at the University of California to make some last minute detailed inquiries into the resolving power of the RCA microscope. When it became apparent that a new Japanese product by JELCO might have higher resolving power than the RCA model, Fulton boarded a plane for San Francisco for a day-long demonstration of the attributes of the JELCO model. Satisfied of its superior performance Fulton recommended the foreign competition! The microscope is still operational today, being the oldest "living" specimen of a JELCO microscope in the United States! A tribute to Japanese engineering, Fulton's good judgement, and Gary Gaard's "tender loving care" over the past twenty years!

Gustaaf A. de Zoeten

In Chapter 3 Pound has pointed out the pivotal role that certain pieces of equipment have played in the history of research in the department. This is certainly true. The acquisition of the electron microscope was, in many ways, responsible for the decisions that led to the hiring of G. de Zoeten in 1967 and to the subsequent strengthening of the department's electron microscope facility. Though the electron microscope was initially used by Fulton for virus research, a need for wider application by the department necessitated the hiring of Gary Gaard to provide maintenance and operating expertise and instruction in specimen preparation. Gaard assumed the responsibility in 1966 for the microscope which was housed in an office-laboratory suite on the seventh floor just outside the elevators. No facilities had been planned for an electron microscope in the new Russell Labs. Users of the electron microscope on seventh floor had been plagued by an erratic instability of the electron beam which eventually was traced to a distortion of the magnetic field by the large iron counterweights moving up and down with irregularity in the nearby elevator shaft! Part of the negotiations over de Zoeten's acceptance of an offer to come to Wisconsin involved the relocation of the electron microscope to the basement of Russell Labs and the construction of a joint facility with the Department of Entomology under the supervision of de Zoeten and Gaard.

In addition to serving as a major resource to the research programs of de Zoeten and other virologists, the facility has serviced many other research and extension projects. Moreover, students such as James Aist, Harvey Hoch, and Edson Setliff have set standards of excellence with their research on the department's electron microscope facility that established them as leaders in their fields.

FIRST J. C. WALKER CONFERENCE

An activity which served greatly to stimulate and reinforce the interest in physiological plant pathology within the department was the organization of an international conference on the physiology of disease and resistance in plants. In honor of J. C. Walker, and shortly following his retirement, the Walker Conference was held June 22–25, 1965, at the University of Wisconsin Center. Twenty-five scientists were invited to the conference to participate with our faculty and students in presentations and discussion on the topic Pathogenesis and Metabolism in Plants. Initial support for the conference came from funds donated to the UW Foundation as an endowment by the Racine Wisconsin Chamber of Commerce in the name of their native son. Over the years the J. C. Walker fund has served to bring many notable scientists to the department (Chapter 5).

In April 1968 the noted plant morphologist Katherine Esau was invited to present a series of lectures on her pioneering work in electron microscopy of plant virus and cell inclusions. Her lectures and a book entitled *Viruses in Host Plants: Form, Distribution, and Pathological Effects* were published by the University of Wisconsin Press with the support of Walker funds.

OPPORTUNITIES FOR EXPANSION—A LONG TERM COMMITMENT FROM THE USDA

The move to Russell Labs not only provided the much needed room for the consolidation of programs in forest pathology, fruits, and vegetable diseases, it also opened the possibility of space for new programs, provided supporting funds were available. The time for strengthening the long and important commitment that the USDA had maintained with the department since its earliest years (Chapter 20) seemed ripe. In a series of discussions involving Durbin, the new chairman (Kelman), and the new dean (Pound) with the higher levels of USDA administration, it was agreed that one of the newly conceived Pioneering Research Laboratories of the USDA Agricultural Research Service would be housed in the Department of Plant Pathology. The department agreed to the appointment of three young researchers funded by the USDA in the unit to be headed by Durbin, and would insist that the appointees be given full faculty status. Selection of the individuals would be with faculty approval.

The vision of the department was to provide a group of young well-trained scientists in the areas of cell biology, biochemistry, and analytical chemistry without strong concern as to whether their backgrounds were with plants or plant pathology. The candidates were to have sufficient strength in their respective fields of specialization that when their credentials were viewed by the corresponding department at the University of Wisconsin they would be favorably approved by that department. It was envisioned that these scientists would interact with various members of the department interested in the nature of disease and resistance in plants, thereby strengthening the overall research in these areas.

John P. Helgeson

In 1966 John Helgeson was appointed as assistant professor in the Pioneering Research Lab. Helgeson had received his Ph.D. under F. Skoog in the Department of Botany at Wisconsin and had completed two years postdoctoral training at the University of Illinois in the laboratory of Nelson Leonard studying analytical methods of organic chemistry. Helgeson brought with him a deep commitment to cell culture technology and analytical methodology that strengthened the department. For many years Helgeson has maintained his primary focus in plant tissue culture as a model for research into host-pathogen relations. His earlier work with tobacco systems and selected pathogens have paved the way for more recent collaborative research on potatoes with G. A. de Zoeten and with Robert Hanneman of the Department of Horticulture and of the USDA. Helgeson has maintained his research at the forefront of technology in cell biology and is recognized for his leadership in host-pathogen studies. Helgeson has been supported in his research throughout the years with the able assistance of Geraldine Haberlach.

Christen D. Upper

Chris Upper joined the department in 1966 following a Ph.D. at the University of Illinois in the laboratory of I.C. Gunsalus studying enzymology and postdoctoral experience at the University of California–Los Angeles in the laboratory of Charles West studying the biosynthesis of gibberellins. Upper has demonstrated an aptitude for critical analysis and incisive thinking that has served the department well over the years. In a series of collaborations with various members of the department, Upper has been able to provide analytical inputs that have strengthened numerous research contributions. Upper's query and insights into the nature of maize leaf dust-*Helminthosporium*-induced frost sensitivity were important to the elucidation of bacterially induced ice nucleation and frost injury in plants. This story is told in Chapter 14. More recently Upper has directed his research to the analysis of bacterial populations as they relate to disease in the field. These studies, in collaboration with Susan S. Hirano, Douglas I. Rouse, and others are providing new insights into the dynamics of bacterial populations in agricultural crops.

John D. Kemp

John Kemp joined the group in 1968 as a biochemist. Kemp had postdoctoral training in the laboratory of D. E. Atkinson at the University of California–Los Angeles studying developmental biochemistry in animals, after a Ph.D. at the University of Washington in Seattle. Kemp had a desire to apply his training to the solution of problems in plant-parasite systems that made him an attractive candidate. I remember many of the raised eyebrows among the faculty and students after Kemp's introductory seminar which dealt largely with enzyme homogenates from rat livers! Again Kemp's progress was vindication of the principle that in structuring the USDA research group the department would seek the best-trained individual with an interest in pursuing fundamental problems on host-parasite relations. It was not long before Kemp settled on the *Agrobacterium* crown gall system. The model was well chosen, for together with a handful of others who were studying this system in Europe and elsewhere in the United States, Kemp was soon at the forefront of the emerging field of plant molecular biology (Chapters 14 and 20). Together with Timothy C. Hall in the Department of Horticulture, Kemp was the first to transfer the gene for the bean seed protein, phaseollin, into sunflower callus, via the modified Ti-plasmid from *Agrobacterium.* Later this gene would be expressed in tobacco seed. Kemp's successes in the department led him to opportunities with industry which he could not turn down. In 1981 he resigned his USDA position to join Agrigenetics Corporation's advanced research laboratory in Madison. For two years while he was with Agrigenetics Kemp maintained an adjunct professorship, occupying laboratory space and maintaining an active collaborative research program in the department through postdoctoral and student research assistants. In 1985 he resigned from both the department and Agrigenetics to head a research unit in molecular biology at New Mexico State University in Las Cruces. Kemp can be credited with contributions to our department by providing training to students and collaborations with our faculty in the area of plant molecular biology, thus ensuring that we remained open to the opportunities that this area of basic science offers our field.

With the USDA commitment to the department came significant increases in federal contributions to the combined state and federal budget. In 1962 when Durbin joined the department the federal contribution to plant pathology was approximately $40,000. By 1968 when the Pioneering Research Laboratory was fully operational, the total budget was $330,000 and by 1985 it was $385,00.

It is important to recognize that with full faculty status in the department, the members of the Plant Disease Resistance Research Unit have contributed significantly to the position of excellence that the department now holds. Many students have received high-quality training in physiology, biochemistry, epidemiology, and microbiology under the tutelage of the USDA-supported faculty. Generally these programs have been supported by full-time professional specialists and the research has been well funded with federal-budgeted dollars as well as by competitive grants.

Even in the early years of Durbin's tenure before the Plant Disease Resistance Research Unit was assembled, important pieces of analytical equipment such as the amino acid analyzer, centrifuges, spectrophotometers, and radioisotope counting equipment were being brought into the department on USDA funds and shared with other faculty.

By the mid 1960s what began in the early years of the decade as a qualified recognition of the importance of physiology to plant pathology was now almost an accepted fact! Many faculty were luxuriating in the fat of excessive federal funds. Laboratories were beginning to burgeon with expensive equipment. Specialized technical staff were beginning to replace students as a component of program research support (Chapter 18). Among the graduate students it was rumored that you were not really doing research unless somehow it had something to do with physiology. A new course, Plant Pathology 708—Advanced Plant Disease Physiology, taught by Sequeira, Williams, and Maxwell, was introduced by popular demand. Sections on disease physiology at the annual meetings of the American Phytopathological Society swelled to overflowing and a new journal, *Physiological Plant Pathology,* was launched.

Paralleling the upswing in research on the physiology of disease, and perhaps following it by a few years, was the use of the electron microscope to gain undreamed-of views of pathogenic organisms, infection processes, and moribund plant cells. Under the supervision of de Zoeten and Gaard, the department's newly constructed electron microscope facility in the basement of Russell Labs was in almost continual use. Students and faculty had to sign up to reserve time on the instrument and plans were being made to house a second microscope installed for use by entomology. Such facilities were being developed in numerous departments throughout the University of Wisconsin and indeed at universities all over the world. The number of papers in *Phytopathology* dealing with ultrastructure rocketed, and a considerable portion of the Ph.D. theses in the department incorporated at least some electron microscopy into them.

CURRICULAR REORIENTATION AND THE DEMISE OF CROPS COURSES

The combined rise in research on disease physiology and descriptive electron microscopy were solid nails in the coffin that was burying the crop orientation that the department had followed for over fifty years. Yet another nail was the dropping of the crops courses. For many years the normal curricular sequence for all students began with a comprehensive introductory course in the principles of plant pathology, known over the years as PP 1, PP 101 or PP 300 (Chapter 17). Walker's general text, *Plant Pathology,* was supplemented with various other readings usually of historical or classical importance. This course and a broad methods course (PP 102) taught by Riker and later by Hildebrandt were the foundation courses which everyone took. Following these, students were expected to enroll in several crops courses depending on their particular interests. Dickson presented the field crops course (PP 116) using his book as the primary resource. Keitt and Moore gave a course in fruit diseases (PP 117) and Walker presented a course in vegetable diseases (PP 120) with his textbook as the central resource. In later years Patton gave courses in diseases of forest trees and wood decay (Chapter 17). These courses were generally taught in alternate years, and although for most students the subject matter was dry and the lectures frequently uninspiring, the amount of technical information on crops and their diseases and control was encyclopedic. Not only were the students getting useful information of practical importance in disease diagnostics and control, but they were hearing the principles that they were introduced to in the introductory courses reinforced in the context of disease after disease, and crop after crop after crop. Supplementing the crops courses were advanced specialized courses in various areas such as plant virology, fungal physiology, and mycology.

What was the underlying reason for dropping the crops courses? Was it perhaps the element of redundancy that led the department to decide that the crops courses should be replaced by principles courses and more specialized subject matter courses? Perhaps the retirements of the Big Four left a void in the personal experiences needed to teach the principles of plant pathology in the crops context. Perhaps there were thought to be sufficient new insights from physiology, biochemistry, electron microscopy, ecology, and genetics, that there was no longer time for reexamining the basic principles of plant disease causation and control in the repeated context of crops. Whatever the reasons were, the crops courses were dropped and replaced by Plant Pathology 205 (later 601) which was taught in a team approach by Sequeira and others. The course surveyed the mechanisms of disease causation from the physiological and organismal levels. A companion course, PP 602, covered the principles and methods of disease control and the behavior of pathogens as populations in air, on the plant surfaces, and in the soil. This course has been taught by several faculty. Various generalized and specialized methods courses have been given since PP 102 was dropped, and the need for advanced coverage of various topics has been treated by the introduction of various subject matter courses focusing on organisms rather than crops, e.g. PP 616—Plant Nematology Techniques, PP 518—Biology of Plant Pathogenic Bacteria, PP 520—Plant Pathogenic Fungi, and PP 510—Forest Pathology (Chapter 17).

Since the demise of the crops courses, the departmental curriculum has been in a state of almost continual evolution. Mandated student course evaluations are a component of faculty merit salary reviews, and have had the effect of placing faculty "on notice" as to the seriousness of their teaching effectiveness.

In spite of continuing evolution of the graduate level courses in the department, the introductory level course, PP 300, has been the course toward which the department has directed most of its teaching resources. PP 300 was restructured in 1966 by A. Kelman, and strengthened by D. Maxwell, as the main lecture and supporting laboratory course introducing the principles of plant pathology to advanced undergraduates and beginning graduate students. The course is extensive in its coverage and is recognized by students in the College of Agricultural and Life Sciences for the excellent organization of its lectures and laboratories and the rigor of its subject treatment. The enrollment was in the range of 30 to 40 in the mid 1960s and reached a peak in the fall of 1976 when over 180 students took introductory plant pathology. Because of the backlog of students, it was necessary to offer this course in the spring and fall of 1977. Over the years, enrollment has averaged about 80 students per year.

An interesting activity in curricular improvement that was initiated in 1971 by the department in conjunction with the teaching committee of the American Phytopathology Society was the development of an NSF-supported national workshop on instructional improvement in plant pathology. For fourteen days, twenty teachers of plant pathology participated in intensive lectures, discussions, and demonstrations on various topics of importance to improving instruction.

Figure 4.5 NSF-supported workshop on instructional improvement in plant pathology, 1971. L-R R. Campbell, A. L. Morehart, E. Klos, A. Epstein, R. S. Halliwell, C. Kenaga, E. E. Trujillo, J. Cook

SHIFTING LOCATIONS

The shifting emphasis in research and teaching within the department saw a shifting of time commitments and resources from the outlying field laboratories to the new facilities in Russell Laboratories. By 1960 the vegetable program had given up occupancy of the Kenosha lab, although the entomologists were still in summer residence there. By the mid 1960s fewer forestry students and faculty were spending their summers at the Wisconsin Rapids and Star Lake facilities. Much of Moore's research continued at Sturgeon Bay.

Within the College of Agricultural and Life Sciences there was a strong movement to relocate the various experimental field research facilities from the Madison farm sites; West Hill, Reader, and Charmany Farms were moved to the Arlington Prairie twenty miles north of Madison. The Department of Plant Pathology was one of the last to develop an experimental farm. The college had purchased the Bussain Farm at North Leeds and this was to be shared between plant pathology and entomology, when the need arose. Smalley's nurseries of *Ceratocystis*-resistant elms were the first to be established on the Bussain farm in 1958. In the mid and late 1960s, Arny's corn and oat research and Maxwell's alfalfa and red clover plots were planted. The vegetable program remained on the Madison campus, shifting its location year by year as building construction on the west side progressed: first an extension of land for the Forest Products Laboratory, then the construction of the WARF Building followed by the Neilsen Tennis Stadium, and finally in 1975 the occupation of "west 20" by the new health sciences complex. All that remains today on the Madison campus is a small plot of land of about one hectare directly south of the Walnut Street greenhouse range. This is shared with the Department of Horticulture.

With the loss of the Madison campus lands, upgrading of the Bussain Farm at Arlington proceeded. A well for irrigation was installed in 1976 and in 1978 a new laboratory and equipment storage facility, shared with entomology, was dedicated on the farm site.

Increasingly since the early 1960s the department has operated much of its field research on the Hancock Experimental Station. Those portions of the central sands area of Wisconsin that are irrigated are under intensive cultivation with potatoes, bush beans, field corn, cucumbers and various other mixed crops. Situated about seventy miles north of Madison, the Hancock Experimental Station is a well-managed operation ideally suited for experimental plot work with uniform soil type and sprinkler irrigation that can be used to regulate the spread of foliar pathogens. Much of the work on root rot and bacterial blight resistance in beans by Hagedorn and his colleagues and the development of black rot resistance in cabbage by Williams and his students was on the Hancock Station. Earl Wade annually conducted extensive fungicide trials on potatoes, cucumbers, and other crops at Hancock. More recently, extensive use of the station has been made by Kelman, Stevenson, Rouse, and Mitchell on various aspects of potato disease, epidemiology, and control, while Rouse, Upper, and Hirano have examined the ecology and epidemiology of epiphytic bacteria on beans.

As the pressure for the alternate use of the vestiges of agricultural research land on the Madison campus and west-Madison experimental farms increase, the college has planned for experimental lands on the far western perimeter of Madison in Middleton township. The new multiuse West Madison Research Station is about six miles west of the campus on Mineral Point Road and will be more accessible and thus more suitable for certain kinds of research than the Bussain or Hancock facilities.

A RETURN TO THE TRADITIONAL MOLD?

A dominant characteristic of the period of transition was that the ideas, influence, and backgrounds of new faculty trained in traditions other than those of Wisconsin were intermixed largely with those of the second generation direct lineage from L. R. Jones.

This mixing provided a tension within the department which was at times unsettling for the senior faculty and at the same time stimulating. There is always concern when traditions that have borne the fruits of success are broken. Nevertheless, in order to press forward old molds must be broken and new ones cast. Only occasionally during the period of transition did the department return to the traditional mold.

Paul H. Williams

In seeking to maintain a continuum in the legacy of responsibility to Wisconsin's cabbage and vegetable industries represented in the lineage of Jones, Walker, and Pound, Paul Williams was appointed to continue upon Walker's retirement (Chapter 3). Williams has continued an active program supporting the changing needs for multiple-disease-resistant cabbages, cucumbers, carrots, and onion through research on the genetics of resistance. He has maintained a close collaboration with C. E. Peterson, vegetable breeder in the Department of Horticulture and the USDA, and with breeders and pathologists in numerous seed companies throughout the United States. Williams has taught the course on breeding for disease resistance (PP 517) which largely supports the needs of students in the interdepartmental Plant Breeding and Plant Genetics degree program.

Gayle L. Worf

As is documented in Chapter 6 on the history of extension in our department, the department, in seeking additional strength in the area of extension to relieve Earl Wade of the enormous burden of grower requests and responsibilities, sought Gayle Worf as the best candidate. Gayle had been trained at Wisconsin under D. J. Hagedorn, and had acquired experience in the area of field crop extension. He had made a significant reputation for himself in the three years that he was on the job at Iowa State University. Since returning to Wisconsin in 1963, Worf has established himself among the national leaders in extension plant pathology and has been vitally involved in expansion of our own extension plant pathology resources into a team of four faculty and support staff that is serving the broad needs of Wisconsin's agriculture.

THE IMPACT OF THE NIGERIAN INVOLVEMENT

The commitment made in 1966 by the College of Agricultural and Life Sciences at Wisconsin to the Nigerian government for the establishment of an agricultural university, with the support of funds from the U.S. Agency for International Development (USAID), had a profound effect on the lives of many in the department in the middle and late 1960s. This story is told by Pound in Chapter 3 and Hanson in Chapter 24. What is given here is an anaylsis of the consequences of the department's substantial commitment. Each of those who chose to go to Nigeria for two or more years were interrupting productive research programs at home to seek new challenges. Some, such as Earle Hanson and Dewey Moore, returned to new commitments. Hanson took on extension responsibilities in forages and Moore assumed the directorship of the Experimental Farms Department. Others, such as Kuntz, Berbee, and Arny, returned to their respective positions with renewed zeal for their research and broadened by their experiences in Africa. The department pays tribute to those men and their wives who embarked on this mission of considerable professional and self-sacrifice.

Douglas P. Maxwell

The opportunity to build a new position in forage grass and legume pathology arose when the Hansons left for Nigeria. This time the department traveled to Cornell University. Douglas P. Maxwell arrived April 1, 1968, directly from his Ph.D. with Durward Bateman. Maxwell had a background in the physiology of pathogenesis and over the years established collaborative projects with Richard Smith (USDA) on red clover, Etlar Nielsen and Paul Drolsom on forage grasses, and E. T. Bingham on alfalfa. After several seasons of evaluating the potential of disease losses on Wisconsin's forage grasses and legumes, Maxwell concluded that the greatest losses were occurring on the alfalfa crop, and directed his program toward problems associated with *Phytophthora* root rot. Soon after his arrival Maxwell assumed major responsibility for instruction in Plant Pathology 300. He also participated in PP 601. His excellence as a teacher has earned the respect of faculty and students alike and in 1975 he was presented an outstanding teaching award in the College of Agricultural and Life Sciences. His interest in fungal physiology led him into studies on the function and role of fungal microbodies in pathogenesis, and a number of students and visiting scientists have worked with him on these problems. In 1976–77 Maxwell spent a sabbatical year on an Alexander Von Humboldt fellowship at the University of Aachen in West Germany.

Over the years Maxwell's effective role on various committees within the university and the department, his sensitivity for the concerns of individuals, and his congeniality augured well for his potential as a department leader. He accepted the department's call in 1980 to represent it as chairman. Maxwell succeeded John Mitchell who had assumed the chair for five years after Kelman's resignation in 1975.

ADMINISTRATION DURING THE PERIOD OF TRANSITION

In Chapter 3 Pound refers to the style of administration under G. W. Keitt in which each of the Big Four had virtual autonomy over their own programs but also assumed certain general responsibilities on behalf of the department. Decisions affecting faculty appointments and hence the future direction of the department were made literally without the vote of junior faculty. When Pound assumed the chair, faculty were afforded a somewhat larger role in departmental governance. Pound was known for his administrative efficiency, incisive decisions, and astute judgements of individuals. His hallmark as an administrator was his unbending commitment to the selection of individuals who represented excellence. From an operational point of view Pound relied little on committee judgements; rather, on administrative issues, he generally used his own judgement. On matters of personnel where he felt the broader department opinion should be sought, he normally tested the opinions of individual faculty and then, knowing the direction of opinion within the department, either brought the issue to a vote or never raised it. As a consequence faculty meetings were infrequent or when faculty requested them.

Audrey Dunlap

An important component of Pound's administrative operation was his reliance on the abilities of his administrative secretary, Audrey Dunlap. Miss Dunlap, reared of solid Iowa stock, assumed the position of Professor Keitt's secretary from Miss Clara Sleicher in 1948. Miss Dunlap was one of a breed of able, intelligent, strong-willed, and strong-minded women who for many years literally ran the department and, in many respects, the University of Wisconsin. Throughout most major departments of the university women like Audrey Dunlap wielded a power that is most difficult to assess today. The academics and scholarly chairmen relied on them to manage much of the day to day operations of the department. They conserved the budget, supervised the payrolls, and scrutinized hirings of much of the supporting staff and graduate students. My own experience as a graduate student on the day of my arrival at the department is revealing in this context. Miss Dunlap's remark to the chairman through the open office door, upon my introduction and after careful scrutiny, that the boy with the "bunny fur" around his neck had arrived (narrated at the beginning of this chapter) is most revealing. In those days all graduate student applications were handled exclusively by Audrey Dunlap. She sent out the application forms, received the completed forms, looked them over, and decided which ones would go to which professors. To make her decision process more interesting Miss Dunlap always typed on the upper right corner of the form, APPLY PHOTO HERE. In this way she had the added opportunity of determining what a student looked like before he or she arrived! In my own case, I had affixed a formal college graduation picture to the form, and the upper part of the black graduation gown was edged with a collar of white rabbit fur!

Perhaps the greatest attribute that Audrey Dunlap had was an undying loyalty to her department. Miss Dunlap's life literally revolved around catering to the many lives of the graduate students, the young faculty and their families, and the older faculty in their infirmities. It was indeed a privilege to be counted among "Audrey's boys", as many male graduate students can attest (Chapter 18). On various occasions over the years she could be overheard to remark to a professor on bringing a completed student application form, "Professor you can look after his research, and I'll look after his stomach!" She was indeed a splendid cook!

Within her own domain, the main office, she ruled with an iron fist, always meticulous, always demanding the highest standards of secretarial performance. Pot luck luncheons were but one way to scrutinize the skills of young, probationary stenographers! When she retired in 1974 after twenty-six years of service to the department Miss Dunlap received salutory letters filling a large volume. In his congratulatory words upon introducing Miss Dunlap at the fiftieth anniversary celebration of the department at the Green Lake, Wisconsin meetings of the American Phytopathological Society, Chairman Pound summarized Audrey Dunlap as being "loyal to the department and devoted to its staff".

CHANGING ADMINISTRATIVE STYLES

With the move to Russell Labs recently completed, the prospects of many new staff appointments looming, and the rapid evolution in research and curricular direction occurring, the newly arrived chairman, Arthur Kelman, had a major administrative burden. The department was entering a period of unprecedented opportunity and change, on top of which was being superimposed new layers of federal, state, and university bureaucratic accounting. The shift of administration of the extension programs from the college and department to the newly formed extension division of the university added measurably to the administrative work load of the chairman. Likewise the need to provide for smooth transitions of students and departmental responsibilities of the various faculty departing and returning from the Nigerian commitment added to Kelman's burden. Kelman's administrative mode was to seek and to provide operational guidance of the department through the committee structure. Issues of departmental operation and direction were pursued in discussion with individuals and in committee. As a result, the department established a lengthy list of committee assignments with responsibilities for faculty, staff, and students. Faculty meetings were held monthly to review committee recommendations. They were frequently long and issues were occasionally contentious.

The committee structure established by Kelman was maintained through the tenure of Mitchell and presently is with Maxwell. Though occasionally burdensome, and frequently time-consuming, some committees have proven to be essential to the positive evolution and growth that the department has undergone. In particular, the Long-range Planning Committee provided important guidance to the department as it charted its course through the period of transition (Chapters 5 and 29).

CHAPTER 5

The New Generation 1975–1985

Douglas P. Maxwell

The ten-year period from 1975 to 1985 has been a time of considerable change and growth in the department. The three dominating factors have been restaffing, which has led to new program directions, a high inflation rate that reduced financial resources, and the application of molecular biological techniques to plant pathology. The department started this decade facing the potential retirement of ten faculty out of a total of twenty-five. The challenge has been to increase scientific excellence while maintaining a balance of research interests between applied/technological and basic programs.

The future direction of the department will be determined by the program decisions and faculty hirings that occurred during this decade. Kelman had anticipated this situation and appointed a Long-range Planning Committee (LRPC) in the early 1970s. This committee had primary responsibility for the development of recommendations which were presented to the faculty for their approval. This committee has always been rather large and represented the various views and research areas in the department. During this ten-year period, three restaffing plans (1976, 1981, and 1985) were adopted by the department based on recommendations of the LRPC.

Before reviewing these three plans, it is essential to record several agricultural administrative policies which had a major impact on the actions of the department. The high inflationary rate of the late 1970s forced Dean L. M. Walsh in 1980 to require all departments in the college to reduce their FTE's (full-time equivalents) and state plus federal formula funds (e.g. Hatch, McIntire-Stennis) by 5 percent. For the department, this meant a reduction in 1.7 FTE's and about $50,000. Also, the dean required departments to prepare lengthy position justification statements when new faculty positions were requested. These were reviewed quarterly and ranked by the college deans. This action quickly created a climate in which expansion in faculty or technical support seemed unlikely. Each department did all that it could to maintain its current positions. During the early 1980s sudden implementation of hiring freezes often thwarted the lengthy and complex process of filling an open position. In 1983, Dean Walsh relieved this frustrating situation by the establishment of an important new policy. It provided that once a staff position had been approved, the department would have a reasonable time to fill it. Thus, if an outstanding candidate was not found initially, the department could mount another search without fear of loss of the position. Currently, the limited increases in the federal formula funds, the requirement by Chancellor Shain to reduce FTE's and budgets by one percent each year for the college, and the 18 percent increase in the graduate student stipends effective July 1, 1985, are continuing to cause serious financial difficulties for the college and the department.

The first restaffing plan was presented to a comprehensive review panel in May, 1976. By this time, several staffing decisions had been made. Steven A. Slack, who would become the director of the Potato Seed Certification Program when H. M. Darling retired, arrived in 1975. He had completed his Ph.D. at the University of California–Davis with R. J. Shepherd on the serological detection of barley stripe mosaic virus, and brought added strength to the plant virology program. The U.S. Department of Agriculture (USDA) carrot, onion, and cucumber investigations under C. E. Peterson in horticulture were expanded via a cooperative agreement with the addition of Alleah B. Haley to our department in 1975. Haley had studied resistance to *Verticillium* wilt of cotton at the University of California–Berkeley with S. Wilhelm. Craig R. Grau arrived in 1976 and assumed the extention/research responsibilities in the area of field crops, an area which had been the responsibility of E. W. Hanson until his retirement in 1976. Grau received his Ph.D. with T. Kommedahl from the University of Minnesota where he completed a study on the relationship of soil-incorporated herbicides to root diseases of pea. John H. Andrews accepted responsibility in 1976 for developing a new program of integrated pest control. Andrews' position was made available when J. D. Moore (fruit crop pathology) became the director of Experimental Farms. Andrews had training in several areas: Dutch elm disease, cytology of virus-infected plants, physiology of downy mildew infections, and pathobiology of aquatic plants. He received his Ph.D. from the University of California–Davis under T. A. Shalla.

The 1976 restaffing plan (Table 1) focused on the projected composition of the department in 1985. Faculty programs were categorized into three areas: technological plant pathology and applied research with ten full-time equivalents, fundamental and applied science (resource faculty, six FTE's), and basic and fundamental science (resource faculty, eight FTE's). It was anticipated that fifteen current faculty would still be in the department in 1985 and that ten to eleven new positions would be available. Sixteen areas for restaffing were identified and it was recognized that the department would be very unlikely to receive permission to fill all these positions.

TABLE 1

Projected faculty members and restaffing areas for 1985, as presented to the comprehensive review panel in 1976.

Technology and Applied Science	Applied and Fundamental Science	Fundamental and Basic Science
Projected faculty:		
Worf, (ornamentals, turf, shade trees)[a]	Smalley (mycotoxins, shade trees)	Durbin (physiology)
Grau (field crops)[a]	de Zoeten (virology)	Kemp (physiology)
Williams (vegetables)	Andrews (integrated control)	Maxwell (physiology)
Berbee (forest trees)	Slack (virology and potato certification)	Sequeira (physiology)
Haley (vegetables)	Kelman (phytobacteriology)	Upper (physiology)
Projected areas:		
Field crops	Soil microbiology	Population genetics
Forest shade trees	Pathogenic fungi	Quantitative epidemiology
Vegetables[a]	Phytobacteriology	Microbial genetics
Fruits[a]	Mycoplasma-like organisms	Protoplastologist
Ornamental plants	Nematology	
Disease clinic, survey[a]	Virology	

[a]Faculty with major extension responsibilities.

Quantitative epidemiology and vegetable pathology (extension/research) were identified as the high priority areas. Douglas I. Rouse was appointed in 1979. Rouse obtained his Ph.D. from the Pennsylvania State University with D. R. MacKenzie and R. R. Nelson, studying components of rate-reducing resistance of wheat to powdery mildew. At this time "Penn State" was the internationally recognized center of training in epidemiology.

The extension vegetable position was filled in 1979 by W. R. Stevenson, who had received his Ph.D. with D. J. Hagedorn in 1972 on pea seed-borne mosaic and subsequently served as extension vegetable pathologist at Purdue University for seven years. Stevenson had developed a facility for the application of computers to extension plant pathology, an expertise important for the future direction of extension and the department.

During the period from 1975 to 1980, Darling, Hanson, Hildebrandt, and Wade retired and Haley resigned. As the department faced the next set of retirements (1980–85), it was anticipated that five more faculty positions might open. Again, the Long-range Planning Committee worked to devise a plan for restaffing based on the plan presented in Table 1. The major difficulty was a forced departmental budget retrenchment of 5 percent as discussed previously. It was decided that one secretarial and one faculty position would be eliminated. The four program areas identified for restaffing were nematology, fruit crop pathology (research/extension), field crop pathology, and soil-borne pathogens. Of the expected retirements, the department decided the area of virology would be adequately covered by de Zoeten and Slack. Also, T. Hall in horticulture and P. Kaesberg in biophysics had strong programs in plant virology. With this as the restaffing plan, all seemed to be in order. In January, 1981, this plan received a strong endorsement from a comprehensive review panel. For our department, this review was also part of a required review by the Cooperative State Research Service, USDA. S. A. Tolin served as chairman of a panel of six plant pathologists.

Times were changing. Faculty members were becoming aware of the future importance of the field of molecular biology. Two unexpected faculty resignations occurred and the loss of these faculty members would have a major impact on the future direction of our department. T. Hall in horticulture and J. D. Kemp in plant pathology joined a Madison biotechnology firm, Agrigenetics Advanced Research Division, Madison.

A long and extensive search brought Sally A. Leong in 1983 to the department as a member of the USDA Plant Disease Resistance Research Unit. Leong received her Ph.D. in comparative biochemistry from the University of California–Berkeley with J. B. Nielands. Her interests have centered on the molecular biology of eucaryotes and she currently is developing vectors for transformation of fungal pathogens. Demands on her time have been great as many students and faculty require information on molecular biological techniques.

Importance of this area of molecular biology led to the hiring of Albert H. Ellingboe in 1984. Ellingboe had extensive experience in host-pathogen genetics at Michigan State University and had gained additional expertise in molecular biological approaches to research on resistance while with the International Plant Research Institute, a biotechnology firm in San Carlos, California. His research objectives include the cloning of the gene in maize for resistance to leaf rust.

After eighteen years without a nematologist in the department, Ann MacGuidwin arrived in 1984 from G. Bird's research group at Michigan State University. Her interests in population dynamics, biocontrol, and teaching were valuable additions to the department.

The areas of soil-borne pathogens and biocontrol were strengthened by the addition of Jennifer L. Parke in 1984. Parke received her Ph.D. training with R. G. Linderman and J. M. Trappe at Oregon State University on ectomycorrhizal fungi in forest soils. She was attracted to the *Aphanomyces* root rot system for her future research on biocontrol.

Proceeding as planned, the department appointed Steven N. Jeffers in 1985 to the faculty with research/extension responsibilities in fruit crop pathology. Jeffers' Ph.D. studies with H. S. Aldwinckle at Cornell University, Geneva, New York, on etiology of *Phytophthora* crown rot of apples, was excellent training for his future challenges in Wisconsin.

Our department has never let too many opportunities slip by. Unexpected events occurring in 1983–84 led to the hiring of three additional faculty. Paul Kaesberg, chairman of biophysics, University of Wisconsin–Madison, approached me in 1983 about our department considering Paul Ahlquist for a joint appointment. Ahlquist had received his Ph.D. with Kaesberg and was currently an assistant scientist in biophysics. His research on the molecular biology of brome mosaic virus was so outstanding that biophysics and plant pathology joined forces to request a new joint position. It was an exceptionally strong case and Associate Dean Hougas was fully supportive. With his strong backing it seemed possible that Dean Walsh might provide half of a full time appointment for our department, and he did! After a national search for a plant molecular virologist, Ahlquist was offered the position. Although he had received in the interim two other offers from biotechnology firms, he joined the department in 1984. The academic freedom of Wisconsin was a major factor in his decision to stay.

Another turn of events allowed the department to appoint Jo Handelsman to the faculty. Chancellor Shain implemented a plan to recognize outstanding senior faculty and provide them with a substantial salary increase. This he achieved through a grant providing funds from Wisconsin Alumni Research Foundation. Arthur Kelman was one of the fourteen recipients of these WARF senior distinguished research professorships. The chancellor had also stipulated that salary savings be used to provide funding for an overlap position in the same area as the awardee until that faculty member retired; thus, the possibility for the addition of a phytobacteriologist was realized. This position would add increased breadth and strength to a program that was already internationally acclaimed. Jo Handelsman was chosen in 1985. Her thesis with W. Brill in bacteriology, University of Wisconsin–Madison, on the nature of the interaction of *Rhizobium* and alfalfa, will set the stage for her future studies on the genetics and biochemistry of specificity and antagonism.

The addition of Murray K. Clayton in 1984 centered around the college's decision to add another 0.5 FTE to the biometry-statistical consulting program. Early hirings in this area had resulted in the addition to the college of E. V. Nordeim (forestry) and B. S. Yandell (horticulture). Our department had made a serious attempt to attract Yandell, but the dean decided to place him in horticulture. This time the dean agreed to let the candidate pick a department in the college. This was the green light for us and Clayton decided to join our faculty. Clayton completed his Ph.D. with D. A. Berry in the Department of Statistics at the University of Minnesota on sequential decision theory.

Besides these additions to the faculty, Raymond F. Evert, professor of botany, UW–Madison, received a part-time appointment in the department in 1978. His appointment in plant pathology increased his appointment from an academic year to a full-year appointment. Again, our department gained.

Between 1980 and 1985, six faculty retired—Moore (1980), Boone (1983), Mitchell (1984), Fulton (1984), Arny (1984), and Kuntz (1984). In addition, Kemp resigned in 1981. In all cases, the emeritus faculty have continued their programs and provided excellent service to the department and to the state. Boone stated recently that he now has more cranberry plots than he ever had. He has also become involved as a consultant on a project concerned with establishment of the culture of cranberries in the U.S.S.R. Mitchell coordinates the research on ginseng and has fostered the new attitude toward support of research by the Wisconsin Ginseng Growers Association. Moore and Arny are our historians and Moore is organizing the seventy-fifth anniversary celebration for September 1985. Fulton continues his interest in tobacco diseases and consults for Agracetus, Inc., Madison. These men have a wealth of experience and share it gladly. They even share offices with each other or with research associates and graduate students. Space is limited but everyone understands.

In summary, during this last decade fourteen faculty have been hired and twelve have retired or resigned. Also, G. S. Pound resigned as dean. These changes brought new program directions particularly in the areas of quantitative epidemiology, molecular biology, biological control, and nematology. Thus, the new generation (Table 2) has arrived. Time will judge the wisdom of these decisions. As the future is faced, the areas of population genetics and forest pathology have been identified for the next round of state faculty positions to be filled, and the possible addition of a USDA assistant professor in the area of procaryotic genetics is being considered.

TABLE 2
Faculty members and programs in July 1985

Technology and Applied Science	Applied and Fundamental Science	Fundamental and Basic Science
Berbee (forest trees)	Ellingboe (field crops, genetics)	Ahlquist (virology)
Grau[a] (field crops)	de Zoeten (virology)	Leong (molecular biology)
Jeffers[a] (fruit crops)	Clayton (biometry)	Sequeira (physiology)
Stevenson[a] (vegetable crops)	Maxwell (administration, forage crops)	Durbin (physiology)
Williams (vegetable crops)	Andrews (biocontrol)	Upper (epidemiology)
Worf[a] (turf, shade trees)	Rouse (epidemiology)	Helgeson (tissue culture, biotechnology)
Patton (forest trees)	Handelsman (phytobacteriology)	Hirano[b] (epidemiology)
Smalley (shade trees)	Kelman (phytobacteriology)	
Hagedorn (vegetable crops)	MacGuidwin (nematology)	
	Parke (soil microbiology)	
	Slack (virology, potato certification)	

[a]significant extension appointments
[b]assistant scientist

During this decade there have been many important changes and achievements (Table 3) besides the restaffing discussed above. Most of these are extensively documented in other chapters. Some of these changes include formalization of faculty governance procedures, organization of technical staff, modification of prelim procedures, final approval of an M.S. pest management program, extensive increases in administrative requirements (budget management, appointment procedures, merit increases, personnel management, record keeping, federally required verification of work percentages) and numerous scientific breakthroughs, for example expression of a bean storage gene in sunflower tissue culture, and the role of ice-nucleating bacteria in frost injury.

TABLE 3
Notable events: 1975–1985

July 1, 1975	John E. Mitchell became department chairman.
1975	Steven A. Slack joined the department, and became the new director of the Potato Certification Program. His research expanded the program in plant virology.
1975	Eugene B. Smalley and Donald Lester received a patent on a Dutch elm disease-resistant elm clone.
1975	Alleah B. Haley (USDA) joined the department and provided expansion of research on diseases of onions and carrots.
1975	An organization of specialists was formed to improve communication at all levels within the department.
January 1, 1976	The addition of John H. Andrews to the staff provided for the development of research and instruction programs in the newly emerging area of integrated pest management.
May, 1976	A comprehensive departmental review was completed.
May, 1977	Research and instruction in the area of the cytology of diseased plants was expanded with the addition of R. F. Evert (botany), on a joint appointment with plant pathology.
1977	Deane C. Arny and Steven Lindow received a patent on a method for reducing frost damage to plants.
March 1, 1978	The Oscar N. Allen Lecture Series was established for the purpose of providing honoraria to bring lecturers in the area of phytobacteriology to the campus.
May 15, 1978	The J. C. Walker Fund was established through the University of Wisconsin Foundation. Its purpose is to provide honoraria for lectures by outstanding scientists in plant pathology.
March 1, 1979	Douglas I. Rouse joined the department and established a program of quantitative epidemiology.
April 19, 1979	The preliminary examination process was restructured to include a comprehensive written examination and an oral defense of the student's thesis research proposition. The first exam was given in June of 1981.
September 9, 1979	The Technical Staff Organization was invited to have a non-voting representative at faculty meetings.
September 28, 1979	Following Earl Wade's retirement, the department hired Walter R. Stevenson in vegetable pathology extension.
May 1, 1980	Douglas P. Maxwell became department chairman.
June 2, 1980	The joint plant pathology/entomology field research laboratory at the Arlington Experimental Farm was dedicated.
1980	*Verticillium* wilt of alfalfa was diagnosed in Dane County, the first in the Midwest.
1980	The soybean cyst nematode was detected in Wisconsin on cabbage transplants from Tennessee.
October, 1980	As the national economy suffered through double digit inflation and a deepening recession, the state of Wisconsin was similarly affected.
January 12–15, 1981	A comprehensive departmental review was completed by a panel of scientists from other institutions.

TABLE 3 *Continued*
Notable events: 1975–1985

February 17, 1981	Due to a worsening state economy, the governor placed a freeze on all state-salaried positions.
May 6, 1981	Word processing capabilities were added to the departmental office.
July, 1981	The first discovery of Goss' wilt of corn in the state was confirmed.
October 1, 1981	Frank C. Vojtik was appointed to the newly created position of department administrator.
October 8, 1981	The provisions of the O. N. Allen Lecture Series in Phytobacteriology were expanded to include support for visiting scientists and graduate students.
1981	Several faculty entered into formal consulting agreements with biotechnology companies.
1981	The first major contract with a biotechnology company (Agrigenetics Research Corporation) was signed.
1981	Procedures for tenure review were formalized.
January 21, 1982	The Vaughan-Bascom Professorship Memorial Fund was established to recognize R. E. Vaughan.
March 9, 1982	The plant pathology conference room in Russell Laboratories was renamed the A. J. Riker Conference Room.
June 17–18, 1982	Our department hosted the North Central Division meetings of the American Phytopathological Society.
January 3, 1983	A committee of the National Research Council ranked the department in first place in the nation in a tie with the Plant Pathology Department at the University of California–Davis.
March 30, 1983	The Oscar N. Allen Graduate Scholar Award was established, to provide supplemental support for one incoming graduate student.
April 1, 1983	Formal appointment letters were required yearly for all academic staff.
April 12, 1983	A new area of emphasis, to provide "advanced training in the relationship between the physical environment and plant disease and epidemiology", was established under Option III of the Ph. D. program.
June 6, 1983	Sally A. Leong (USDA) joined the department to develop vectors for transformation of fungi as one phase of research in application of molecular biology techniques to plant pathogenic fungi.
June 21, 1983	Susan S. Hirano received an appointment as the first Assistant Research Scientist in the department.
July 1, 1983	Austerity measures continued in state government: all state-salaried employees were denied salary increases for fiscal year 1983–84.
December 13, 1983	The research associates (post-doctoral scientists) formed their own departmental organization, and were invited to participate in faculty meetings.
February, 1984	Arthur Kelman was awarded a Wisconsin Alumni Research Foundation Senior Distinguished Research Professorship.
February 14, 1984	Albert H. Ellingboe accepted a faculty appointment in the area of diseases of field crops and host-pathogen genetics.
March, 1984	Paul G. Ahlquist received a joint appointment in plant pathology and biophysics in the area of molecular biology.

TABLE 3 *Continued*
Notable events: 1975–1985

March 17, 1984	Ann E. MacGuidwin joined the faculty in the area of plant nematology.
July 16, 1984	Jennifer L. Parke joined the faculty to establish programs emphasizing biological control of soil-borne pathogens.
August 27, 1984	Murray K. Clayton received a joint appointment in plant pathology and statistics in the area of biometry.
September, 1984	The Elite Foundation Seed Potato Farm at Three Lakes was relocated to the Lelah Starks farm at Rhinelander.
March, 1984	The Master of Science program in crop management was approved.
October 9, 1984	Andrews and Heye received a patent on a biological control fungus.
1984	The college administration returned 50 percent of the overhead charge for contracts to the department for the first time.
1984	The J. W. Brann Memorial Fund was established.
1984	A precedent was established by charging for the diagnosis of a plant disease (potato ring rot).
February 12, 1985	The A. J. Riker Memorial Fund was established.
April, 1985	The commons room was relocated to Room B–66, and Room 492 was remodelled into laboratory space for MacGuidwin and Parke.
May 1, 1985	Jo Handelsman joined the faculty in the area of phytobacteriology.
June 1, 1985	The Plant Disease Diagnostic Clinic established a fee schedule for all specimens submitted.
June 1, 1985	Steven N. Jeffers joined the faculty in the area of fruit crop pathology.
June, 1985	The legislature approved a "catch-up" pay plan, to be implemented in stages during the biennium, offering 15 percent to Madison campus faculty and 4.7 percent to some academic staff.
June, 1985	The department received a Trochos project award from IBM providing support for instructional use of computers.

Industries and other universities have always been interested in hiring faculty members from our department. It is common for each of our faculty members to receive several serious invitations to apply for other positions each year. The potential loss of faculty became unusually serious in the early 1980s. This was caused by several events. Salaries became an important issue as the high inflationary rates of the late 1970s, coupled with modest or no salary increases, caused faculty to have increasingly less purchasing power with their income. Also, biotechnology firms and other universities were offering salaries which were as much as $10,000 to $15,000 higher, sometimes more. These factors all focused attention on faculty salaries and a climate of unrest developed. These high offers were not restricted to faculty, as several academic staff were lured away by 30 percent salary increases. The university administration supported numerous arrangements to keep faculty here. These arrangements included nine-month appointments at twelve-month rates, base pay adjustment in salaries, higher than anticipated salary increases in the merit process, college-supported salary increases when promoted, program shifts, graduate school research support, and the encouragement of consulting arrangements. (These arrangements were sometimes equal to 10 percent of the faculty member's salary.) Because of these aggressive policies, our department has not lost a state-salaried faculty member since K. R. Barker left in 1966. Also, since 1975, all candidates offered a faculty position have accepted.

Faculty governance has been important in maintaining high morale among members of this department and has contributed in a very significant way to the retention of and enticement of faculty. Attitudes toward faculty governance and the styles of departmental chairmen have varied. In his chapter, Pound stated that all departmental recommendations forwarded to the dean received unanimous approval and that this was a strength. Over time, this has changed and faculty members have now accepted the concept that it is unlikely that every action will have unanimous support. Is it really likely that twenty-six faculty would always have exactly the same view on each issue? Now it is both possible and acceptable to disagree with the majority. Yet, the strength of full faculty support exists behind the majority decisions. This has allowed the chairman to deal in a unified way with the college administration. It is a strength valued by all.

Capital equipment has always had an impact on our science. Walker (Chapter 2) discusses the first growth chambers and soil temperature tanks and Pound (Chapter 3) describes the importance of centrifuges and a cold room. In this most recent decade, the computer has dominated capital purchases for the department. Electronic communication, word processing, data storage, graphics capabilities, and statistical analyses were the major driving forces behind this expansion. The first move toward the use of computers was the purchase in the late 1960s of an IBM mag card typewriter for the main office. This equipment had a magnetic card and was an early form of word processing. Chairman Kelman was committed to modernizing the office and although he initially met some resistance, Dean R. Hughes gave his endorsement and the first IBM mag card unit in the college was purchased at a cost of about $8,000. A new age began. Following this, an Olivetti 101 (8K memory) was purchased in 1971–72 to assist with statistical analysis and limited programming. The big addition came in 1976 with the Wang 2200 computer, plotter, and printer for Helgeson's research group. With 32K memory, J. Steele was busy writing programs. This was only the beginning. Between 1979 and 1981, a Cromemco System Three with a letter-quality printer was added to facilities available to the extension group. Stevenson was the primary user and an enthusiastic supporter of the system. Federal Integrated Pest Management funds were used to place similar units in entomology, horticulture, and plant pathology. Also, a DEC PDP 11 (128K memory) arrived for Helgeson, and Williams purchased the first IBM personal computer (64K memory). Rouse coordinated the purchase of a Decwriter and connection to MACC (Madison Academic Computing Center). The stage was set for exponential expansion. The decision to change from typewriters to word processing units in the main office was encouraged by Maxwell and Stevenson. M. Schneeberger was the first secretary to try word processing (WordStar). She thought it was marvelous and now the office has four Wang work stations. The main expansion has been in personal computers (PC's). Twenty of the twenty-six faculty have a personal computer or terminal in their office or laboratory. It is only a matter of time before a computer terminal will be in every faculty office.

As a healthy plant is expected to grow, so is a healthy department. This has been the case for our department (Tables 4 and 5). Dramatic increases in the budgets (59 percent) and personnel occurred between 1980 and 1985. It should be noted that eight new faculty arrived during this time and five of these faculty are beginning to request research support. Where will we be in another five years?

TABLE 4
Distribution of personnel in plant pathology

Category	1976	1980	1985
Faculty	27[a]	25	27
Emeritus faculty	4	8	12
Assistant Scientist	0	0	1
Adjunct Professors	3	3	2
Visiting Scientists	1	4	2
Classified Civil Service	22	22	22
Specialists/Academic Staff	24	30	37
Research Assistants	52	57	56
Research Associates	8	9	20
Project Associates	1	0	2
Hourly helpers (LTE and student labor)	30	51	101
Total	172	209	282

[a]Numbers reflect numbers of individuals and cannot be equated with FTE's (full-time equivalents) because appointment percentage may be less than 100.

The nearly 60 percent budget increase was brought about by increased support from extramural competitive grants (mainly USDA), contracts with biotechnology companies, and commodity support. Because of the nature of this support, there has been a shift away from applied and technological toward basic research. Traditional funds for applied research, such as federal formula funds and Wisconsin Department of Natural Resources funds, are decreasing (Chapter 9). There were some increases in commodity support, particularly for research on diseases of cabbage, potatoes, mint, and ginseng. It appears that if applied research is to be done, commodity groups will have to support it. At least for the near future, basic research will occupy a greater proportion of the effort of the faculty.

The functioning of the department would not be possible without the generous endowment funds that have been received. The library acquisitions are totally supported from endowment funds and gifts (Chapter 20). Recently, the retirement gifts for D. C. Arny, and Helen and James Kuntz, were given to support the library. Funds to support visits to the department by distinguished scientists have come totally from endowment funds in honor of O. N. Allen and J. C. Walker. As the competition to attract outstanding graduate students has increased, these funds have been the only way that graduate students could be invited to the department. This has greatly increased the chance of a student accepting an offer. Still, some students have decided to go where they would receive fellowships. Mrs. O. N. Allen in 1983 gave funds for one fellowship, which provides a $2,000 supplement to a regular research assistant stipend and is to be offered to an incoming student.

Many important departmental needs were still unmet. In 1984, the J. W. Brann Memorial fund was established to provide support for graduate student and academic staff travel to professional meetings, undergraduate scholarships, and other needs at the discretion of the chairman. The J. E. Mitchell Fund will assist student travel. A Vaughan-Bascom professorship was created to honor R. E. Vaughan. Gayle L. Worf was the first faculty member to be so honored. The A. J. Riker Memorial Fund (1985) will become important in the future as it will provide two or three

TABLE 5
Budget sources and amounts[a]

Source	75–76	80–81	84–85
State			
Instruction			
salaries		136,699	135,324
expenses		6,500	10,870
Extension			
salaries		64,843	89,482
expenses		4,195	5,156
Research			
salaries		566,285	682,367
expenses		27,860	52,392
	765,857	806,382	975,591
Federal			
Hatch/McIntire-Stennis	175,630	334,033	320,104
Bankhead-Jones	0	4,300	0
Extension			
salaries	55,023	63,267	53,358
expenses	0	3,000	3,000
	230,653	404,600	376,462
USDA Cooperative Agreements	0	155,866	17,000
WDNR	4,400	38,879	37,639
Graduate School	22,231	82,082	122,017
Grants			
NSF		106,448	235,572
EPA		91,113	65,641
SEA/USDA		45,311	383,340
Other		87,914	267,723
	185,423	330,786	952,276
Gifts and Contracts	40,589	128,490	603,898
Potato Certification Program	106,000	213,532	202,362
Plant Disease Resist. Res. Unit (USDA-L/A)	330,000	350,000	398,000
Capital			
overhead (grants)	0		35,423
overhead (contracts)	0		22,650
state	34,265		10,000
Hatch	0		10,845
	34,265	8,700	78,918
	1,719,418	2,519,317	3,764,163[b]

[a]Grants and contracts, amounts include indirect and direct costs
[b]Grant support for Ahlquist is not included

research assistantships in the areas of forest pathology or tissue culture. The department has been fortunate to have received these gifts; they have contributed immeasurably to supporting our goal of excellence. As state support decreases, these funds and future gifts will be critical to the department.

This decade has been a time of exceptional change. Faculty have retired; new faculty have arrived. Dynamic new programs of research have been established. Growth has occurred. Hallways have filled to overflowing. Storage space has been converted to office space. The stage is set for an exciting future!

Part 2

Areas of Major Departmental Activity

Chapter 6

Extension in the Department of Plant Pathology

Gayle L. Worf and Earl K. Wade

From the department's inception, extension programs have been as much a part of the operations as have researchers and graduate students. Shortly after L. R. Jones arrived in Madison, he reached back to Vermont to invite a bright young student by the name of Richard E. Vaughan to come to Wisconsin. Vaughan had graduated in 1907 with his B.S. degree after having worked on an undergraduate thesis under Jones' direction on the subject of apple canker. He continued in the Horticulture Department there, working primarily on potato scab and late blight resistance, using a collection of varieties secured in Europe and the United States by Jones.

It isn't clear what Jones had in mind for Vaughan when he arrived in Wisconsin. He was assigned as a graduate student to work on the "pea blight" problem which was plaguing the canning industry at the time, but other events were also occurring, and the "time for extension" was nearing. Thus, the move to Wisconsin proved to be a momentous decision for both Jones and Vaughan, as the latter was soon to become Wisconsin's first, and probably the nation's first, full-time extension plant pathologist.

With Vaughan's arrival in Wisconsin, extension plant pathology was initiated. It is interesting to look at some of the earlier history to gain a perspective on the establishment of extension plant pathology.

SETTING THE STAGE FOR EXTENSION

College records show that those who led the college for the decades just preceding the department's establishment—Deans Henry and Russell—had paid close attention to the needs of Wisconsin farmers, and had stood side by side with them in sharing the results of the research that was beginning to pour forth from the experiment station. This helped to set the stage for the "Wisconsin Idea" of extending the benefits of the university to the boundaries of the state (see Chapter 21). It is not surprising that extension programs were an early part of the department's operations.

However, it wasn't always so! There were other events that had to take place first. Modern day students would do well to know something about how this rich heritage has come about. The "land grant university" and all that it means was not the product of an accident. Perhaps we should start the story with the Morrill Act of 1862, which created a land grant university for each state of the Union. It is remarkable that Congress should have taken the time during that period of civil war strife to pass such a law, but fortunately they did. Not only that, but they passed two other pieces of legislation that were to prove almost as significant to our story. In that same year, they passed the Homestead Act, which opened up lands to the common citizens, and also established the U.S. Department of Agriculture (USDA). The latter is significant to the extension story that follows, for until just recently most extension faculty have also had joint USDA appointments. The relationship would ultimately evolve into a remarkable federal-state-county partnership that remains to this day, but more on that later.

The Morrill Act provided public land in each state for the establishment of a "college of agriculture and mechanical arts" intended to teach such information to students who would gather there at the fountain of higher knowledge. But what was there to teach? Hindsight tells us that the cart had been placed before the horse. That is, there was no research base and relatively little other information upon which to draw. It took the state of Wisconsin, in 1883, and eventually the federal government—through the Hatch Act of 1887—to establish experiment stations as the second leg of what was to become the "three-legged stool" of research, teaching, and extension to bring about the full meaning and significance of the land grant institutions.

There is an interesting coincidence that we should not pass by in our story. Readers of the department's history are acquainted by now that L. R. Jones had spent considerable time in Vermont before returning to Wisconsin. We have also mentioned Vaughan's Vermont background. Isn't it interesting that Representative (afterwards Senator) Justice S. Morrill was also from Vermont!

Though it was not until 1914 that extension was to get its federal charter through the Smith-Lever Act, the state of Wisconsin became active in providing counsel to its farmers at about the same time the experiment stations came into being. Professors were anxious to share their knowledge outside as well as inside the classroom, and it probably never went unnoticed by administrators that such activities helped build support and good public relations for the university! Earlier support for the college had fallen into serious disrepair by 1880, and it is quite possible that the "land grant vision" would have faded away, had not the experiment stations and outreach programs appeared on the scene when they did.

Early extension programs were carried out primarily in one of three ways. The first was Farmers Institutes and their Institute Bulletins. These were formal, off-campus training sessions supported by state legislative funds. Of course, this was before the department's time, but this was certainly a time for teaching about plant disease control. Bordeaux mixture had been discovered, and farmers were anxious to learn about it.

As departments began to take firmer shape within the college, projects began to emerge through the departmental budget, sometimes with special state appropriations, or through grants by individuals or organizations interested in a particular subject. It appears that this is the situation that set the stage for extension—and Vaughan—to make entry into the department's history. The federal government finally entered the picture with the Smith-Lever Act at about this same time. Federal, state, and county funds became available; county agents were hired; and the formal extension programs as we know them today came into existence.

THE VAUGHAN ERA—1911–1950

These had to be exciting times for Vaughan. He arrived in 1911, the same year that Wisconsin's first county agent was appointed (Ernest L. Luther in Oneida County). His first job was to investigate the subject of pea blight and help the Wisconsin canners find some answers to the perplexing problems of pea failure, which were on the increase. He made several trips into the state, looking at the problems, and talking with growers and company field men. It was noted that blight was more severe on fields that had produced peas for several years. Disease was also more severe near viner stations where pea refuse was abundant. (Pea viners and pea vine stacks—together with their very characteristic aroma—are remnants of the past, to be recalled by fewer people with each passing year.) Fungicides were tried without success. Seed quality was becoming suspect, and Vaughan made a trip to the seed fields of the Northwest. He became convinced of the importance of pathogen-free seed to control *Ascochyta* blight, which was a major contributor to the pea problem at the time. Not everyone was happy with his findings. One seed company president tried to get Vaughan fired, but Vaughan was correct. He survived, and as he later recalled: "Perhaps this experience aided me in getting along with all kinds of people and thus contributed to my success as an extension plant pathologist."

Vaughan was officially appointed extension plant pathologist on July 1, 1915. Whether he was the first or second such appointment in the United States has been a matter of some dispute, for M. F. Barrus at Cornell was appointed about the same time, and present historians tend to give them equal billing for that distinction.

His interest in pea disease control continued, but other crops soon demanded attention. New discoveries on the control of plant diseases began pouring out of research programs. It was imperative that this new-found knowledge should be shared with growers in a fashion that it would be accepted and used. Many farmers of that time knew no other way than that of their fathers or grandfathers, and they were more than a little skeptical about these new-found ways! What better way could be found than to "show and tell", through demonstrations around the state for farmers to see? Non-replicated field demonstrations on neighbors' farms and at nearby experiment stations soon emerged as a technique which was to become a classical extension teaching method, and there were lots of opportunities! Jones' work with yellows-resistant 'Wisconsin Hollander' cabbage was progressing. Disease-resistant seed was distributed among farmers in the Racine–Kenosha area. Field tours were arranged to look at the result. Seeing was believing! Winter meetings followed for growers. The Vegetable Growers' Association of America later held its summer convention in Milwaukee, and also visited the Racine area on a field trip.

Figure 6.1 R. E. Vaughan discussing potato blackleg with growers in Oneida County, 1920.

Grain seed treatment demonstrations for the control of smut diseases on oats and barley became important about the time of World War I. These were conducted throughout the state in cooperation with the Department of Agronomy, and were a follow-up on earlier work of Professor R. A. Moore about 1900, who at the time was advocating the use of formaldehyde. Vaughan's demonstrations also included hot water treatments, and, later, the new organic mercurials and disease-resistant varieties. Barley scab outbreaks occurred in 1928, 1929, and again in 1935. Swine feeding demonstrations, in cooperation with animal husbandry, showed the dire consequences of the fungus in feed. Many barley improvement schools were then held, and hundreds of samples of barley were examined. Farmers could then go home with the knowledge that their crop was or was not fit for seed or hog feed. (Nothing was said what they did if the crop was deemed unfit for such uses. Presumably, it found its way into the famous Wisconsin breweries!) Orchard spray operations for apple scab control using lime sulfur and Bordeaux were regarded as successful, but "fireblight control was only partially successful". (Judging from the continued failure of control measures for that disease, it would seem that some things never change!) Potato seed treatment and spraying demonstrations were conducted cooperatively with John W. Brann and with Professor J. G. Milward in the Department of Horticulture. Field demonstration plots remain an important extension educational tool, but upon reflection of the past many years, history may well record the period of 1920 to 1940 as the golden era for such techniques.

Over the years summer tours, winter meetings, expositions, and demonstration trials were considered, tested, and included in the bag of extension tricks that were used to acquaint growers with new ideas. Many aids were used to persuade the less aggressive farmers of the value and acceptability of the new technologies. Preserved, pressed and fresh specimens, lantern slides, microscope mounts, and charts all became important educational tools that Vaughan developed, not only for his extension responsibilities, but also for the courses he taught on campus. Of his many responsibilities with canners, Vaughan was especially proud of the canners short course, which he set up in 1923 and guided until 1940. He also started the first undergraduate course in plant pathology in the department in 1929, an assignment he often handled on Saturdays and Mondays until 1934. He continued, until his retirement, teaching the farm plant pathology short course, which he initiated in 1918.

It is interesting to note that the short course has continued to be taught since that time, first by Earl Wade, and now by Craig Grau. It is a part of the college's Farm and Industry Short Course, which celebrated its 100th birthday this year!

Professor Vaughan was a pioneer in extension work. Virtually everything he tried and did was new. He could be noted for many achievements, but the most important legacy he no doubt left his successors was the strong sense of cooperation that he helped to foster between research professors within the department, and also with extension colleagues of other departments. This was a trademark of his era; it accounted for much of the success that was achieved during that time, and it established a pattern that has become a model of operations through the present time.

He retired on January 31, 1950, to an Iowa farm he and Mrs. Vaughan had purchased. Professor Vaughan passed away three years later.

JOHN BRANN'S EXTENSION-POTATO CONNECTION

John W. Brann was a lifelong colleague of Vaughan, having started at the same time—July 1, 1915—and retiring shortly before Vaughan, in 1947. His appointment was with the potato seed certification program. Initially it was one-third in horticulture, but later it was assigned fully to

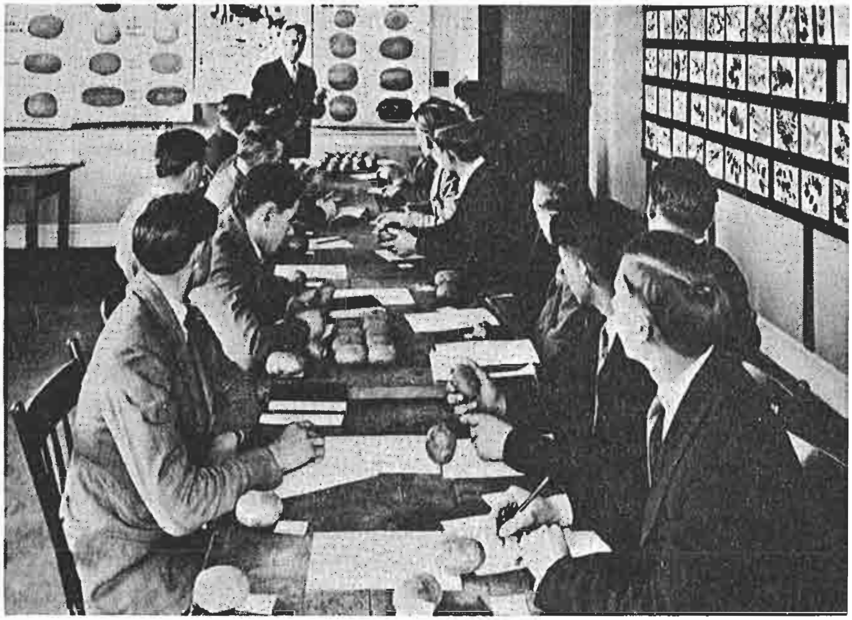


Figure 6.2 John Brann, "Mr. Potato" teaching in the Short Course.

the Department of Plant Pathology. It also carried an extension component, although not a federal appointment. Although it was only a partial extension role, one only needs to examine his annual reports, which are filed in the University Archives, along with Vaughan's, to appreciate the thousands of meetings and annual contacts he made on behalf of the healthy potato. In one year alone, he participated in over 70 meetings and recorded over 5,000 personal contacts. For many years, he was especially active with "Smith-Hughes instructors" (high school vocational agriculture teachers), and for all his extension efforts he became known affectionately as "Mr. Potato".

The record should note that Brann did not work on potatoes alone. At about the time of his official appointment he was working with steam sterilization as a possible control for "ginseng root rot", a problem and project many of us have thought was reserved for future generations of plant pathologists!

The connection of the potato seed certification program with extension has continued through the appointments of Henry Darling, and, more recently, with Steve Slack.

WADE ASSUMES COMMAND

After spending four years in the Air Force, Earl K. Wade was on his way back in 1946 to his home farm near Marshfield, Wisconsin. Stopping by the College of Agricultural and Life Sciences in Madison for a chance visit with Henry Darling, he learned of an opening with the Wisconsin Seed Potato Certification Program. After further visiting, Earl ended up taking the job, and for four years was involved with the potato certification program while continuing his graduate studies.

Agriculture following World War II was marked by a period of rapid expansion and technological change. Before the war, it took one farmer to feed every eight to ten persons. By 1960, that was down to one for twenty-five consumers. (Within another two decades, it would be reduced to one for every eighty persons!) There were fewer farmers, but those that remained had become dramatically more specialized and sophisticated. Wade was to experience the strongest impact of those changes as they came to bear upon extension programs. Greatly increasing the numbers of county extension meetings was one approach to getting out the new information. These meetings were conducted by teams of specialists from several disciplines touring together, starting in one county during the early part of the week, and continuing into as many nearby counties as time would permit before returning to Madison for a fresh supply of pamphlets and energy. Mass media was also being touted as a more important way than ever before to move information out quickly and efficiently. Professor Wade produced thousands of news articles and radio broadcasts over university station WHA and other outlets during that time.

There was also a change in the department structure that was coming about which was to have a profound and lasting effect upon the role of the extension faculty. Slow at first, the change from field-oriented research, which had been the framework of much of the department's research, toward basic research, intended to provide answers and information on long-term questions, would leave Wade and future extension faculty increasingly dependent upon their own and other non-departmental resources for much of the information and materials they would need to answer the questions of their clientele. Interestingly, this was occurring at about the same time that the agricultural chemical industry was accelerating the development of new, more precise and sophisticated pesticides that could help to control old and new disease problems. Part of the approach Professor Wade took in responding to these changes was to develop field fungicide research and demonstration plots, especially for potato early and late blight control, but on a great many other crops as well. His annual reports speak to the numerous field trials he conducted, and his dedication to the task of providing current and useful information for his clientele.

During his tenure, Wade did much to strengthen the role of the extension pathologist in field investigations, and also to inspire stronger bonds with county extension personnel. Most of his summer hours were spent in growers' fields, often with the county agent, helping to solve the problem of the day.

A TIME FOR INCREASED STAFFING

From 1950 until 1963, Professor Wade remained Wisconsin's only extension plant pathologist (except for the partial extension appointments associated with the potato seed certification program), but, as he pointed out, the increased demands, new technologies, and specialization by growers made it impossible to service the entire crop area. Consequently, the extension administration was persuaded to support the department's request for an additional position.

Gayle L. Worf became the third extension plant pathologist on July 1, 1963. Worf had served as a county agricultural agent for three years in Kansas before completing his Ph.D. in 1961 with Donald Hagedorn in the Department of Plant Pathology at Wisconsin. For the next two years he served as extension plant pathologist in Iowa, before crossing the Mississippi to rejoin the department at Wisconsin.

For the first time, we had to deal with the question of "division of labor" among extension personnel. There were two possibilities. One was to divide the state geographically so that one person would deal with half the state, regardless of crops, and the other person would take the other half. This was a popular approach in many states at the time, but we rejected it because, even though it would reduce travel, and had some public relations advantages, it wouldn't help with the question of inceased technological competency, which we deemed to be the most important. Worf was raised on a Kansas irrigated crops farm, had agronomic training prior to his plant pathology work, and felt especially comfortable with field crops. Wade had come up through the "potato ranks" and thoroughly enjoyed his work with the vegetable industry as well as with the fruit growers. Therefore, Wade took the vegetable and fruit crops; Worf took the agronomic crops and "everything else that was left over".

It was during this time that one of the most significant outbreaks of field crop diseases was to occur. Beginning with yellow leaf blight, soon followed by eyespot disease, and then southern leaf blight of corn, the late 1960s and early 1970s resulted in substantial crop losses and profound visibility for both plant diseases and extension programs. It was an important lesson for both scientists and private citizens to learn, or learn again, that no matter how much previous progress may have been made, there is no insurance program available for healthy crops other than the maintenance of the research and extension programs that the land grant university system provides. We suddenly had a very attentive ear of the agri-business industry about disease control matters, and the effect of disease upon farm economy. The corn seed industry launched a crash program to return to "normal cytoplasm" rather than "Texas male sterile cytoplasm", an idea they had looked upon with some disdain when it was suggested two years earlier. Wisconsin agricultural bankers went to corn blight short courses specially arranged for them, and implement companies put on hold their new no-til equipment promotions until these foliage blight problems were solved.

It was also an opportunity for the first extension telephone "hotline" to be established as a way to cope with current grower problems, and we were finally able to introduce color illustrations into extension publications. This was a feature we had tried in vain to accomplish earlier. Although a bit more expensive, few would argue, other than budget handlers, of the importance of color for such purposes. The demand for increased diagnostic help on plant problems in urban crop areas was occurring then, too, and resulted in the development of the interdepartmental "Urban Phytonarian Handbook". For these two reasons, we have been able to continue with color in extension publications, and were probably the first state to do so, at least with the frequency and degree that has taken place with Wisconsin extension publications.

However, other issues were coming into play besides the strictly plant health problems that had dominated extension programs of earlier times. Rachael Carson's famous *Silent Spring* came off the press in the early 1960s, and her dramatization of horrible side effects catapulted society's growing concern about pesticide problems and stimulated Congress to invest more funds in the area. All states received some increased federal funding in 1965, and it was determined that these dollars would be used to beef up departments involved with pesticides to do a more precise job of understanding them and educating users. There was enough money for three and one-half positions in the college. Insecticides and herbicides were regarded as causing more concern at the time than fungicides, so agronomy, horticulture, and entomology were each allowed to add another faculty member; plant pathology received funds for an academic staff position. Mr. Robert Ahrens was the first person employed, and his primary emphasis was to assist with field plot work, along with helping out with disease diagnostic problems. Ahrens was especially good with equipment and mechanical ideas. He did much to improve field demonstrations and chemical evaluation trials during the period from 1966 to 1974 that he was with us.

THE PLANT DISEASE DIAGNOSTIC CLINIC EMERGES

Growers have always needed help in figuring out what's wrong with their crops when they become diseased. Their first trip has traditionally been to the county extension office, and if the agent cannot identify the problem, it is forwarded to the extension plant pathologist. One of the frustrations that the extension specialist always faced was the pile of sick plants that had accumulated during the week while he was out in the state. During the summers, this meant long night and weekend duties to perform. There are no figures on specimens handled in earlier years because no one was taking time to keep track of them, but the numbers of specimens steadily increased during the 1960s.

When Ahrens departed to satisfy his desire to develop a truck farming operation, we suggested that the position be shifted to one dealing primarily with diagnostics. There had been some earlier questions about establishing a diagnostic clinic. Not everyone was in favor of it: "You'll spend all your time running a clinic". "You'll spin your wheels and have nothing to show for it." "It's not the thing that extension is all about. Extension is mass education—not answering questions on an individual basis." The truth was that we really had no way to avoid the increasing number of specimens. Any good winter meeting that presented information on plant health problems generated individual inquiries the following summer. As educational programs continued to emphasize proper diagnosis as a component of control and pesticide selection, it appeared to us that we really had no choice but to put the finishing touches to a program that was already occurring, whether we liked it or not, so the diagnostic clinic was established, not with fanfare that would generate more specimens, but with a clinician and an admission that we were in the diagnostics business. Dan Opgenorth served from 1974 until 1977, at which time he left to pursue further graduate studies at the University of California–Riverside.

Sister Mary Francis Heimann, O.S.F., had been a graduate student in the department some years earlier. When she heard about the position becoming vacant, she asked whether we thought she might be considered for the position. Her Order of St. Francis of Assissi was encouraging its members to become active in areas of service outside the Order, and she had a penchant for this type of work. She ended up with the job. It has been interesting, over the years, to note the response of many who receive back an answer about their plant disease problem from a Catholic Sister. There may have been some who questioned her accuracy, but none who ever challenged her honesty on a witness stand!

Operating a clinic has not always been without its problems! For one thing, improvement in practical, but accurate, laboratory procedures for processing and diagnosing the wide variety of plant problems has not taken place at the same rate that progress has occurred in other sectors of plant pathology. Perhaps there will be a spin-off that will come from the new wave of biotechnology, such as the development of useful monoclonal antibodies or other procedures, and certainly there is now a growing number of clinicians across the nation who are pressing the need and helping to improve the service that is available. Sister Mary is one of those important additions to the staff.

THE "LONG-RANGE PLAN"—MORE STAFF ADDITIONS NEEDED

Demand upon extension programs has continued to increase. Society's concern about pesticides in the environment has resulted in the creation of more federal and state regulations and more stringent control of both the chemicals and their applicators. Today, all persons using "restricted use fungicides" must become certified, and the training associated with certification is extension's responsibility. The development of integrated pest management programs as alternative or supplemental approaches to the dependency upon pesticides for pest control is another outcome of this concern that has increased the workload. Agricultural practices continue to change, and practices such as no-til that help conserve soil also often increase pest problems. Since the beginning of modern agriculture, "mother nature" has continued with her relentless creation of new pathogens and new strains of old pathogens that cause problems where none existed previously.

Wisconsin has always been a state with very diversified yet specialized agriculture. Dealing with problems of many crops, in turn, requires more diversified research and extension programs than states that have more extensive monocultures such as corn and soybeans. This need for diversification has intensified over the last twenty years as Wisconsin's city dwellers have come to outnumber cows. The urban plant problems such as Dutch elm disease, urban forestry, golf courses, and ornamentals have brought about a dramatic increase in calls for assistance from the cities.

These external changes have occurred at the same time that the department has continued to intensify its basic research projects in response to resources and fundamental interests, leaving extension people with increased dependency upon their own efforts at detecting and identifying new disease problems and providing answers about them. Fortunately, the department remains sensitive to some of those needs. Some research programs continue to provide immediate assistance to extension program and clientele concerns, and several research faculty still participate in extension activities, but it became clear that the existing extension staff could not cope with everything going on in the plant disease world, and, as a result, future plans called for an extension person each for the agronomic, fruit, urban agriculture, and vegetable crop areas. These positions were to carry an applied research as well as traditional extension responsibility. Those plans have been the background of several decisions that came in the mid 1970s.

The first major change took place when Earle Hanson returned from his assignment in Nigeria. From 1972 until his retirement in 1976, Hanson assumed extension as well as some research responsibilities with the forage, small grain, and soybean crops. His previous years of experience with the USDA and state with these crops were well utilized in extension.

Perhaps more than any other group of crops, the agronomic crops require someone with extensive knowledge of the cropping as well as the diseases, so when Hanson retired, we looked for someone who had a strong background in agronomy, along with expertise in plant pathology and a bent toward extension. This person would become responsible for all of the agronomic crops. We found the right person in Craig Grau, who was brought up on a farm in western Iowa. He obtained his M.S. degree at Iowa State University and his Ph.D. at the University of Minnesota working on field crop diseases. Grau was recruited from a postdoctorate position at North Carolina State University, where he was working on a corn problem. He arrived in Madison on August 1, 1976. His first major assignment was to participate in the certified pesticide applicator training meetings being initiated for the hundreds of agronomic crop applicators in the state. Grau and his wife, Leslee, both wondered whether they had made the right decision after those hectic months, but he was afforded an excellent opportunity to get acquainted with the state, and also the knowledge that no matter what, things would be better after the first year! Grau's program has flourished since his arrival, and his expertise with forage crops has achieved national recognition. Grau provided leadership in the development of a national forage Integrated Pest Management (IPM) program, developed state programs to deal with *Phytophthora* diseases on both alfalfa and soybeans, detected *Verticillium* wilt of alfalfa and devised strategies to avoid the potential losses it posed, while looking after the usual number of problems associated with the field crops.

With Grau's arrival, Worf was assigned to full-time work on the "urban agriculture" crops—urban forestry, turf, nursery, floriculture, and other areas. The number of inquiries and problems directed to the department in this area represents more than half of the total received. Major attention has been given to the commercial crops. For many years, Dutch elm disease commanded much attention with efforts directed towards minimizing losses while cities converted to a more diversified planting, but the replacement maples, ash, and honey locusts have not been without serious problems, and the Wisconsin Arborists Association emerged as an organization, much through extension efforts. More recently, the turf industry, including the state's golf courses, sod producers, and landscape and lawn care services have encountered serious disease problems. Accordingly, the Wisconsin Turfgrass Association was developed to encourage and support research and educational efforts.

Even before Wade retired in 1979, some changes were occurring in the fruit research area that were to have lasting effects upon the extension programs. J. Duain Moore left his tree fruit disease research position after more than twenty years at that position to become director of the Wisconsin Agricultural Experimental Farms system, and Donald Boone was asked, along with Earl Wade, to assume the tree fruit fungicide evaluation programs, along with continuing the small fruit work. Then, when Wade left, Boone assumed full teaching, research, and extension responsibilities for all fruit crops in the state. Boone had developed a national reputation for his work with cranberry diseases and had several projects to continue with this important crop, but he graciously consented for the good of the department and for the growers in the state to take on the broadened assignment. Boone retired in 1984, but has continued to consult with cranberry producers and represent the department in the process. This paved the way for a smooth transition as Steven Jeffers assumed the fruit crop pathology position in research and extension in the spring of 1985. Jeffers obtained his Ph.D. from Cornell University, and had been stationed at the New York State Agricultural Experiment Station, where fruit disease research is emphasized. His background in *Phytophthora* disease research, as well as association with both research and extension projects on all fruit crops there, has equipped him to be a valuable addition to the faculty.

Wade's retirement also left the state with a void in the vegetable crop area. Most readers know of the importance of canning crops, as well as potatoes, to Wisconsin's agriculture. The department was anxious to obtain the best field-oriented vegetable pathologist to serve this important clientele group. Walter Stevenson was the person chosen for the position. His potential was recognized by the department because he was a student here with Professor Donald Hagedorn a decade earlier, and he was one of a very few students who knew from the day he arrived as a student that he wanted to become an extension plant pathologist! He received excellent experience and developed a strong reputation while at Purdue University, where he served Indiana vegetable growers.

Stevenson has proven to be a valuable vegetable pathologist, as was expected. During his first season, late blight developed in the potato fields more severely than growers had known for many years. Stevenson not only earned his stripes and gained the growers' confidence through the way that he handled that epidemic, but then proceeded to play a leadership role in establishing the first extension IPM program on any crop in the state. Its success was important not only to the participants but to the reputation of extension's IPM efforts. It was a success; IPM programs have progressed well since then. Stevenson has added an important and entirely new dimension within the extension program, however, through his expertise in computer programming and operations. He and colleagues in related departments have developed "Pest Profile Programs" which were among the first computer program offerings made available to county extension personnel and to growers. He also has served as chairman of the state extension Computer Advisory Committee, and will be remembered in future years for the leadership he has provided in the computerization of diagnostics and plant health management.

Technical assistance for extension-applied research programs is a welcome addition of the past decade. Funded primarily by non-extension resources, the work of technicians nevertheless has made it possible for the faculty to participate in expanded research roles while maintaining extension programs. Joy Perry and Jane O'Laughlin were the first technical staff additions. Current project specialists include Kathy Ritchie and Jana Stewart. Peter Sanderson recently resigned such a position to enter graduate school. The importance of their contributions should certainly be recognized.

A SUMMARY OF EXTENSION POSITIONS IN THE DEPARTMENT

Listed below are members of the faculty and academic staff who have had federal and/or state extension appointments of some amount during their period of employment. We have not discussed those involved with the potato seed certification program, even though they have traditionally had some extension responsibility assigned to them, for their contributions are described in Chapter 11. The most recent departmental chairmen have also been given some extension time that reflects changes in the administrative structure of extension over the past two decades.

Name	Period of Appointment	Type of Responsibility
Vaughan, Richard E.	July 1, 1915–January 31, 1950	General
Brann, John W.	July 1, 1915–1947	Potato certification
Darling, Henry M.	1940–1976	Potato certification
Wade, Earl K.	July 1, 1949–June 30, 1979	General, then fruits and vegetables
Worf, Gayle L.	July 1, 1963–present	Agronomic and other, then urban agriculture
Kelman, Arthur	June, 1965–June 30, 1971	Administration
Ahrens, Robert W.	June, 1966–Dec. 8, 1977	Technical assistant
Mitchell, John E.	July 1, 1971–June 30, 1980	Administration
Hanson, Earle W.	Dec. 8, 1971–July 31, 1976	Agronomic crops
Opgenorth, Daniel	Aug. 15, 1974–Dec. 31, 1976	Disease diagnostician
Boone, Donald M.	1974–1983	Fruit crops
Grau, Craig R.	Aug. 1, 1976–present	Agronomic crops
Heimann, Sister Mary F.	June 1, 1977–present	Disease diagnostician
Kostichka, Charles J.	July 1, 1978–June 30, 1981	Dutch elm disease educational coordinator
Slack, Steven A.	July 1, 1975–present	Potato certification
Stevenson, Walter R.	1979–present	Vegetable crops
Maxwell, Douglas P.	July 1, 1980–present	Administration
Jeffers, Steven N.	June, 1985–present	Fruit crops

Although the list of extension faculty was compiled for historical purposes, the record of extension activities in the department would not be accurate in any sense if it did not also indicate the contributions of many of the research faculty over the years. To list even some would do injustice to those omitted, but, by way of example, we will mention the work of Walker, Hagedorn, and Williams with the vegetable industry; Kuntz and Smalley for their forest and shade tree work; Arny and Dickson for their work on cereal and corn crops; Moore for fruit crop extension work over the many years; and Fulton, Kelman, and Mitchell for miscellaneous crops. These, and others, have helped make the extension programs strong and useful to growers in Wisconsin and elsewhere.

WHAT OF THE FUTURE?

No one has a corner on predicting the future, but if the past is any indicator of what is to be, then there should continue a strong need and opportunity for extension plant pathology in Wisconsin. Agriculture will continue to change, perhaps at a more rapid rate than it has in the past, with the aura of biotechnology offering new promises, and the concerns of distressed environment and the spector of "future sustainable yields" serving as examples of new problems for future generations to overcome.

Responsibilities may change. Increased time devoted to applied research on disease control has already been addressed. That trend will doubtless continue, leaving only the rate and its effect on extension programs to be hypothesized. Future specialists may need broader training to better relate to the potential that modern biotechnology may have to offer, and certainly they will have to exercise more skills than were necessary in the past to communicate within the departmental faculty as a means of assuring that adequate future research will pertain to farming needs of the then current generation!

Extension tools will change. Witness the change over the past five years in computer technology, as an example. Every extension office has a computer terminal, and computers may soon be as important as the microscope and the pocket knife. Programs without them will be virtually obsolete. Video programs may soon replace much of the slide shows of today.

The role of the county agricultural agent is certainly undergoing changes now, and this is extremely important, not only to the extension faculty, but to the department and college. During the past half century, agricultural agents have been extremely important in helping to communicate with growers as well as assisting with local political support when the college has needed it. A way must be found to keep them vital and effective.

Extension's clientele are certainly going to be different. They are much more mobile today, and county extension meetings have increasingly given way to area or state offerings. Commodity groups have increased in importance. They not only serve as support groups, but educational meetings are often associated with and carried out through their organizations. Unlike their predecessors, today's farmers are eager for new technology, but they seek it in different ways. They are much better educated, willing and anxious to obtain information from anywhere around the globe. Growers often seize ideas and give them a try before those thoughts have been given the benefit of research trial and error. They are increasingly diverging into two economic groups, larger scale operators who rely substantially on experts in specialized fields, and small producers who are often part-time in the business. How will the land grant university system, through extension, serve the needs of such increasingly diverse clientele?

Crop consultants are becoming increasingly common. Perhaps they will provide part of the answer. Contrary to some who may view this new wave of specialists as competitors for extension, they are more likely, at best, to be part of the solution in dealing with the increasing need for precision in agriculture, or, at worst, to provide a basis for "creative tension." As new technologies emerge, then the clientele of the future may well be the "phytonarian" who prescribes and administers to the needs of the grower on a daily basis.

There will continue to be major societal concerns that will require holistic treatment of issues. Who, other than extension, will deal with such problems? Integrated pest management programs may ultimately give way to systems that concern themselves with even broader approaches and visions, but it is an absolute certainty that plant diseases will remain in the picture, presenting to the producer a continuing threat, and to the plant pathologist, challenging opportunities.

Chapter 7

Fruit Disease Research Programs

J. Duain Moore and Donald M. Boone

The major commercial fruits produced in Wisconsin are apples, sour cherries, cranberries, and strawberries. There has been limited commercial production of European-type plums, usually Italian prune. Though various growers have planted pears and sweet cherries, and even peaches and apricots, sooner or later these have all failed due to Wisconsin's severe winters. In some instances trees have grown well, but flower buds have not survived to support a commercial operation.

Wisconsin's commercial growers have not been plagued with the serious so-called summer diseases of apples that affect fruit grown in states to the south and east of Wisconsin. This has meant that our apple spray programs could be developed primarily for apple scab, fireblight, and cedar-apple rust control with some concern for sooty blotch and flyspeck. On the other hand, Wisconsin's relatively short growing season has limited the range of apple cultivars that can be grown, and in most years apple scab can develop to epidemic proportions on cultivars such as McIntosh and Cortland if not adequately controlled by protectant sprays. This fact led to the studies on the use of eradicant fungicides discussed later in this report.

EARLY WORK ON TREE FRUIT DISEASES

The first studies on fruit diseases in the department were carried out by G. W. Keitt. Before coming to Wisconsin as a graduate student in 1911, he had worked as a special agent for the U.S. Department of Agriculture (USDA) for fruit disease investigations on peach scab (*Cladosporium carpophilum*) in Georgia. After coming to Wisconsin, he continued the study in Georgia as the thesis for his Ph.D., which was granted in 1914.

Keitt then began studies on cherry leafspot (*Coccomyces hiemalis*) in Door County, Wisconsin. These early studies with assistance from graduate students E. E. Wilson, E. C. Blodgett, and R. O. Magie resulted in a series of publications on the epidemiology of cherry leafspot and its control and culminated with *Wisconsin Agricultural Experiment Station Research Bulletin 132* in 1937. Keitt's early studies on epidemiology and control of apple scab (*Venturia inaequalis*) were started in 1919, and with assistance from graduate students L. K. Jones and C. N. Frey resulted in a series of publications including *Wisconsin Agricultural Experiment Station Research Bulletin 73* in 1926. These two research bulletins on the epidemiology and control of cherry leafspot and apple scab concerned detailed studies of the fungus and the weather in relation to seasonal development of the diseases, and established a rational basis for disease control.

A. J. Riker and Keitt began studies on crown gall in relation to nursery stock in the early 1920s. These studies led to the understanding of the various overgrowth problems associated with the propagation of nursery stock such as crown gall, hairy root, and wound overgrowth and established working relationships with commercial nurserymen that were of significance in Riker's later research with forest tree diseases and Keitt's stone fruit virus disease program. Others involved with the nursery stock overgrowth studies were W. M. Banfield, W. H. Wright, H. E. Sagen, and E. M. Hildebrand.

Research on fireblight (*Erwinia amylovora*) was initiated in the early 1930s and involved Keitt, Riker, J. A. Pinckard, Luther Shaw, J. B. Carpenter, A. N. Brooks, and S. S. Ivanoff. Ivanoff and Keitt demonstrated for the first time the occurrence of aerial-borne infection by *Erwinia amylovora* of blossoms, fruits, and shoots of apple.

Other early studies on tree fruit diseases were the bases of Ph.D. theses by N. J. Giddings and C. J. Nusbaum who worked with apple rust and H. G. MacMillan who worked with black knot of plum. H. H. Foster carried out inoculation experiments with black rot of apple, and E. J. Kohl studied apple blotch.

For many years, field research programs were carried out in the Gays Mills area in Crawford County in southwestern Wisconsin and in the Sturgeon Bay area in Door and Kewaunee Counties in northeastern Wisconsin, since these are the main areas of tree fruit production in the state. The Gays Mills work was headquartered in the Kickapoo Development Company orchard, and in the Sturgeon Bay area the B. W. Sackett orchard was used as a field station until the program was moved to the Peninsula Branch Experiment Station in 1949. Traditionally, graduate students or students and staff were located at the field stations during much of the growing season.

The spray trials were always carried out in privately owned orchards where problems already existed. In the Gays Mills area, most of the research on apple scab and fireblight was performed in the Kickapoo Development Company orchards, until the work was discontinued at the time of World War II.

In the Sturgeon Bay area, many orchards were used through the years. The names of W. I. Lawrence, S. T. Learned, B. W. Sackett, Richard Griffin, Horseshoe Bay Farms, Reynolds Brothers, Raymond Barnard, Edward Kassner, Sawyer Farms, and Triangle Orchard were prominent in annual reports.

The first field laboratory in Sturgeon Bay was a tent in the S. T. Learned orchard until a permanent building was erected in the B. W. Sackett orchard by Mr. Sackett, both to house the plant pathologists during the growing season and serve as the field laboratory. This building was, according to Mr. Sackett, the first prefabricated Sears and Roebuck cottage erected in Door County. It was known as the "honeymoon cottage" and was occupied by L. K. Jones, Blodgett, C. N. Clayton, J. Duain Moore, and J. S. Boyle until 1949, when the work in the Sackett orchard was

Figure 7.1 Field lab in the Learned Orchard, Sturgeon Bay.

Figure 7.2 Honeymoon Cottage, Sackett Orchard, Sturgeon Bay.

discontinued. The orchard was owned by Richard Griffin at that time. He had purchased it from Sackett in 1948. The meteorological equipment used by Keitt and his associates was located on a barn and in the field on the Sackett orchard until it was moved to the Peninsula Experiment Station.

ERADICANT FUNGICIDES

In 1927, Keitt and Wilson reported on their initial studies of eradicant fungicides for apple scab control. The primary aim was to control apple scab by making fall applications of fungicides to the leaves on the trees to prevent the development of the perfect stage of the fungus in infected leaves after they fell to the ground. Many chemicals were used in these studies, with the most effective consisting of copper sulfate plus lime plus monocalcium arsenite with a cold-pressed fish oil as a sticker. Many formulations of copper-lime-arsenite were studied by Keitt and D. H. Palmiter. However, all effective formulations were too phytotoxic on apple trees and never came into commercial use on apple. In 1943 after Keitt, Moore, E. C. Callavan and J. R. Shay reported on the occurrence of European brown rot on sour cherry in Door County, Wisconsin, effective control of this disease was obtained by the use of dormant spring applications of copper-lime-arsenite plus stickers without objectionable host injury if the dormant spray was followed with an application of Bordeaux mixture during bloom.

With the difficulty encountered with fall applications of eradicant fungicides for apple scab control, attention was turned to eradicating the fungus from dead leaves on the ground that contained developing ascocarps. Many chemicals were tried, including those that had been used in the fall applications to the trees. In talking with fruit growers about the concept of using a ground

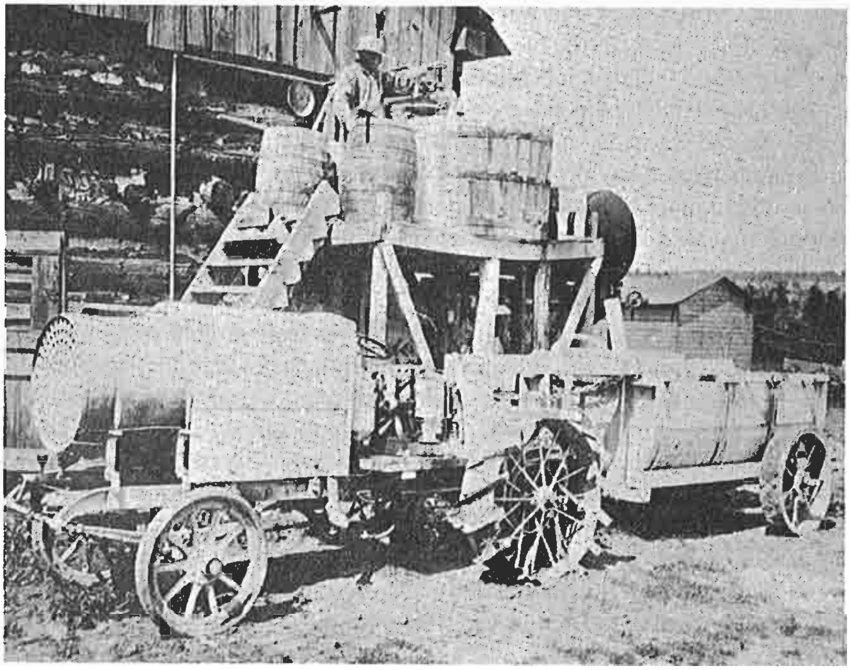


Figure 7.3 Mixing 'Bordeaux' on the Learned Orchard, Sturgeon Bay.

spray to control apple scab, Keitt would point out, "The weak point in the life history of the scab fungus occurs while the fungus is prostrate in the dead leaves on the ground. If this destructive pest were large enough to be seen readily, it is unlikely that we would let it pass this stage unmolested. If it were as large as Canada Thistle, would we allow it to survive year after year on the floor of our orchards?" Various fertilizers, such as ammonium sulfate and ammonium nitrate, were used also. Some beneficial effect could be demonstrated in small-scale plots with many of the treatments tried, but none were completely satisfactory because of cost, sufficient effectiveness, ease of application, etc. About this time (early 1940s), broad-leaf weed control in small grain was making great progress and a representative of the Standard Agricultural Chemical Company suggested to Keitt that Elgetol be tried. This was a super-saturated solution of sodium dinitro ortho cresol that was being used on small grain and when added to water in a spray tank became a completely soluble solution with a yellow color. A solution of 1 gallon of Elgetol in 200 gallons of water applied at the rate of 600 gallons per acre proved to be highly effective at a reasonable cost. The yellow color of the solution made it easy to determine the uniformity of the coverage.

The first large-scale tests were carried out by comparing control on sprayed and unsprayed trees in separate orchards located near each other, but not immediately adjacent to each other. These original studies were made in apple plantings near the Forest Products Laboratory in Madison, in the Stephenson and Oenes orchards near Sturgeon Bay, and in the Kassner and Heim orchards near Casco, Wisconsin. Beginning in 1942, very detailed studies were carried out in a sixty-acre block of McIntosh, Red Delicious, and Grimes Golden apples at Horseshoe Bay Farms, Egg Harbor, Wisconsin. Forty acres on the north part of the block received the ground treatment and the twenty acres on the south end were not treated. Apple scab development was monitored on McIntosh trees in both parts of the block, on trees with no protectant sprays as well as on trees with a reduced number of foliage applications and on some with complete spray schedules of different fungicides. These studies, which were performed in the field by Moore and Callavan, proved conclusively that ground spraying was both effective and practical, and ground spraying became a part of the recommended spray program for apple scab control. Ground spraying not only enabled growers to obtain more consistent scab control, but gave them the option to use milder and safer fungicides so that they could produce higher quality fruit free from injury.

Ground spraying was continued as a standard recommendation until new highly effective organic fungicides became available.

It should be pointed out in passing that the first large-scale ground spray applications were made with an ordinary handgun, with the operator walking backwards and stooping to get under the overhanging branches of the trees. After ground spraying was shown to be practical, Moore and Keitt developed a special spray boom to make the applications. This boom had a split shoe or a set of caster wheels to carry the section of the boom under the tree, and an end section that would swing backwards on making contact with a tree. The split shoe was used initially during World War II when rubber tires were not available for caster wheels.

It should be added that the dinitro ground sprays prevented ascospore maturation if applied early enough, but were equally effective by reducing ascorpore discharge by 98 percent or more even if mature ascospores were present at the time of application by plasmolyzing the epiplasm in the ascus and preventing discharge.

LATER WORK ON TREE FRUIT DISEASES

By 1940, the early epidemiology and control studies with protectant fungicides had formed the basis for control recommendations to Wisconsin growers for apple scab and cherry leafspot. Exploratory work had been started with eradicant fungicides both applied to the trees in the fall and to leaves on the ground in the spring. The basic protectant fungicides for apple were liquid lime sulfur and wettable sulfurs, and for cherry, Bordeaux mixture and fixed coppers. Scab was the main problem in apple throughout the state, with fireblight and cedar-apple rust (*Gymnosporangium juniperi-virginianae*) important in certain locations in some years. Cherry leafspot was the main problem on sour cherry, and American brown rot (*Sclerotinia fructicola*) and powdery mildew (*Podosphaera oxyacanthae*) were of minor importance.

With the very low price for cherries and several years of wind and hail damage to ripening fruit, many fruit were left on the trees and American brown rot started to become important. At about the same time, European brown rot was discovered in Door County, primarily in orchards close to Lake Michigan.

There is no perfect stage of either fungus in Door County. The American brown rot fungus overwinters in mummified fruit and pedicels that remain on the tree and produce conidia in the spring. The European brown rot fungus overwinters in infected twigs, leaves, and infected flower parts from the previous year and provides conidia in the spring. In spray trials, European brown rot was controlled with a dormant copper-lime-monocalcium arsenite spray followed by a Bordeaux application during bloom to prevent serious spray injury. The dormant spray gave 95 to 98 percent control of blossom infection by preventing conidial formation. However, the use of the dormant spray did not prevent sporulation of the American brown rot fungus and did not give satisfactory control. At present the brown rot control problem is intensified by two important changes in harvesting and marketing of sour cherries. First, the advent of mechanical harvesting with limb and tree shakers left many more fruit on a tree as compared with good hand picking. Second, the national marketing order for sour cherries requires growers to divert a part of their crop any year that the total production for the United States is estimated to be more than 300 million pounds. One way to divert was to leave fruit on the trees. Any procedure that leaves fruit on the trees makes the brown rot problem worse. Now, American brown rot is controlled by the use of certain fungicides if applied when about 10 percent of the blossoms are open and as fruit begin to show color.

A number of important contributions to the understanding of the brown rot diseases and their control were made by Calavan, R. K. Grover and D. A. Biris.

STONE FRUIT VIRUS DISEASE STUDIES

In 1940, Keitt and Clayton reported on a bud-transmissible disease of sour cherry. For several years before 1940, they had been mapping sour cherry orchards in Door County to determine the incidence and possible spread of a chlorosis known to Wisconsin growers as "boarder tree" and to New York and Michigan growers as physiological yellow leaf. These mappings had shown a consistent increase in the number of trees with symptoms. Chip buds from trees with symptoms used to inoculate orchard trees without symptoms resulted in symptoms in the inoculated trees, while uninoculated trees remained without symptoms. Keitt and Moore decided to carry out inoculation experiments in the greenhouse with potted nursery trees to avoid the complications of natural spread and the symptoms from Bordeaux spray injury and Bordeaux/black cherry aphid honeydew injury that could be confused with the chlorosis problem now called sour cherry yellows. Greenhouses were used also to carry out more detailed studies during the winter months. The first inoculations in the greenhouse were made with twig grafts on Montmorency nursery trees just breaking dormancy, and resulted in the production of necrotic spotting on the inoculated trees, but no symptoms on the growing scions. This necrosis was similar to symptoms seen on orchard trees in the earlier surveys, but were not understood because they rarely were seen in the same tree the year after the first observation. This necrosis was also observed by other investigators and called necrotic ringspot. Moore and Keitt carried out numerous experiments on sour cherry yellows and necrotic ringspot, and showed that the yellow chlorosis symptom was markedly controlled by temperature effects and that continuing night temperatures above 60°F beginning in bloom could completely mask the yellows symptoms. On the other hand, night temperatures of 70°F and above intensified necrotic ringspot symptoms on nursery trees inoculated at budbreak with buds from trees with necrotic ringspot. It was discovered that with most strains of necrotic ringspot virus, an inoculated sour cherry tree would show symptoms only one time if it had been healthy when inoculated, or never show symptoms if already carrying a necrotic ringspot virus when inoculated. These studies helped to explain the geographical and seasonal variation in yellows symptom expression and the reason that necrotic ringspot symptoms usually did not recur on a tree in the orchard. It was shown ultimately that most bearing sour cherry trees in Door County orchards were infected with the necrotic ringspot virus without showing symptoms, and yellows was spreading at a rate of about 3 percent a year.

In 1948, Moore, Boyle, and Keitt reported on the mechanical transmission of a virus to cucumber from sour cherry. This discovery opened the way for much research at Wisconsin and elsewhere on mechanical transmission of tree fruit viruses. A number of Keitt's and Moore's graduate students prepared Ph.D. theses on stone fruit virus disease research. These included Boyle, R. M. Gilmer, D. A. Slack, E. H. Varney, C. G. Ehlers, and Elsayed Megahed. K. L. Callahan studied the *Prunus* host range of a virus transmitted by grafting from American elm with elm mosaic.

A number of these researchers worked on experimental and natural woody and herbaceous host ranges of the viruses, methods of transmission, natural spread, and direct and indirect indexing procedures for detecting the presence of viruses in plants without symptoms.

In 1949 when Research and Marketing Act funds became available to Wisconsin through the North Central Regional Project 14 (NC–14) Regional Research Committee, R. W. Fulton was invited to move from the Department of Horticulture to the Department of Plant Pathology and become involved in stone fruit virus research. He and his graduate students have had an active role in determining the properties of stone fruit viruses and developing an herbaceous host range. He or his students were the first to obtain electron microscope pictures of a number of the stone fruit viruses. These students included R. E. Hampton, H. E. Waterworth, Avalina Paulson, L. S. Loesch and E. L. Halk.

COOPERATIVE RESEARCH ON TREE FRUIT VIRUSES

Director V. R. Gardner of the Michigan State University Experiment Station called a conference in 1941 to discuss cooperation and interchange of information among investigators of tree fruit virus diseases. This conference was attended by workers from throughout the United States and Canada, and resulted in the formation of a committee which prepared a *Handbook of Stone Fruit Virus Diseases* in North America that was published in 1942 as a miscellaneous publication of the Michigan Agricultural Experiment Station. At a second national conference called by Gardner in 1944, a publication committee was appointed to revise and update the first handbook. This revision was published in 1951 as Agriculture Handbook 10, *Virus Diseases and Other Disorders with Virus-Like Symptoms of Stone Fruits in North America.* This handbook was made possible largely by the passage of the Research and Marketing Act of 1946 and the subsequent establishment and funding of regional research projects to investigate stone fruit virus diseases. Keitt had an active role in both conferences and became chairman of NC–14. He held the chairmanship until 1957. Moore served as secretary during Keitt's tenure as chairman and succeeded Keitt as chairman.

Keitt took the leadership in forming an informal interregional committee which met each year in connection with the annual meeting of the American Phytopathological Society. This committee was composed of the members of each of the four regional research committees, but all interested persons were invited and urged to attend the meetings. Keitt served as chairman with Moore as secretary. Initially, this committee was called an interregional research committee and it functioned actively in helping to establish the formal Interregional Technical Committee and Project (IR–2) in 1954. The informal committee was continued as an interregional correlating committee for several years after IR–2 was established. Blodgett was chairman and Moore was secretary of IR–2 in the early years until a rotation system was established for the officers who, along with the pathologist in charge, formed the executive committee.

It should be pointed out that Keitt had been very effective in obtaining cooperation and support from the American Association of Nurserymen through the association's executive secretary, Richard White. In 1949, a meeting was held in Chicago with nurserymen from throughout the United States to discuss the virus situation in stone fruits and to propose ways of solving the problem.

When Handbook 10 was revised and updated as Agriculture Handbook 437, *Virus Diseases and Non-Infectious Disorders of Stone Fruits in North America,* issued in 1976, Moore and R. M. Gilmer served on the editorial and publication committee.

EFFECTS OF FUNGICIDES ON FRUIT QUALITY

As early as 1929, Wilson and Keitt had shown that the weight of cherries sprayed with Bordeaux mixture was significantly less than that of fruit sprayed with liquid lime sulfur. In the 1937 research bulletin on the epidemiology and control of cherry leafspot, Keitt, Blodgett, Wilson and Magie reported that the choice of fungicide influenced not only fruit weight but also Brix readings, malic acid percentage, and pH readings of expressed juice.

With the use of newer organic fungicides in comparison with Bordeaux mixture, obvious differences in fruit size and color were noted, and cooperative research on fruit quality was initiated with K. G. Weckel in the Department of Food Science. J. von Elbe, one of Weckel's students, became actively involved when he became a member of the food science faculty. Certain of these studies were used as a basis for M.S. and Ph.D. theses by some of Weckel's graduate students. Fruit from the different spray plots were used not only to determined fruit size, color, soluble solids, total solids, titratable acidity, and flavor, but samples were processed and frozen to determine drained weights, can life, and keeping quality. Significant differences were obtained among fungicides with every criterion studied. These determinations were used, along with records of disease control and phytotoxicity, in making spray recommendations for sour cherries. It was shown in the studies on can life carried out in cooperation with the American Can Company that cherries sprayed with ferric dimethydithiocarbamate had a significantly reduced can life compared with fruit sprayed with other fungicides studied. Research on apples sprayed with different fungicides never gave significant differences in fruit size, color, soluble solids, total solids, titratable acidity, or flavor.

In the studies on fruit quality, cooperation was obtained from local canning companies. Sorting, pitting, and can filling was done initially at the Goldman factory with processing either at Reynolds Brothers or the Fruit Growers Cooperative, until a commercial pitter was rented and a small complete canning factory was developed at the Peninsula Experiment Station. Sorting, pitting, and can filling was done in the old machine shed with the processing done in the headhouse of the greenhouse with steam from the greenhouse boilers. Most of the frozen cherries were handled in the freezer plant of the Fruit Growers Cooperative. Studies on bleaching fruit for making maraschino cherries were also carried out at the Fruit Growers Cooperative.

PERSONNEL INVOLVED IN TREE FRUIT DISEASE RESEARCH

In the early years the field programs at Sturgeon Bay were carried out entirely by graduate students or young faculty with only occasional temporary summer help. As the work expanded in the 1950s and the field headquarters was moved to the Peninsula Experiment Station, farm laborers were hired for as long as eight to nine months each year until 1955 when the USDA provided funding for a full-time agricultural aid to assist with the stone fruit virus disease program and to operate the greenhouse facility that had been built in the station in 1950 with USDA funds. E. H.

Ehlers was hired and provided invaluable assistance until his untimely death in 1968. Also in 1955 William Junion began working as a summer farm laborer on state funds. He was given a permanent civil service position on state funds in 1962 and was stationed year round at Sturgeon Bay until 1984 when his position as a Gardener II was shifted from the fruit disease program to the potato seed program at Rhinelander. In 1953 Kenneth Halversan joined the fruit group as a project assistant. He resigned in 1956 to take a position with the soil conservation service in Madison and was succeeded by Clifford Ehlers who had just finished his Ph.D. in the department. Cliff became an assistant professor in 1957 and worked both in Sturgeon Bay and Madison until 1962 when he resigned to become the horitcultural agent in northeast Wisconsin.

A COMPREHENSIVE STUDY OF THE APPLE SCAB PATHOGEN

In 1916, Keitt began research on apple scab and the studies were continued by him and his students for over half a century. Investigations of epidemiology and control of the disease led to studies of the inciting fungus and the phenomena of infection. Many critical investigations of the genetics, nutrition, and pathogenicity of *Venturia inaequalis* were carried out. The work was supported in large part by grants from the National Institutes of Health, the National Science Foundation, and the University of Wisconsin Graduate School with funds received from the Wisconsin Alumni Research Foundation. Much of the work was reported on as invitational papers in the United States and in international science meetings.

Keitt and L. K. Jones noted in 1926 that certain cultures of the fungus incited typical scab lesions on the leaves of some apple varieties, while on the leaves of others they incited mere flecks. Further studies on the variability of *V. inaequalis* were carried out by Palmiter in 1932. Nusbaum and Keitt made a cytological study of host-parasite relations of two monoconidial isolates of *V. inaequalis* and three apple varieties that showed a compatible relationship with the fungus in susceptible varieties but a hypersensitive reaction in resistant ones. Keitt and M. H. Langford found that pathogenicity to certain apple varieties, as induced by the fleck or lesion reaction, was inherited as if single-gene controlled. Because Langford demonstrated such a steady hand in isolating ascospores in serial order from asci, Keitt remarked that he had no nerves, to which Langford replied that the brain is made up of nerves, so what was Keitt implying!

Keitt and Palmiter demonstrated in 1938 that the fungus was heterothallic, being "hermaphroditic" but self sterile, and that there were two mating types or sexual compatibility groups. In a cytological study (1940), E. J. Backus and Keitt found evidence that the haploid chromosome number of *V. inaequalis* was as much as six and that the orientation of the spindles in the nuclear division in the ascus was such that the later serial order of the ascospores reflected their nuclear descent much like what occurs in the much-studied saprophytic neurosporas. Later, 1957, P. R. Day, Donald M. Boone, and Keitt (1956) determined the chromosome number to be seven.

Curt Leben and Keitt (1948) found that the fungus was capable of growing on a minimal medium of salts and sugar but certain vitamins were stimulatory and some other carbon sources were favorable to growth. R. L. Pelletier showed that certain amino acids were more favorable to growth than nitrates or ammonium nitrogen. Keitt and Langford had reported that apple leaf decoction, when added to culture media, favored perithecial development. B. J. Williams and Boone (1963) found no qualitative differences in amino acid content between leaves of resistant and susceptible apple varieties that might support a nutritional basis for differential virulence by the fungus.

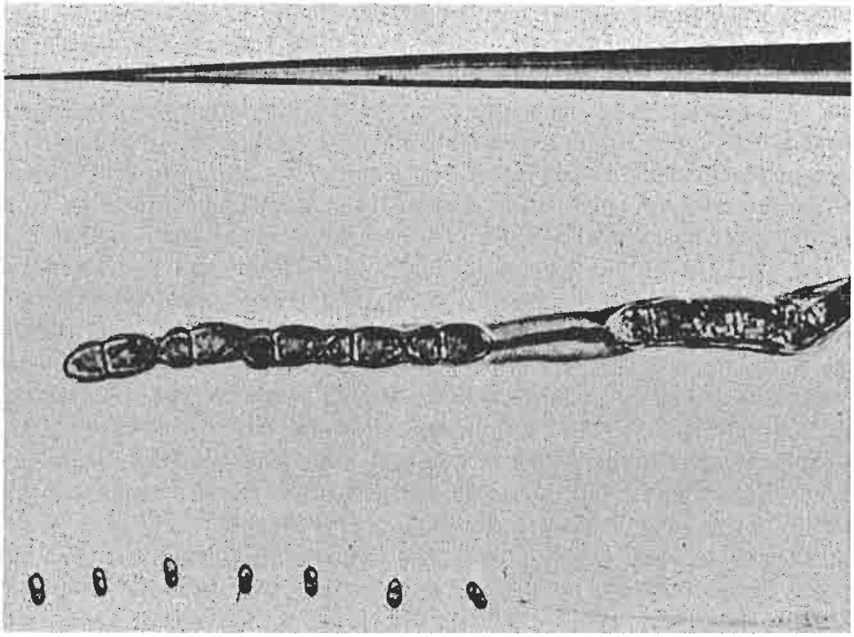


Figure 7.4 It takes a steady hand! Ascospores of *Venturia* in serial order.

In further studies on the inheritance of virulence of *V. inaequalis,* Keitt, Leben, and Shay (1948) showed that the differential lesion reaction to two varieties was controlled at one gene locus, and to two other varieties at another. Boone and Keitt (1957) described five additional gene pairs at different loci controlling virulence to different varieties or groups of varieties. H. S. Bagga and Boone (1968) described genes at six other loci conditioning virulence to flowering crabapples.

Keitt and Langford (1941) reported a high degree of constancy for cultural characters and pathogenicity of *V. inaequalis*. However, some mutant sectors were observed. Keitt, Langford, and Shay (1943) described two mutants, tan and nonconidial, and Shay and Keitt (1945) described two other mutants and studied the inheritance of all four. Boone, J. F. Stauffer, M. A. Stahmann, and Keitt (1956) induced mutants in the fungus using either nitrogen mustard or ultraviolet radiation. Morphological, color, and nutritionally deficient mutants were obtained. Boone and Keitt (1956) reported on the inheritance of the color mutant characters which served as marker characters in further genetic studies.

The success of using biochemically deficient mutants of *Neurospora* in working out biosynthetic pathways was encouragement to use similar mutants of phytopathogens in biochemical studies of the nature of pathogenicity and disease resistance and of host specificity. It was for this reason that biochemical mutants of *V. inaequalis* were sought.

Tests by H. A. Lamey, Boone, and Keitt (1956) established the responses of the nutritional mutants to the amounts of their required substances supplied to them in culture medium. Tests by D. M. Kline, Boone, and Keitt (1957) showed which of the required substances could be obtained from the leaves of the apple host in sufficient quantity to enable the mutant pathogens to grow and incite disease. Most of the mutants requiring vitamins or reduced sulfur were pathogenic whereas those requiring nitrogen bases or amino acids were not. All but those requiring purines were pathogenic when their required substances were applied to the surface of the inoculated leaves. A histological study by Kline, Boone, and Keitt (1964) showed that both pathogenic and nonpathogenic biochemical mutants were able to penetrate the leaf cuticle and establish themselves in the characteristic subcuticular position, but that the latter mutants failed to develop further. Boone (1962) found that mutants nonpathogenic when inoculated alone would develop syntrophically and incite disease when inoculated as mixtures. Conversely, fleck-inciting wild type lines failed to incite the sporulating lesion reaction when inoculated as mixtures, indicating that the fleck-inciting mechanism of wild type isolates was not a simple nutritionally related one.

Shay and Keitt (1945) gave segregation and recombination data for mating type and four mutant characters and prepared the first linkage map for *V. inaequalis*. Keitt, Leben, and Shay (1948) gave data for two genes for pathogenicity. Boone and Keitt (1956) described three linkage groups using color mutant characters. Keitt and Boone (1954) and Boone located several more genes with reference to their centromeres or with other mutant genes. More than twenty-five genes were located with reference to their centromeres. Altogether more than thirty markers were included in linkage groups and more than fifty were used in genetic studies. If Langford's steady hand was reputedly correlated with brain cell deficiency, then Boone's mental capacity is surely suspect after his having isolated ascospores from over 20,000 asci.

Leben, Boone, and Keitt (1955) attempted by mutation to induce resistance to fungicides in *V. inaequalis* and succeeded in obtaining a mutant resistant to the antibiotic antimycin A.

A. T. Saad (1965), in an effort to substitute apple callus tissue as test host material in place of apple trees, found that *V. inaequalis* failed to grow on tissue from either resistant or susceptible trees until the tissue became senescent, because the growing tissue of both types appeared to be producing an inhibitory substance that was heat labile, poorly diffusable in agar medium, more fungistatic than fungicidal, and more inhibitory to mycelial growth than to spore germination.

L. S. Leu (1967) found that certain isolates of *V. inaequalis* produced a substance that stimulated anastomoses between germ tubes and hyphae. The substance was heat stable, dializable, and non-volatile. The ability to produce the substance and to respond to it appeared to be inherited as a single unit and to be single-gene controlled.

Christen Upper, A. R. Thomas, and Boone attempted to develop a control of apple scab in the field by introducing many avirulence, ascospore-aborting, or nutritional deficiency genes into the natural population of *V. inaequalis,* and in a limited experiment succeeded in attaining mating between some fungi already established on apple leaves and mutants applied some time later.

Other aspects of these studies have been investigated but are too numerous to mention here. As a result of all these studies, *V. inaequalis* and its apple host would appear to comprise one of the best available systems for studying the genetic and physiologic controls of host-parasite interactions.

R. O. Magie (1934) studied the variability of monosporic cultures of *Coccomyces hiemalis.* Langford (1940) investigated heterothallism and variability of *Venturia pirina.* J. O. Andes (1947) and F. B. Struble (1949) studied variability in *Glomerella cingulata* and K. S. Thind (1958) investigated variability and nutrition of *Sclerotinia fructicola.*

SEARCH FOR ANTIBIOTICS FOR USE IN PLANT DISEASE CONTROL

As a result of the achievement of controlling disease in humans and animals by the antibiotic penicillin, interest was stimulated for development of antibiotics to control plant disease. G. Stessel, Leben, and Keitt began a search for antibiotics for use in plant disease control (Chapter 13). J. L.

Lockwood and Leben described the production and properties of antimycin A from a *Streptomyces* isolate. P. Tsao and Leben searched for antibiotics that would act systemically in plants.

CRANBERRY DISEASES IN WISCONSIN

Much of the early work on cranberry diseases in Wisconsin was done under the auspices of the USDA. C. L. Shear, N. E. Stevens and H. F. Bain were most active in this work. Stevens apparently made periodic visits to the state. After his departure from the USDA, Bain came to reside in Wisconsin Rapids and served as a consultant with several marshes. Also, G. Peltier, who as a young man worked for a time at the Wisconsin Cranberry Experiment Station at Cranmoor, WI, came back to Wisconsin after retiring from the University of Nebraska and served as a consultant with the Indian Trails cranberry marketing company.

In 1957, because of the impending retirement of both men from active work with cranberry, a request was made of the University of Wisconsin that someone in plant pathology be assigned the responsibility of investigating cranberry diseases and their control in the state. Boone was given this assignment and he and his graduate students made extensive studies of the more important cranberry diseases in the state and related them to diseases in other cranberry-growing areas.

The most pressing need at the time was that of control of storage rots in fresh fruit held for the Thanksgiving and Christmas markets. End rot caused by *Godronia cassandrae* was the most common of these rots and black rot caused by *Ceuthospora lunata* was second in importance.

Since cranberry growing is limited to only a few states, there were few researchers working with cranberry diseases and there was very little up-to-date information available to use. Disease cycles had to be worked out, and the effects of modern cultural practices on disease incidence, the effectiveness of the newer fungicides, etc., had to be determined.

Boone established fungicide testing plots in which different fungicides and different spray schedules were tested and isolations were made from cranberry leaves, fruit, and stems to help determine disease cycles. L. W. Carlson helped carry out these tests and studied the physiology of the pathogens. Much sorting of stored test samples was done in the fall and winter to determine the effectiveness of fungicide treatments, storage temperatures, and the effects of wet raking and dry raking on disease incidence. Residue samples of fruit were obtained from the plots for use in registration of fungicides for use on cranberry.

R. J. Friend, another graduate, used his mycological training in a survey of incidence of different fungi on cranberry and succeeded in obtaining many good photographs of cultures, spores, and mycelia of fungi associated with the crop.

S. Tontyoporn did a comparative study of cultures of *Exobasidium* found on heath plants and determined that a red leaf spot disease and a rose bloom disease were caused by different distinct species rather than a single species, previously a subject of controversy.

G. J. Weidemann investigated different isolates of *Phyllosticta* on cranberry and determined that instead of one species, as indicated in the literature, there are two distinct species with very different effects on cranberry, one of which is widely distributed in the cranberry growing areas and the other restricted to New Jersey and Massachusetts and responsible for much of the field rot that occurs in those states.

M. Schwarz studied the black rot disease cycle and also determined that much of the black rot occurring in New Jersey is caused by *Strassaria oxycocci* rather than by *Ceuthospora lunata.* He described two distinct strains of *Ceuthospora,* one of which may be described as a new species.

K. Brown studied *Physalospora* isolates and determined that there were sufficient differences to warrant naming one white strain as a new species, *Physalospora albavaccinii.* Boone and Tontyaporn determined that a leaf spot and berry speckle disease in Wisconsin is caused by *Gibbera myrtilli* rather than by the much different *Gibbera compacta* that is indicated in the literature to be the only *Gibbera* on cranberry.

The investigations have shown that the cranberry disease problems vary greatly from region to region, sufficiently so that disease control programs need to be worked out individually for each region. They also have shown that due to these differences there has been incompleteness and confusion in the literature.

When Keitt retired in 1958, Moore succeeded him as leader of the fruit program, with Boone becoming responsible for the small fruit disease work. Through the years some studies of cane fruit and strawberry diseases had been carried out, primarily by graduate students for their M.S. or Ph.D. theses. These students included E. W. Roark, L. K. Jones, C. W. Bennett, and Blodgett between 1918 and 1934 and H. E. Smith and J. E. Duffus in the 1950s. Om Sehgal studied the nature of strawberry multiplier disease in 1961.

During the time Moore was in Nigeria helping to develop the University of Wisconsin/U.S. Agency for International Development project at the University of Ife, his virus disease program was continued by E. H. Varney (1968–69) who took sabbatical leave from Rutgers University and by Roy Cropley (1969–70) from East Malling Research Station, Maidstone, Kent, England. The fungicide program was taken over by E. K. Wade in addition to his extension work.

In 1974, when Moore became director of Experimental Farms for the University of Wisconsin, Boone and Wade again assumed responsibility for the tree fruit fungicide program of the department. In 1979, when Wade retired, Boone added tree fruit extension to his responsibility until his retirement in 1984. In the interim between Boone's retirement and June 1985 when Steven Jeffers arrived in Madison, Gayle Worf has carried the tree fruit disease research program along with his extension responsibilities.

Chapter 8

Vegetable Disease Research

Donald J. Hagedorn and Glenn S. Pound

CRUCIFERS

Research on cabbage diseases at the University of Wisconsin has been coincident with the Department of Plant Pathology. It is strange that so much of a department's history would center around a relatively minor crop, but such is the case.

As Walker (Chapter 1) and Sequeira (Chapter 14) have also narrated, the first real thrust in research on plant diseases in Wisconsin was just before the turn of the century and dealt with the bacterial disease of cabbage, black rot. Harry L. Russell had joined the university faculty in 1893 as an assistant professor of bacteriology. He was trained in plant microbiology at Johns Hopkins University but because of the importance of dairying in Wisconsin, Dean Henry had demanded that he forego his interests in plant microbiology to develop a program in this higher priority area. Nevertheless, in the late 1890s, Russell began an investigation of the black rot disease of cabbage that had become a serious threat to the kraut and fresh market cabbage industry of the state.

At exactly the same time of Russell's investigations, and practically on adjoining farms, Erwin F. Smith, of the U.S. Department of Agriculture (USDA) and the world's most renowned plant bacteriologist, was studying the same disease from a tent field laboratory. Smith's detailed paper was published in 1897, a year earlier than Russell's. While this was a great disappointment to Russell, the experience was perhaps fortuitous for plant pathology at Wisconsin, for it undoubtedly directed the department's first research effort to another cabbage disease (*Fusarium* yellows), a program that was spectacularly successful.

When L. R. Jones came to Wisconsin in 1910 to begin a department of plant pathology, Russell impressed upon him the seriousness of the cabbage disease problems, and Jones approached the yellows disease problem immediately. He recognized the disease as being the same *Fusarium* disease described by Smith in 1899 as occurring in the eastern part of the country. Jones had the identity of the pathogen confirmed by H. W. Wollenweber, the world authority on the fungus genus *Fusarium.*

Jones was well aware of the success that W. A. Orton, one of his former students, had achieved in developing varieties of cotton resistant to *Fusarium vasinfectans.* Thus, in the fall of 1910, he made selections of surviving plants among a severely diseased population of the Hollander cabbage cultivar. These plants were stored through the winter and allowed to cross pollinate in outside plantings the following spring. By saving seed from each plant separately, a few breeding lines were established that were field tested. By repeated selections, the first resistant cabbage cultivar was introduced in 1916 as Wisconsin Hollander.

Wisconsin's cabbage industry had two major market targets: 1) fresh market, served by production in early summer, and by late fall production stored through the winter and fed to the market as demanded; 2) sauerkraut. Wisconsin Hollander was of late fall maturity and fit the winter storage needs but was not the best type for kraut. It did, however, hold the losses from yellows in abeyance until further selections could be made. It was at about this point that J. C. Walker assumed leadership of the cabbage program.

Kraut packers liked to have production spread out over a lengthy season so that they could fill their fermentation vats more than once. They usually began with early and mid-season round-headed types represented by the cultivars Copenhagen Market and Glory of Einkhuizen, and ended with late maturing, heavy yielding flat-headed types represented by All Seasons and Brunswick. Since these cultivars all showed some resistance in the field, selections were made within these types. In a short period of time the following cultivars were developed and released to the trade:

Wisconsin Brunswick from Brunswick
Wisconsin All Seasons from All Seasons
Marion Market from Copenhagen Market
Globe from Glory of Einkhuizen
All Head Select from All Head Early

Three of these cultivars deserve special mention from an historical point of view. Marion Market was developed from a plant selected by Walker from a field near Marion, Virginia, while Walker was on his honeymoon. Globe became the workhorse for the kraut industry in Wisconsin because of its heterogeneity that gave it unusual summer hardiness. In times of hot, dry summers, Globe would come through with comparatively good production. All Head Select was important because it led to the discovery of single gene resistance and was thus the progenitor of all subsequent varieties. This discovery is detailed below.

When Wisconsin Hollander was first used, an observation was made from a large transplanting that occurred over several days and during an increasingly intense heat wave. The amount of yellows was observed to increase as the air temperature increased. However, by late fall when cool temperatures prevailed, the diseased plants recovered and resumed production. Obviously, resistance was not complete.

Back in Madison, studies were underway with other root diseases, specifically flax wilt and tobacco root rot, that led to the development of the famous "Wisconsin Soil-Temperature Tanks". This equipment contributed greatly to the department's classical studies on the role of environmental factors on disease incidence and development. W. H. Tisdale used the soil-temperature tanks to demonstrate that the cabbage yellows disease increased in severity as soil temperatures increased from 16°C to 28°C, and that the resistance of Wisconsin Hollander broke down completely at constant soil temperatures of 28°C. This explained the earlier field observations of the performance of resistant varieties during hot summers.

When selections were made from All Head Early, three heads were chosen to cross pollinate the following spring. Two of these died in the seed row and, surprisingly, the third produced abundant seed. This was not expected since it was known that self-incompatibility was common in cabbage. The progeny was extremely uniform in type, confirming self pollination. M. E. Anderson took the plants of this selection (soon to be known as the All Head Select variety) into the soil temperature tanks and learned that this variety, in contrast to all those previously developed, had uniform resistance, even at 28°C. A second type of resistance had been discovered, one that was much more desirable than that possessed by Wisconsin Hollander. By crossing and back crossing to know susceptible plants it was established that this resistance was controlled by a single, dominant gene. This was the first demonstration of single gene resistance to a vascular fusarium.

The germplasm of All Head Select, plus the bud pollination technique worked out by Oscar Pearson of the University of California by which self-incompatibility could be overcome, plus use of the soil temperature tanks, became the foundation of all further breeding and disease studies. The single gene could be easily introduced into desired types and effectively monitored in segregating populations by the use of soil temperature studies. These techniques, together with studies on breaking dormancy, make it possible to treat cabbage as an annual rather than as a biennial. Throughout most of the early years, whole plants were stored under refrigeration and used for seed production. Later, it was learned that stumps alone would do just as well. This permitted much refined selections since the internal head quality could be known before storage. Still later, P. H. Williams developed techniques of making cuttings and obtaining seed after brief growth in greenhouses held at low air temperatures. This not only multiplied the productivity from a square foot greenhouse space by 200 to 300 percent but permitted the rapid build-up of a desired clone. Over the years, some twenty yellows-resistant cabbage varieties have been developed, covering a wide range of horticultural types.

When use of Wisconsin Hollander was begun, there was, of course, no source of commercial seed. It was suggested that farmers grow their own seed. This was almost a disaster and the advance made against the yellows disease was almost lost due to the blackleg disease caused by *Phoma lingam*. Jones put another student, M. P. Henderson, to work on blackleg. His thesis, published in 1918, established that this disease was seed transmitted and spread rapidly in plant beds during periods of rain. When J. C. Walker entered the cabbage program in 1919, he was faced with this production problem. It was an accepted premise in plant pathology that a thirty-minute soak in mercuric chloride would effectively sterilize plant surfaces. *Phoma lingam,* however, was not just a surface contaminant. It invaded the seed and mercuric chloride did not provide complete control. Walker demonstrated that soaking seed in hot water (thirty minutes at 50°C) did eliminate the fungus but greatly reduced germinability. It did provide control, however.

Walker was attracted to the climatic conditions of the Puget Sound area where there was little or no rainfall during both the plant bed and seed pod phases of seed production. Would *Phoma lingam* spread from infected seed under these conditions? In 1921, Walker made duplicate plantings at Mt. Vernon, Washington, and Racine, Wisconsin, of a large amount of seed known to be infected with *Phoma lingam*. The results showed that the climate of the Skagit Valley did provide disease-free seed even if stock seed was infected. This became the standard control of both the blackleg and black rot diseases in the Midwest.

When Pound was working in the Puget Sound area during World War II, he discovered a variant of *Phoma lingam* that occurred regularly on cabbage as a very low grade pathogen. On seed fields of Chinese cabbage it was more severe. This was a terrestrial form that occurred throughout the pacific coastal area. He returned to the University of Wisconsin in 1946, and in 1947, a severe epidemic of blackleg occurred throughout the cabbage-producing areas of the Midwest and East. By careful field and laboratory studies, the source of infection was traced to a seed lot, infected with *Phoma lingam* and planted for increase at Mt. Vernon, Washington. It was also revealed in these studies that the Puget Sound strain of *Phoma lingam* could be regularly isolated from seed lots grown in Washington and could be isolated from occasional mildly stunted cabbage plants in Wisconsin fields. These were troublesome discoveries and prompted a detailed study of variability of *Phoma lingam* by Pound and a study of induced variability in the Puget Sound strain by O. Calvert and Pound. They found no evidence of mutability of the Puget Sound strain toward the virulent eastern strain and concluded that environmental conditions that prevailed in the Puget Sound area in 1946 had permitted spread in the field. This is the only recorded instance where this is known to occur and use of western-grown seed continues to provide dependable control.

In late 1946, the attention of Pound was drawn to a severe disease of radish being grown on peat soils of southern Wisconsin. This was determined to be caused by a variant strain of the cabbage yellows *Fusarium* which was non-pathogenic to cabbage. A resistant variety was developed by making field selections and testing the progenies in soil-temperature tanks. The released cultivar, Red Prince, possessed polygenic resistance that effectively controlled the disease wherever it occurred in the United States. Red Prince has been used by seed companies for the development of other resistant types. Williams and Pound released resistant round and intermediate-length white radishes derived from white mutants that regularly occurred in plantings of Red Prince. Pound and his students, J. C. Horton and T. P. Pirone, also made important studies of radish mosaic viruses.

In the 1930s and 1940s, a number of virus diseases of crucifers were described in Wisconsin and California. In both states, symptom severity and type were associated with climate. In Wisconsin, two types of symptoms (veinbanding and severe mottling) of cabbage mosaic were described and associated with prevailing air temperatures, veinbanding occurring in spring and fall when air temperatures were low, and the mottle occurring in mid season when temperatures were high. In the bay area of California, where temperature fluctuations were much less, no such observations were recorded although necrosis was more prevalent in cabbage than mottling.

Walker and coworkers showed that the mosaic disease in Wisconsin was actually caused by two distinct viruses, which they named Cabbage Virus A and Cabbage Virus B, occurring together in the plant. Pound and Walker demonstrated that the Cabbage Virus A and the virus causing black ring of cabbage in California were both strains of the turnip mosaic virus described by Hoggan and Johnson in 1935, and that the Cabbage Virus B was a strain of the cauliflower mosaic virus from California.

Pound and his associates have published extensively on the environmental factors affecting the disease syndromes of the crucifer viruses and the virus multiplication in host plants. A series of eleven papers described this work and thirteen additional publications reported the effect of various environmental factors on tobacco mosaic virus multiplication. Turnip mosaic virus was shown to be affected by air temperatures. In regard to host nutrition, factors enhancing host growth generally enhanced virus accumulation in plants.

R. J. Shepherd and Pound purified the turnip mosaic virus and described its morphology. Pirone, Shepherd, and Pound purified the cauliflower mosaic virus and showed it to be a small spherical virus whose nucleic acid contained DNA rather than RNA. In later studies, both Shepherd and Pirone further characterized the chemistry and morphology of the cauliflower mosaic virus which has provided a system for studies of plant molecular biology.

As detailed in Chapter 3, Pound was associated with the Vegetable Seed Production Laboratory at Mt. Vernon, Washington, during the years 1943–46 as an employee of the USDA, but in cooperation with J. C. Walker of the University of Wisconsin. This was a war emergency program begun because of a severe shortage of cabbage seed.

In the crop culture used in the Puget Sound area, seeds were sown in plant beds in midsummer and in the fall transplants were moved to seed production fields for overwintering and seed production the following summer. There was an overlapping period of two months between seasons, and plant beds were located without regard to maturing seed fields. Aphid infestations were common and severe. As a result, the cabbage fields and plant beds were universally affected with virus diseases and the disease incidence was 100 percent. To break the cycle it was recommended that plant beds be located outside the seed growing area. In one year the disease problem was eliminated and seed yields, region wide, increased 100 percent.

The severe disease incidence provided an opportunity to observe varietal responses to virus infection. Marked differences occurred. With these observations in hand, when Pound returned to the University of Wisconsin in 1946, he immediately began a breeding program to develop genetic lines of resistance. In 1965, a number of self-incompatible lines possessing monogenic resistance to cabbage yellows and polygenic resistance to the mosaic viruses were released to the trade for use in hybrid production by Pound, Williams, and Walker. Included in these were the cultivars Badger Belle and Badger Blue Boy.

In the late 1940s, the kraut packers were faced with another serious problem, internal tip burn, which resulted in an unsightly kraut pack. Because of the inability to detect tip burn by observing the outside of the head the problem was very critical. The almost sudden appearance of this burn was baffling and was probably related to a greatly stepped-up program of fertilization following World War II.

Walker together with L. V. Edgington began a very extensive investigation of the tip burn problem and soon showed that, whatever the cause, genetic differences in cabbage varieties existed and control was possible by the development of tolerant varieties. A breeding program was begun and by the mid 1960s the resistant varieties TBR Globe, Globelle, and Sanibel were ready for use. In addition to having resistance to yellows, mosaic, and internal tip burn, the hybrid Sanibel fortuitously carried resistant genes to *Rhizoctonia* stump rot and to powdery mildew. This variety thus carried resistance to five major cabbage diseases.

Clubroot of crucifers had been known the world over since its description by Woronin in 1877. Throughout the years it had defied control. It was known that liming of soil provided some relief, but it was far from a truly effective control. It had also been shown that biological races of the organism occurred and that resistance in cabbage, turnip, and rutabaga was possible against some races. Wisconsin's first real contribution was the 1934 thesis of R. H. Larson on the mode of tissue invasion by the pathogen.

In the late 1940s, quite by accident, Walker and Larson found a Kale rogue growing in a severely infected cabbage population near Arlington, WI. This plant was saved and the resistance it possessed was successfully transferred to cabbage. In this case, the breeding process was considerably complicated due to the fact that resistance was polygenic and recessive. Nevertheless, the breeding program was successful and the resistant variety Badger Market was released. This program in late years has been continued by Williams.

The bacterial black rot disease of cabbage has been the most troublesome disease of crucifers throughout the world. It is seed transmitted and the pathogen can remain viable in soil for at least one year. Thus, disease-free seed and good crop sanitation are very important. Puget Sound grown seed has been consistently free of infection, whereas seeds from northern Europe and Japan are consistently contaminated. Under such conditions, states like Wisconsin have had to give strict attention to the entry of contagion via transplants from southern states. Even so, epidemics occur from time to time and losses can be severe.

Williams has surveyed the brassicas for resistance to black rot and has successfully incorporated it into suitable horticultural types of cabbage.

When Williams came to the University of Wisconsin in 1959 to do his Ph.D. with Pound, it was suggested that he study the variability of the crucifer white rust pathogen, *Albugo candida.* R. D. Raabe and Pound had just finished a study of the white rust of spinach and had found some exciting information about the role of environment on the incidence of this disease. The studies by Williams contributed greatly to our understanding of radish white rust. With Pound he researched the variability of host-parasite relationships and reported biological races, the nature and inheritance of resistance, and metabolic processes associated with the disease.

The cabbage ring spot disease caused by the ascomycete *Mycosphaerella brassicicola* has long been of interest because it is a disease only of crops grown in narrow coastal belts in temperate zones. It has been observed in tropical climes but only at high altitudes. Nelson and Pound (1959) studied this disease and showed that relatively long periods of cool, moist climate are necessary both for sporulation of the fungus and for spore germination and host penetration.

Associated in one way or another with Jones and Walker on collaborative research of cabbage and other crucifer diseases but not mentioned above were the following persons, listed in chronological order: J. Monteith, F. L. Wellman, R. Smith, L. M. Blank, S. Morell, H. H. Foster, D. E. Pryor, M. A. Stahmann, W. S. Flory, Jr., J. P. Jolivette, J. G. McLean, W. J. Hooker, F. G. Smith, F. J. LeBeau, M. W. Felton, R. E. Foster, J. E. Kuntz, O. H. Calvert, J. F. Stauffer, R. E. F. Mathews, M. E. Gallegly, A. A. Cook, N. N. Winstead, E. Echandi, S. D. Van Gundy, A. L. Taylor, R. Heitefuss, D. J. Buchanan-Davidson, W. L. Seaman, K. R. Barker, J. F. Darby, B. E. Struckmeyer, J. M. Halloin, J. O. Strandberg, G. A. de Zoeten, and G. Gaard.

Associated with Pound in researching diseases of crucifers were D. L. Fowler, P. C. Cheo, L. G. Weathers, C. Garces-O, J. L. Peterson, J. Klisiewicz, J. C. Horton, H. Tochihara, L. Gonzalez, M. San Juan, and L. L. Black.

When Pound moved from our department to become dean of agriculture, Williams took over the crucifer improvement and disease research programs. He continued the research orientation of his predecessors, Walker and Pound, and added new approaches. At first, in conjunction with one or both of his mentors, North American races of the clubroot pathogen were studied, the inheritance of powdery mildew and *Rhizoctonia* bottom rot resistance in cabbage was elucidated, and control of internal tip burn through breeding was researched. In a series of studies with the clubroot pathogen *Plasmodiophora brassicae,* Y. Yukawa, S. McNabola, J. R. Aist, and S. Aist elucidated the fine structure of host-parasite relations. N. T. Keen, J. Kavanagh, N. M. Reddy, and J. Strandberg examined the *in vitro* culture and physiology of clubroot. B. Jacobsen discovered the effectiveness of benomyl in clubroot control. R. V. James studied the genetics of clubroot resistance in *Brassica campestris.* Williams developed a system for the determination of races of the clubroot pathogen, and with J. O. Strandberg and H. Leung studied the inheritance of resistance in Chinese cabbage.

Black rot resistance of crucifers was studied by J. C. Sutton who investigated the relation of xylem plugging to lesion development and extracellular polysaccharide production. Fluorescing materials associated with vein blackening and leaf necrosis and the inheritance of resistance in cabbage were studied. Virulence studies were made and screening techniques for determining disease reaction were described.

The histology of blackleg of cabbage seed infection was studied and control measures suggested. An important contribution was the development of Hybelle and Sanibel, multiple disease resistant hybrid cabbages by Williams, Walker, and Pound.

Williams researched the nature and inheritance of resistance to radish white rust pathogen, and also its biological races. L. C. Black and D. T. Gordon did metabolic studies on the host-parasite reaction which included CO_2 analyses. H. Harding studied chlorophyll changes, photosynthesis, and ultrastructure of chloroplasts in the "green islands" induced on detached leaves of *Brassica juncea,* and D. Fox developed a visual white rust rating scale for comparing white rust symptoms to spore production. *In vitro* growth and spore production of the radish *Aphanomyces* was studied by H. Humaydan who also determined cruciferous hosts of this pathogen, as well as developing resistance in radish.

Not mentioned above but also associated with Williams in research with diseases of crucifers were D. Seidel, J. Darby, D. P. Maxwell, P. R. Verma, G. A. Petrie, H. Bissonnette, D. A. Palzkill, T. W. Tibbitts, R. L. Gabrielson, M. W. Mulanax, K. Matsuoka, G. P. Whiteaker, J. D. Maguire, J. M. Bonman, B. J. Cours, P. A. Delwiche, and X. K. Niu.

ONIONS

Research on onion diseases played a major role in bringing scientific eminence to Walker. Recognition of his achievements in this area began early in his career—when he was still an undergraduate. At the 1914 graduation ceremonies he was awarded a bronze medal (and a rousing cheer by his fellow students called a "skyrocket") for having submitted the most outstanding B.S. thesis—requirement for graduation in those days—on the onion smut disease. In 1917, while in graduate school, he published the first of dozens and dozens of papers in *Phytopathology,* this one "Studies upon the anthracnose of the onion".

Onions were an important crop in southeastern Wisconsin at that time, both bulb onions and onion sets acreage being about equally divided. Walker chose to research the troublesome onion smudge for his doctorate thesis.

Our department graduated four Ph.D.'s (the entire university only had twelve), including J. C. Walker, in 1918. Graduation was in the Stock Pavilion. Walker published two more papers on anthracnose of onion that year, and in 1919 a USDA bulletin on onion diseases and their control and a Wisconsin circular on onion smut. Even before he graduated with the Ph.D., he took a wartime appointment with USDA's W. A. Orton in 1917 to study post-harvest or market diseases; this prompted the U.S. Secretary of Agriculture to request deferment from military duty for Walker from the Racine draft board. A very good move on the part of the secretary! Walker returned from the market pathology program in 1919, and was appointed an instructor in the department. He retained a part-time appointment in USDA until 1944, carrying their research programs in cabbage and onion disease.

Walker was promoted to assistant professor in 1920 and, as time progressed, L. R. Jones gradually turned over more and more of the vegetable disease research program to him. He continued to emphasize research on diseases of cabbage and onion. During the period from 1920 to 1923, he authored or co-authored, with R. E. Vaughan, nine papers on diseases of onions describing results with the ongoing research on the formaldehyde-drip method for control of smut, *Macrosporium* rot, dodder, smudge and resistance to it, rust, soil temperature in relation to onion smut infection (a classic), and a revision of the USDA bulletin on onion diseases and their control. The important studies on soil temperature in relation to onion smut infection revealed that infection only took place at temperatures of 12–25°C and only when the onion seedlings were very small. There was no infection at 29°C or when older plants were exposed to inoculum. This explained why onions being grown in the warm southern parts of the United States did not become infected. In 1922, Walker went to Europe for six months for the USDA to study onion and cabbage diseases, an excellent educational and broadening experience.

During the years 1924–26, Walker and associates continued research and the reporting thereof concerning diseases of onions and cabbage. Of the fourteen publications on onion diseases, some of which were co-authored by F. L. Wellman, C. C. Lindegren, E. C. Tims, or F. M. Bachmann, most reported research on white rot and *Botrytis* neck rot, and one pointed out the relationship of onion scale pigmentation to disease resistance; the latter was a report that was to have very important consequences. The next publications on onion diseases included two of a general nature: 1) onion curing to prevent decay in storage, and 2) a spraying and dusting calendar.

Very significantly, 1929 was the year during which the first known data on the chemical nature of disease resistance was reported in four papers by Walker, K. P. Link, and H. R. Angell. Walker describes some of this activity in Chapter 2.

The relationship of protocatechuic acid to disease resistance in onion was described in a "landmark" paper published in *Phytopathology* in 1930. Walker and A. Murphy then described an onion bulb decay by *Aspergillus alliaceus,* and later Walker co-authored, with USDA researchers Edmundson and Jones, papers on onion set production and on smut resistance in an *Allium* species hybrid.

The period 1940 to 1949 was the time of great expansion of the vegetable disease research program in our department. A large number of graduate students studied vegetable diseases for their thesis problems. Pound returned to the plant pathology faculty in 1946 from a USDA position in Washington; he replaced the deceased James P. Jolivette. An additional half-time faculty member, first Woodrow W. Hare (1946–48), then Donald J. Hagedorn, joined the vegetable disease group to research pea diseases. (The other half-time appointment was in the Department of Agronomy where responsibilities included pea breeding and production problems.)

Walker had a keen interest in the relationship of plant nutrition to disease development. This interest was transferred into a classical research effort on the subject wherein a substantial number of important vegetable diseases and several plant nutrients were studied. The experimental methods were continually being improved until the well-known (among University of Wisconsin students) "drip system" was perfected. For years the drip system occupied most, if not all, of Babcock Drive greenhouse number thirty-four, and sometimes there was a drip system set up in the "tank house" if temperature requirements for disease development had to be provided in temperature tanks. With this system, plants were grown in six- or eight-inch diameter clay pots containing white silica sand which was remarkably free of plant pathogenic organisms and was very inert regarding nutritive value. Liquid preparations of various plant nutrients were made up frequently, using approved formulae, and kept in and dispersed from large earthenware covered crocks. These were elevated three to four feet above the greenhouse benches to provide effective gravitational "pressure" to the elaborate system of rubber hoses and glass "T"s, "Y"s, and "drip" tubes which provided the specific nutrient under study to each individual pot of plants.

A very impressive series of at least twelve research papers resulted from this research, which was wisely directed by Walker, and accomplished by daily careful and diligent efforts by many graduate students over a number of years. No weekends off for these people!

Even though Wisconsin onion disease research by J. H. Owen, W. C. Hatfield and Walker continued to delve into the interrelationships between certain naturally occurring chemicals in onion and diseases of this crop, there was more and more research effort by Larson placed upon the control of onion smut via chemical (Arasan and thiram) seed treatment instead of the messy formaldehyde drip method, and on the pink root disease. Pink root was a troublesome disease in many of the United States onion-growing areas even though its effect on the onion plant was often not as dramatic as other diseases. A. M. Gorenz, Walker, and Larson determined the reaction of onion varieties to various isolates of the fungus, studied its morphology and taxonomy, and also studied factors affecting the pathogenicity of the pathogen. E. C. Gasiovkiewicz and associates found that variability in the fungus could be quite readily induced by nitrogen mustard. An improved method of screening onion seedlings for pink root resistance was devised wherein the seedlings were grown in sterilized quartz sand.

Others associated with Walker on onion disease research were A. D. Dickson, A. E. Clarke, T. M. Little, C. G. Nichols, and W. H. Gabelman.

CUCURBITS

During the 1920s and 1930s, cucumbers for pickling were grown primarily in southern Wisconsin and northern Illinois. The three most common diseases, which had been known for many years, were angular leaf spot, anthracnose, and mosaic. By practicing good rotations these diseases were not very troublesome. But in the 1940s the disease situation took a turn for the worse. Walker describes the problems and some of the research activities as follows:

> As the crop changed, however, from fields of a half acre or less per farmer to acreages up to fifty acres per field, and as the acreage moved north to central and northeastern Wisconsin, the disease situation changed. By 1946, cucumber scab or spot rot had become a major limiting factor. The disease was until then considered a minor one. It occurred chiefly in cool summer regions as in Maine. As our acreage moved north, it became more destructive. It was especially serious because the fungus was most destructive on young fruits, the stage most valuable for pickling. We showed by controlled experiments that it was most destructive at about 17°C while at 21°C and above lesions were rapidly cicatrized by host tissue reaction. This explained why the disease was never observed in the latitude of Madison. A resistant garden variety had been developed in Maine some years earlier and introduced as Maine Number 2. It was highly resistant when tested in Wisconsin. By crossing with standard pickle varieties, such as Chicago Pickling, it was determined that resistance was controlled by a single dominant gene. A suitable pickle variety resistant to scab was soon developed and released as Wisconsin SR6. In the meantime, a mosaic-resistant pickle cultivar was introduced by the Ohio Experiment Station as Ohio MR17. We crossed this with Wisconsin SR6 and developed double resistant varieties which were introduced as Wisconsin SMR 12 and Wisconsin SMR 18.

Associated with Walker's successful effort to control two of the most severe diseases through breeding for resistance were some important basic and practical researches on these and other cucurbit diseases. Publications on these diseases began to appear in 1949 when resistance to cucumber scab was described, and studies on morphology, variability, pathogenicity, and physiology of the cucurbit black rot fungus were reported by W. F. Chin and Walker. Later research by Walker on the scab disease involved the relationship of environment to resistance, and C. F. Pierson and Walker studied the relation of the causal fungus to susceptible and resistant cucumber tissue.

Research on cucumber mosaic and its causal virus in Walker's laboratory was diverse and prolific. It included a pioneering study on electron microscopy by W. H. Sill, Burger, Stahmann, and Walker, use of cowpea as an assay host for presence of the virus and relation of a virus inhibitor in cucumber to mosaic resistance (Sill), inheritance of resistance to common cucumber mosaic virus in cowpea (J. B. Sinclair), descriptions of two new resistant cucumber varieties, cross protection among virus strains, and assays for resistance in pickling cucumbers. Even the wild cucumber mosaic virus was studied biophysically. Wild cucumber is very prevalent in Wisconsin. J. Tomlinson, from England, came to Walker's lab as a visiting scientist in the mid 1950s and teamed up with R. Shepherd in a monumental but successful effort to purify the cucumber mosaic virus and study its properties and serology. Then inheritance of resistance to the virus was studied by S. L. Wasuwat and Walker, who also worked on the relative concentration of the virus in resistant and susceptible cucumbers. The metabolism of such varieties was determined by G. H.

Menke, as was the influence of temperature on penetration of the virus through cowpea epidermis. Strains of the virus pathogenic to crucifer were identified and other strains which attacked peas and beans were described.

Other cucurbit viruses were studied by Walker and his students, G. D. Lindberg and D. H. Hall, and associates from the Department of Biochemistry. These investigations included studies of the melon mosaic virus and the determination of some physical-biochemical characteristics and three components of the squash mosaic virus.

The angular leaf spot disease of cucumber has been the subject of extensive research in our department. In early researches by A. B. Wiles and Walker the epidemiology and control aspects of the problem were important areas of investigation, as was the relation of the pathogen to cucumber fruits and seeds. S. D. Van Gundy and Walker studied seed transmission, over-wintering, and host range of the pathogen as well as its amino-nitrogen nutrition and the relation of temperature and host nutrition to disease development. J. N. Chand, Walker, and Wade investigated the role of seed- and soil-borne inoculum, sprays with copper-containing chemicals for control, and the relation of leaf age and varietal resistance.

Cucumber wilts were the diseases involved in studies of 1) plant nutrition in relation to disease development by C. T. Wei, Walker, and R. P. Sheffer; and 2) physiological responses of susceptible and resistant cucumbers by C. E. Main and Walker. Anthracnose of cucumber (by L. V. Busch) and watermelon (by J. L. Anderson) was also studied, resistance to the former and histology of the latter.

When Williams took over the cucumber disease research in the mid 1960s, studies with N. T. Keen involved the identification of extracellular enzymes produced by the cucumber angular leaf spot pathogen and their relation to disease development. Histology of infection of the bacterium was examined as was the relation of cell permeability alterations to the water congestion and symptomatology. Biochemical aspects of pathogenesis were also studied.

The inheritance of powdery mildew resistance in cucumber was studied by S. Shanmugasundaram with the discovery that resistance is controlled by a major recessive gene, but that two other genes also influence disease reaction. The response of cucurbits to the bacterial wilt pathogen was determined by J. Watterson as was the multiplication and movement of the bacterium in resistant and susceptible cucurbits. The inheritance of resistance anthracnose and target leaf spot in cucumber was studied by Z. Abul-Hayja.

Walker's other associates on cucumber and other cucurbit disease research were R. V. Rice, R. V. Riu, P. Kaesberg, P. H. Geil, and N. T. Keen.

In addition to those mentioned above, associated with Williams' research of diseases of cucurbits were C. D. Upper, C. E. Peterson, R. D. Durbin, N. M. Kauffeld, E. D. P. Whelan, C. B. Hill, M. Palmer, and P. Louward.

BEETS AND CARROTS

Another classic story involves the solving of the problem of boron deficiency of red beets (Chapter 2).

Walker and his students found that borax could be sprayed on beet plants to control black spot, and studies were made by Walker, Jolivette, and Hare on the relative susceptibility of beet cultivars to boron deficiency.

Very little research effort was devoted to carrot disease problems, but the physiology of *Rhizopus* infection on carrot was reported by G. H. Menke in 1963 and 1964.

Associated with Walker on these beet and carrot researches were J. G. McLean, J. E. Kuntz, and P. N. Patel.

Williams and associates have studied carrot diseases during the past fifteen years. J. Mildenhall described a troublesome *Rhizoctonia* crown rot and cavity spot of muck-grown carrots and *Pythium* brown rot attacking this crop. The effect of soil temperature and host maturity on infection by *R. solani* was determined. They devised methods for detecting resistance to these two diseases in seedling carrots. The pathogenicity to carrots of *Pythium* species from organic soils was also studied by R. Howard and R. Pratt.

POTATOES AND TOMATOES

Walker's first publication, which appeared in 1913 when he was still an undergraduate, was on control of potato diseases in Wisconsin. His interest in this subject may have come naturally, due to exposure to these diseases as one of the first field inspectors hired by the fledgling Wisconsin Potato Seed Certification program. Potato diseases did not receive major concentrated research effort until R. H. Larson and Walker began a series of potato investigations in the mid 1930s. The major effort was on virus diseases, with the yellow dwarf virus problem receiving initial attention in soil temperature studies. Early potato scab research pointed out that potato scab was less severe at low soil pH levels (5.0 and below), and that potato cultivars with russet skin were quite resistant to the pathogen. Potato wilt, incited by two *Fusarium* species, was reported in 1941, and H. M. Darling and Larson found a similar disease a few years later.

Important early research by Johnson and Tompkins found that the ordinarily latent potato virus X showed symptoms at low temperatures of 16–20°C, so potatoes for seed certification were grown in the north under cool conditions.

The potato virus investigations led by Larson included several interrelationship studies involving virus strains. Ringspot strains of potato virus X were investigated, as were potato latent ring-spot and virulent ring-spot viruses (R. C. Ladeburg, Larson, and Walker), veinbanding viruses, a latent-mottle virus, potato virus Y (J. F. Darby), potato leaf roll virus (R. E. Webb), potato virus A (D. S. MacLachlan), and interveinal mosaic incited by three component potato viruses M, S, and X (D. S. MacLachlan and R. H. Bagnall). Other viruses studied were potato virus S, the brownspot and yellow strains of potato virus X (A. J. Hanson), a soil-borne virus associated with the corky ringspot disease, potato virus F, and the alfalfa mosaic virus which caused a tuber necrosis. C. Willis and Larson found that crimson clover was a new host for potato virus X, and ground cherries served as overwintering hosts of potato yellow leaf and veinbanding viruses. Serological relationships of potato viruses S and M and the carnation latent virus were determined by Bagnall, Wetter, and Larson. Mutations of potato virus X were induced by nitrogen mustard.

In cooperation with "Prof" Albert (Department of Soil Science), Larson investigated a physiological internal tuber necrosis, finding that the diseased area was the parenchyma of the internal medulla and that deeply formed tubers had less disease. Standard cultivars showed more tolerance than those newly introduced.

The potato rot nematode suddenly appeared in the seed potato production area in Oneida County in 1953. Gerald Thorne, USDA nematologist from Salt Lake City, came to Wisconsin at our request to help H. M. Darling investigate the situation and undertake quarantine and control measures. He made major contributions to solving the problem. These men found that soil fumigation was very effective.

Verticillium wilt of potato was the subject of *Wisconsin Agricultural Experiment Station Research Bulletin 202* and also other publications.

Others associated with Walker on potato and tomato disease research were the following: S. O. Fogelberg, J. G. McLean, O. C. Whipple, Jolivette, H. J. Hooker, R. E. Foster, J. B. Kendrick, Jr., Pound, J. E. Kuntz, M. E. Gallegly, M. A. Stahmann, R. W. Colburn, S. S. Gothoskar, E. K. Wade, R. P. Scheffer, J. R. Bloom, L. V. Edgington, A. O. Paulus, D. B. Robinson, R. Rohringer, M. V. Nayudu, and C. Wetter.

Potato diseases, especially bacterial soft rot, have received the careful and intensive research attention of Arthur Kelman and his associates since the early 1970s. The initial research on soft rot centered around development of useful materials and methods—selective media for isolation were compared by D. Cuppels and Kelman, and procedures for detection of the pathogen on potato tubers were studied by S. H. De Boer and Kelman. This made possible several research efforts including studies by these scientists on the relation of various storage factors to susceptibility of potato tubers to *Erwinia carotovora*. Population dynamics studies were made by Perombelon and associates in relation to potato tuber soft rot and pathogen soil survival. J. A. Phillips and Kelman were able to trace the dissemination of *E. carotovora* from an inoculum source using a direct fluorescent antibody technique. Pectolytic *Clostridium* spp. were found by A. Campos, E. A. Maher, and Kelman to play a role in soft rot of potato tubers, and the oxygen status of potatoes in storage was found by Maher and Kelman to be important in the tissue maceration process by pectic enzymes.

Recent research by McGuire and Kelman has shown that severity of soft rot in potato tubers could be reduced by increased calcium content. Calcium nutrition was also studied by K. C. Tzeng and coworkers in relation to internal brown spot and sub-apical necrosis of potato sprouts. Simulated commercial washing and fluming of potato tubers were used by J. Bartz and Kelman to show the high percentage of tubers that are inoculated during these processes, and they found that tuber lenticels could be infiltrated by *E. carotovora* under hydrostatic pressure with resulting severe disease development.

Others associated with Kelman in these studies have been B. M. Lund, E. Allan, K. E. Simmons, and K. A. Kelling.

The early dying potato disease complex became more troublesome in the late 1970s when potato production expanded greatly in the irrigated central sands area. Jack E. Mitchell, M. K. Rahimian, W. C. Warfield and Douglas I. Rouse began studies of this disease at that time, initially determining the causal organisms involved. The impact of plant stress associated with the disease with regard to plant growth and yield was also studied by these scientists and J. B. Kotcon. Stem colonization and synergistic relationships of *Verticillium dahliae* and *Erwinia carotovora* pv. *carotovora* were studied in detail by Rahimian and Mitchell.

Tomato research in the early 1940s was involved in chemical control of foliar diseases of this vegetable through spraying, the subject of a research bulletin by Walker and coworkers in 1944. Predisposition and the relation of host nutrition to *Fusarium* wilt were the next research subjects reported by Walker and R. Foster. J. B. Kendrick, Jr. and Walker studied anthracnose of tomato and bacterial canker, the latter with regard to plant nutrition in relation to predisposition and disease development. Perhaps the most significant tomato research undertaken for many years involved the development and release of the new 'Wisconsin 55' tomato by Walker, Pound, and Kuntz in 1948. This vigorous, well-adapted, disease-tolerant tomato is still in use in home gardens in Wisconsin after thirty-three years! This is remarkable considering that dozens of "new" tomatoes have come and gone during this period.

Pound made a detailed study on the relation of temperature to development of tomato early blight using four isolates of the pathogen. Pound and Stahmann found a toxic substance which caused chlorosis and necrosis in tomato whether its source was sterile culture filtrate or plant lesions caused by *Alternaria solani.* This toxin incited symptoms identical to those caused by the fungus itself. It was identical to alternaric acid.

Environmental factors and plant nutrition were subjects of research with bacterial wilt by M. E. Gallegly and Walker. *Fusarium* wilt continued to be investigated by R. P. Scheffer, S. S. Gothoskar, and M. A. Stahmann, especially regarding the distribution and nature of resistance, disease physiology, and the pectic enzymes involved.

Lloyd Edgington and Walker researched the influence of soil and air temperature on tomato *Verticillium* wilt, and the relation of plant nutrition to disease development was studied by Walker, Gallegly, J. Bloom, and Scheffer. Other plant nutrition studies by Bloom and Walker, in this case with *Fusarium* wilt, involved the influence of calcium and boron nutrition. Bacterial spot of tomato studies by M. V. Nayudu and Walker included the influence of leaf composition, temperature, and age and nutrition of the host.

"*Fusarium* wilt of tomato" is the title of Walker's *American Phytopathological Society Monograph No. 6,* published in 1971.

Henry M. Darling joined our faculty as an assistant professor in 1940 primarily to take charge of the Wisconsin Potato Seed Certification Program and to establish the Wisconsin Foundation Seed Farm. He received his Ph.D. from the University of Minnesota in 1942. In addition to his major responsibility, he was an active researcher and teacher. His Ph.D. thesis was on resistance to the potato scab disease, and he continued interest and research on this disease with T. H. Schultz and K. C. Berger studying control through use of urea-formaldehyde. He studied the relation of copper and manganese to disease development with J. J. Mortvedt and K. C. Berger. Darling with R. L. Self also researched the purple-top disease, nutrition levels, and potato virus X with Berger, the transmission of the spindle tuber virus by true seed with D. E. Hunter and W. R. Beale, and the inheritance of resistance to *Verticillium* wilt with D. E. Hunter, F. J. Stevenson, and G. E. Cummingham.

However, Darling's most consuming interest as a researcher and teacher was nematode diseases. When the potato rot nematode was found in the northern Wisconsin potato seed fields, in cooperation with Thorne and Walker, effective control measures were quickly devised and implemented. More basic studies were then undertaken with the following nematodes: spiral, stem or bulb, lesion or meadow, dagger, and *Aphelenchus avenae.* Darling's intimate knowledge of all spheres of potato production and storage, and the problems involved, led to invitations for him to write at least three lengthy papers on such subjects and to consult in Peru and Korea.

Others associated with Darling on research on potato diseases were: R. H. Larson, V. G. Perry, L. R. Faulkner, M. H. Fleischfresser, G. C. Smart, O. J. Dickerson, G. D. Griffin, R. V. Anderson, K. R. Barker, and H. O. Werner. The scientific contributions of most of these people will be given in the chapter on nematology.

When Darling retired, Steven A. Slack took over as director of the Wisconsin Potato Seed Certification Program. Slack's research program has concentrated on the development and evaluation of techniques for the detection of potato pathogens in seed potato stocks with Kelman and J. B. Perry, and on the epidemiology of potato disease caused by viruses and bacteria. A latex agglutination test, studied with H. A. Sanford, F. E. Manzer, and M. A. Khan has been very helpful for the serological detection of potato viruses S and X and *Corynebacterium sepedonicum.* The phenomenon of reinfection of potato seed stock with potato viruses S and X was studied with Y. Hahm and R. J. Slattery. The potato spindle tuber viroid was detected by an electrophoretic assay studied with M. A. Pfannenstiel and L. C. Lane, and the response of potato cultivars to the viroid was determined. Symptoms were enhanced and viroid concentration amplified by high light intensity and temperature in studies by M. E. Grasmick and Slack. A. L. Bishop has investigated the effect of temperature on ring rot.

Others associated with Slack on his research with potato diseases have been A. Volker, D. E. Bidwell, C. L. Sutula, L. Yang, B. Reddick, R. G. Clarke, D. R. Douglas, J. A. Fletcher, J. A. Leach, A. Branch, H. Robertson, M. D. Peterson, and D. Gakovich.

Potato diseases have also been an important research effort by Luis Sequeira. With E. R. French he studied variability within *P. solanacearum* strains from South America. He discovered resistance to the potato bacterial wilt pathogen in certain clones of *Solanum phureja,* developed an efficient root inoculation technique to screen seedlings with L. C. Gonzalez, and studied the inheritance of resistance to race 1 of the pathogen with P. R. Rowe. Three dominant and independent genes provided resistance and there was evidence of modifying genes. An inhibitor of bacterial growth in potato was identified with J. C. Zalewski and its role in resistance was determined. Studies have been made with L. Ciampi on the influence of temperature on virulence of race 3 of the bacterial wilt pathogen and on latent infections in potato tubers. At 16°C, only one of eight bacterial strains caused wilting, but all strains were virulent at 28°C. Differences in virulence were not correlated with growth rates in liquid culture at 16°C. Resistance to the disease has been studied in detail with J. Bowman using infectivity titrations in relation to multiplication and spread of the pathogen. A bacterial agglutinin from potato has been isolated, purified, and characterized by J. M. Leach and M. A. Cantrell. This agglutinin, a hydroxyproline-rich glycoprotein, interacts with bacterial lipopolysaccharides. T. L. Graham, J. Durich and C. A. Hendrich in Sequeira's laboratory have explored this relationship as a possible explanation for bacterial attachment to plant cell walls.

Greenhouse and field studies carried out by J. Kempe and R. McLaughlin showed that biological control of potato bacterial wilt is effective using an avirulent mutant of the pathogen as a seedpiece treatment. This, and other studies indicated above, illustrates that Sequeira's researches are an important blend of basic and practical scientific endeavor. A valuable associate with Sequeira on research on potato diseases has been E. A. Barlow.

Extension vegetable pathologists Earl Wade and now Walt Stevenson both have given potato diseases major emphasis in their extension and research activities. A large effort has been put forth to determine the most effective chemical control measures, recommendations that have been critical to the well-being of potato production in Wisconsin. In recent years, Stevenson, J. W. Pscheidt, and others have shown that potato early blight can be successfully controlled with fungicide sprays that are applied on schedules adjusted for differences in weather factors. Potato cultivars have been evaluated for early blight resistance with the finding of substantial differences in resistance between cultivars. Cultivars maturing in early- and mid-season become less resistant earlier in the summer than late-maturing cultivars. Stevenson has also devised a very useful integrated program for managing potato late blight. Other associates have been J. Perry, J. Stewart, G. Weis, K. Ritchie, Slack, and F. A. Gilson.

Most recently, Rouse has applied his epidemiological and statistical expertise to researching potato diseases. In association with studies by Kotcon, Rouse, and Mitchell on the dynamics of root growth in potato fields affected by the early dying syndrome, root deterioration due to *Verticillium dahliae* has been investigated by Kotcon and Rouse. The interactions of three fungi and one nematode in the early dying syndrome of Russet Burbank potatoes were also researched by Kotcon, Rouse, and Mitchell, as were some approaches to prediction of disease severity and modelling of the impact of plant stresses associated with the disease.

BEANS AND PEAS

One of the outstanding early studies of bean diseases conducted in our department was by W. J. Zaumeyer who made a classical comparison of the pathological histology of three bacterial diseases—common blight, halo blight, and wilt—for his 1929 thesis under L. R. Jones. Walker became very involved with bean diseases soon thereafter.

Garden, processing, and field beans all over the United States were being severely reduced in yield by a virus disease called mosaic, the most important disease of beans. W. H. Pierce came to the University of Wisconsin to work toward a Ph.D., and Walker asked him to research the bean mosaic problem. Pierce showed that two viruses were involved, the seed-borne bean common mosaic virus (BCMV) and the bean yellow mosaic virus (BYMV) which lived in leguminous hosts. Meanwhile, R. Corbett of the Sioux City Seed Company selected a single healthy 'Stringless Green Refugee' bean plant from a very highly infested seed field in Montana in 1929. When seed from this plant was planted in the same field in 1930, all developing plants remained healthy while most other plants were severely diseased with BCMV. Disease resistance had been confirmed.

Walker was given a few seeds of this BCMV-resistant bean. Pierce crossed the resistant bean with Stringless Green Refugee. With Walker, he released the first two highly mosaic resistant snap beans named 'Idaho Refugee' and 'Wisconsin Refugee'. Resistance was dominant and segregations fitted only loosely into a single gene pattern. The yield and quality of the new Idaho Refugee bean especially proved to be very good, and it was widely accepted.

R. G. Grogan and Walker showed via cross protection tests that BCMV and BYMV were closely related. These researchers described a pod-distorting strain of BYMV from Wisconsin and worked out the relation of BCMV to black root of bean, described by Jenkins as a new disease. Soon thereafter Bridgmon and Walker reported on the relation of southern bean mosaic to black root, and gladiolas were determined to be a good reservoir host of BYMV. Angular leaf spot of bean was considered a new disease in Wisconsin in a 1955 report by Walker, and it was studied further the following year by C. Cardon-Alvarez and Walker.

Halo blight of bean was occasionally troublesome to Midwest bean growers when western seed supplies became contaminated during production. Walker and Patel began a breeding program to develop resistance to halo blight and to study various physiological and epidemiological aspects of the disease. A second race of the causal bacterium was found, so resistance to both races was now needed. Such resistance was found in 'PI 150414' and was conditioned by one recessive gene.

While these researches were underway, the bacterial wilt of bean was also being investigated by S. Richard and Walker, as was bacterial brown spot, a disease new to Wisconsin which had been recently reported by Patel and his associates.

Upon Walker's retirement in 1964, Hagedorn took over the bean disease research program. The breeding for resistance to both races of the halo blight pathogen continued with subsequent development and release of Wis. (HBR) 40 and Wis. (HBR) 72 beans—the first processing type beans with double resistance. The latter bean has been highly resistant in several parts of the world and has been widely used as parental material.

The bacterial brown spot (BBS) disease continued to increase in severity and economic importance, so increased research effort was put forth on this problem with the very important assistance of R. E. Rand who joined the bean disease research program in 1965. In an intensive search for resistance to BBS, dozens of field and processing bean cultivars were field tested without any high level of disease resistance being found. Almost one thousand bean plant introductions (PIs) were then tested in large field plots over a period of three years before a highly resistant bean was discovered which was also highly resistant to inoculation under controlled conditions. Crosses with this tall, late, day length-sensitive bean were made with several commercial processing cultivars, and after back crossing and repeated inoculation and selection three new beans were released by Hagedorn and Rand to bean breeders. The new beans were designated Wis. (BBSR) 130, Wis. (BBSR) 17 and Wis. (BBSR) 28. Number 130 was particularly significant. It was the first bean developed with a very high level of resistance to bacterial brown spot and with resistance to six other bean pathogens, making it perhaps the most disease resistant bean ever developed.

Meanwhile, other associated BBS research was underway. An important overwintering source plant was found by Ercolani and coworkers to be hairy vetch, on which the causal bacterium lived very well as an epiphyte. Copper-containing sprays were found by Hagedorn, Wade, and Weis to be quite effective for control. S. Saad and Hagedorn found that disease initiation in the greenhouse could be made more reliable by simple manipulations, and pathogen isolates from many host and geographic sources were not more pathogenic than local bean isolates. S. Antonius and Hagedorn reported that testing small seedlings for disease reaction in the laboratory could be a helpful addition to other disease testing procedures. M. Daub and Hagedorn found that disease resistance was not associated with size, action, or numbers of leaf stomata; instead leaves of resistant bean lines sustained substantially fewer epiphytic pathogen bacteria than susceptible beans. Resistance to BBS was conditioned by several genes, according to Antonius and Hagedorn.

Alternaria leaf spot also required some research by Saad and Hagedorn in order to determine the incitant and disease epidemiology. Two days or more of wet, overcast conditions were needed for disease development. Host penetration took place both directly and through stomata; secondary hyphae grew into spongy parenchyma from the substomatal cavity.

When a statewide study was made of bean root rot, *Fusarium solani* was found by S. M. Yang and Hagedorn to be the primary pathogen. In the newly irrigated central sands area Hoch found that severe root rot is associated with poor rotations and a complex of *Pythium* species was the major disease incitant—particularly *Pythium ultimum* and *P. myriotylum*. Several other *Pythium* species were also involved. Reeleder and Hagedorn found that cultivation of these sandy soils was conducive to *Pythium ultimum* population build-up. A search for field resistance among commercial cultivars and bean breeding lines was begun by Hagedorn and Rand. Selections were made from a resistant line from New York and one from Oregon. These were crossed together and the F_1 crossed to several commercial cultivars. Repeated selection of promising beans under heavy disease pressure subsequently resulted in the release by Hagedorn and Rand of the first processing-type beans resistant to the Wisconsin bean root rot complex. They were Wis. (BRR) 77, Wis. (RRR) 83, and Wis. (RRR) 46. These beans have been widely used as parental material, and progenies from crosses made by commercial companies are now being tested by us for disease reaction.

In addition to *Pythium* spp., *Aphanomyces euteiches* f. sp. *phaseoli* was found by W. Pfender and Hagedorn to be a very important pathogen in Wisconsin's central sands.

Two other methods to combat bean root rot have been researched. The first involved the use of the herbicide dinoseb (DNBP) applied preplant and thoroughly incorporated. This practice was found by Hagedorn, Binning, and Rand to be very useful in substantially suppressing root rot and increasing bean yields. The other method, studied by K. Kobriger and Hagedorn, is the assaying of field soil samples to determine the root rot potential of a given field. This will allow "dangerous" fields to be avoided.

White mold is becoming a bean disease of increasing economic importance. Recent field studies by Stevenson, Hagedorn, and Rand indicate inconsistencies in the reaction of snap bean cultivars to the disease, but possible useable tolerance seems to be present in breeding lines from Geneva, New York and in certain PIs.

Various scientific aspects of some other bean diseases have been investigated by Hagedorn and associates during the last twenty years. Diseases included have been *Pythium* blight (with M. O. K. Adegbala), angular leaf spot (with D. A. Inglis), seed-borne *Rhizoctonia* (with N. Kramer), and yellows and wildfire from Brazil (with R. Ribeiro). The use of dry, rather than liquid, inoculum is being studied with E. Carlson, R. Gilbertson and D. M. Maxwell, especially as an alternative approach in field inoculation of foliage pathogens.

More recently, the bacterial brown spot disease of bean and its incitant have been studied by Rouse and associates from an epidemiological standpoint. The progress of disease incidence and severity has been studied by C. E. Morris, Rouse, and Hagedorn and the diversity and succession of epiphytic bacterial communities on bean leaves and pods by Morris and Rouse. The frequency of bacterial ice nuclei on bean leaflets as a predictor of disease has also been studied in conjunction with S. S. Hirano and C. D. Upper.

Our department has been one of the world centers for research on pea diseases. Pea anthracnose was reported by F. R. Jones and R. E. Vaughan in *Phytopathology* in 1921. During the next several years research emphasis was on root diseases, especially *Fusarium* root rot, wilt, and *Aphanomyces* root rot. The latter two diseases were by far the most important, with the wilt disease threatening to do away with pea production in many areas of the United States. Jones and M. B. Linford were active in researching pea diseases here during the 1920s and early 1930s.

Figure 8.1 Students in a pea field in 1922.
L-R M. Bensaude, F. R. Jones, N. Evans, A. J. Riker, R. Streets, L. R. Jones

During this period Walker and associates began their search for resistance to pea wilt, identified good sources of resistance and proceeded, in a joint effort with E. J. Delwiche in agronomy, to develop a very substantial number of wilt resistant canning peas with a range of plant characteristics in order to meet the diverse needs of Wisconsin's important canning industry—the largest in the United States. Cultivars with such names as Wisconsin Early Sweet, Wisconsin Merit, and Wisconsin Perfection were widely used for years; the latter cultivar was very important.

In the early and mid 1930s a new wilt disease, called near-wilt, was found in Wisconsin, and other United States and European pea production areas. W. C. Snyder and Walker reported on studies made by Snyder in Europe. It attacked all of the wilt-resistant cultivars and soon became a very troublesome problem, especially in mid- and late-season cultivars. Since all wilt-resistant cultivars were susceptible, a search for resistance was made among public and private pea "collections" using an infested field plot near DeForest, Wisconsin, between 1940 and 1942. Resistant selections made from this plot by Walker and Hagedorn were crossed with such cultivars as Wisconsin Perfection and Perfected Wales. The F_2 generation was tested for disease reaction using artificial inoculation under controlled conditions in Wisconsin temperature tanks. Delwiche Commando, a wilt and near-wilt resistant pea, was released about 1944, but was of unacceptable canning quality.

While these pea breeding activities were progressing, the wilt diseases were being studied from such aspects as relation of temperature and moisture to near-wilt, relation of the near-wilt fungus to the pea plant (W. J. Virgin and Walker), seed transmission of wilt, transpirational history and wilting, variability of the pea wilt fungus, influence of environment and nutrition on wilt, and description of a major (single dominant) gene for near-wilt resistance (Walker, Delwiche, and Hare).

The pea disease and pea breeding activities were combined in 1946, becoming the responsibility of one man, W. W. Hare. He held half-time appointments in the Departments of Plant Pathology and Agronomy. However, in late 1947 or early 1948 he resigned and Hagedorn was hired as his replacement in March 1948. During both transitions the breeding of peas for wilt and near-wilt resistance progressed quite smoothly.

The first "doubly" resistant, acceptable canning pea, New Era, was released by Hagedorn in 1952. Subsequent releases were New Season, New Wales, and a series of fourteen numbered pea lines, many of which carried resistance to other diseases in addition to wilt and near-wilt. The most significant of the new pea varieties were 1) Wis. 729 and Wis. 741, the first freezing peas resistant to powdery mildew, wilt, near-wilt and bean virus 2—perhaps the most disease resistant peas ever developed, and 2) Wis. 7105 and Wis. 7106—the first small-"berried" Early Perfection-type and first Dark Skin Perfection-type peas resistant to the pea seed-borne mosaic virus. Earl Gritton was a key co-investigator in many of these researches.

Our department has carried on a research program on the very important pea *Aphanomyces* root rot disease for many years. The disease was first fully described in Wisconsin by F. R. Jones and C. Drechsler in 1925 after five years of study. Host range studies and the effect of moisture, fertility, and fertilizer placement on the disease were reported by Walker and F. L. Musbach. No resistance was known among commercial peas of any kind so Hagedorn and associates field tested hundreds of lines in the USDA pea collection in the late 1940s and early 1950s, without finding good resistance. Since crop rotation was not practical and no chemical controls were known, another approach was taken to deal with the problem. A biological soil assay was devised by R. T. Sherwood and Hagedorn whereby the pea root rot potential of a given field could be determined. Thus, fields with high root rot potentials would not be used for peas and the disease would be avoided. Since this soil test has been available (1958), thousands of midwestern pea fields have been tested, with the result that millions of dollars in potential disease losses have been saved.

Research on root rot and *Aphanomyces* continued with studies by J. L. Cummingham and Hagedorn on penetration and infection of pea roots by zoospores of the pathogen. Effect of oxygen tension on growth of the fungus was studied by R. T. Sherwood and Hagedorn. Zoospore morphology and attraction of zoospores to roots were examined by Cummingham, and various aspects of pathogen biology by Sherwood. Important studies by M. V. Temp and Hagedorn on effects of cropping on disease severity showed that highly infested fields with heavy soils, even after up to eight years without peas, maintained high disease levels. Chemical control research by Mitchell and Hagedorn indicated the disease could be controlled quite well in the field with Dexon, but costs were prohibitive. *Pythium-Aphanomyces* relationship studies by R. Alconero and Hagedorn showed that root rot was not significantly more severe when *Pythium* was added to *Aphanomyces*-infested soil. When peas were totally exposed to *Aphanomyces-Fusarium* infested soil by D. W. Burke, Hagedorn, and Mitchell, root rot was much more severe than when peas were given only partial exposure; related studies concerned selective conditions for infection and distribution of pathogens in relation to pea root rot.

Mitchell and students for a number of years conducted an active research program on *Aphanomyces* root rot of pea, emphasizing rather basic studies with the pathogen (C. Y. Yang) and several aspects of the infection process (H. S. Bhalla). In natural soil at 28°C the number of motile zoospores needed for infection was 282; when the soil was steamed, only 16 such zoospores were needed. Infection could take place at 16°C, but symptoms developed most rapidly at 28°C. P. O. Oyekan and Mitchell found that the nematode *Pratylenchus penetrans* increased the severity of pea *Aphanomyces* root rot in silt loam and sandy loam soils with very low levels of the pathogen, but was more severe in silt loam soil with moderate levels of the fungus. A severe root rot developed when wilt-resistant peas were inoculated with the same nematode. This nematode caused extensive breakdown of root cortex, but no damage to the stele. H. C. Hoch and Mitchell studied ultrastructure of *A. euteiches* zoospores and their encystment and germination.

In cooperation with weed control scientists R. G. Harvey and J. R. Teasdale, a series of experiments was conducted on the effects of herbicides on the *Aphanomyces* root rot disease and its incitant. Repeated trials showed that dinitroaniline herbicides, especially trifluralin, suppressed root rot and increased yield at normal herbicide dosages. However, there was no disease suppression under very warm temperatures and high soil moisture conditions. Thorough pre-plant incorporation was essential for maximum results. A major mechanism of suppression was the immobilization of the zoospores due to lack of flagella formation.

Recent studies by Pfender and Hagedorn on *Aphanomyces* root rot disease progress and yield loss showed that in sandy loam soil the pathogen spread from an infected plant to neighboring plants and yield varied inversely with logarithm of soil inoculum level.

Wisconsin research on virus diseases of peas was initiated by Walker, whose student, M. Stubbs, submitted a Ph.D. thesis on the subject in 1935. Later, a major research effort of Hagedorn, Walker, and associates for twenty-five years concerned virus diseases of peas. These studies have provided a very substantial amount of scientific knowledge (eighty publications) concerning the three major virus diseases of peas in the United States, plus two minor virus diseases. The major diseases and their incitants include pea enation mosaic (PEMV), pea streak (WPSV), and pea seed-borne mosaic (PsbMV); minor pea virus problems were alfalfa mosaic (AMV) and cucumber mosaic (CMV).

Studies on PEMV were first concerned with host range: twenty of twenty-seven leguminous species were susceptible, twenty-two of them previously unknown as possible PEMV hosts. When five PEMV isolates from diverse geographical sources were compared by E. Rüppel and Hagedorn using several criteria, no major differences were found. Histopathological studies by P. W. Tsao indicated that leaf enations were initiated from parenchyma cells which became meristematic due to presence of the virus in the phloem. *Chenopodium album* was found by Hagedorn, R. E. C. Layne, and Ruppel to be a satisfactory local lesion host. When forty-three commercial pea lines being developed for PEMV resistance were tested by Hagedorn and R. O. Hampton for reaction to PEMV under three environmental situations, degrees of resistance ranged from some to excellent. Those performing well under one environment generally reacted well under the others.

Wisconsin studies with pea streak dealt primarily with the Wisconsin pea streak virus (WPSV) and were concerned with practically all aspects of disease and causal virus biological characterization. M. A. Stahmann, Hagedorn, and W. C. Burger studied the virus with the electron microscope and found long flexuous rods—pioneering research for 1950. Detailed aphid transmission studies were made by C. B. Skotland and Hagedorn, and forty-seven streak-inciting virus isolates from disease sources were compared and placed into five groups by W. S. Kim and Hagedorn. *Chenopodium amaranticolor* was found to be a good local-lesion host and the virus was purified and morphology and physiochemical properties elucidated by E. Rosenkranz and Hagedorn. Virus movement in the plant was monitored and the effect of antibiotics on virus multiplication determined by J. Maduewesi and Hagedorn.

The pea stunt disease, incited by the red clover vein mosaic virus (RCVMV), was found by C. H. Graves and Hagedorn to be widespread in Wisconsin peas and clover. Many commercial pea cultivars and PIs were tested for reaction to RCVMV by Hagedorn and Rand but high levels of resistance were not found. The virus was completely systemic in red clover and sweet clover according to E. W. Hanson and Hagedorn. Electron micrographs by Hagedorn, L. Bos and van der Wett showed the virus particles as thin rigid rods. Bean virus 2 appeared to incite pea mosaic in Wisconsin pea fields, but recessive single gene resistance (K. W. Johnson and Hagedorn) was common in commercial cultivars.

The threatening pea seed-borne mosaic virus (PSbMV) appeared in Wisconsin in 1968. W. R. Stevenson and Hagedorn discovered many biological and physical aspects of the virus (a long flexuous rod), purified the virus, provided details on seed and insect transmission (with W. L. Lim and L. C. Gonzalez), studied overwintering, and discovered resistance. Resistance was controlled by a single recessive gene in studies made by Hagedorn and Gritton. Resistant pea lines were developed and released. A classic success story!

The alfalfa mosaic virus (AMV) often incites pea streak symptoms and reduces alfalfa yields. J. P. Crill developed effective techniques for determining disease reaction in alfalfa and for identifying strains of the virus. A cucumber mosaic virus with a wide leguminous host range was found in Wisconsin peas.

Wisconsin research data on virus diseases of peas, and research by others worldwide, was brought together by Hagedorn in 1974 in the *American Phytopathological Society Monograph No. 9.*

Other pea diseases have been researched by our department. Hare made a classical study of the three *Ascochyta* diseases and described tip blight. S. H. Ou discovered new information on the infectivity capabilities of the pea anthracnose pathogen. Gayle Worf provided details of the interaction in soil of the *Fusarium* root rot and near-wilt pathogens and recorded associated host responses. L. R. Susuri, Hagedorn, and Rand have described and researched various aspects of

Alternaria leaf blight and Hagedorn and Rand studied water congestion. P. Reeser, Hagedorn, and Rouse have studied powdery mildew and Hagedorn and E. T. Gritton, an important cooperator in the Department of Agronomy, successfully developed resistance to this disease.

In addition to those mentioned above, associated with Walker on research concerning diseases of beans and peas were J. G. Adams, O. C. Whipple, P. G. Smith, J. P. Jolivette, D. G. Wells, B. J. Deverall, C. D. Garcia, and M. Teliz-Ortiz, and those associated with Hagedorn on pea and bean disease research have been P. Kaesberg, N. T. Flentje, H. A. J. Hoitink, J. M. Halloin, K. Yoshii, M. D. M. Porto, A. Kelman, D. L. Pinnow, J. M. Halloin, G. A. de Zoeten, R. D. Durbin, T. F. Uchytil, J. C. Faria, P. Delwiche, G. Grau, and J. Mullen.

SPINACH-LETTUCE

Very important research has been accomplished by scientists in our department on diseases of spinach and lettuce. Three significant new blue mold-resistant savoy-type spinach cultivars were developed and released by Pound. Disease resistance was derived from PI 140467. Badger Savoy was darker green and longer standing than common cultivars and because of its erect habit could be harvested by machine. Wisconsin Bloomsdale had an attractive dark green sheen and medium savoy and was long standing and fast growing. Savoy Supreme was very dark green and very long standing. All of these new spinach cultivars were high yielding and possessed high quality.

Pound and P. C. Cheo studied several aspects of cucumber virus 1 in spinach, including resistance to the virus in spinach and relation of air and soil temperature, photoperiod, light intensity, and host nutrition to virus concentration. The relation of certain environmental factors to the initiation and development of blue mold of spinach was researched by R. D. Raabe and Pound, as well as the morphology and pathogenicity of the pathogen.

Sequeira and associates have made important contributions to Wisconsin's lettuce-growing industry through the development of new disease-resistant lettuce cultivars. The severe production problem was known as corky root rot, the cause of which was identified by Sequeira as a toxic substance (a secondary amine related to m-ethyl-aminobenzoic acid) which formed as a result of lettuce crop residue decomposition. About 200 PIs and commercial cultivars were tested for disease reaction, with five PIs and one cultivar displaying a high level of resistance. Various crosses, backcrosses, sibbings, and selections were made resulting in the release of the new highly resistant cultivar Marquette which received immediate and wide acceptance in Wisconsin. Resistance was controlled by multiple factors.

Resistance to lettuce downy mildew was discovered in two lettuce PIs, especially PI 164937 which was resistant to all Wisconsin races of the pathogen. Resistance was controlled by a single dominant gene. No *Bremia lactucae* spores formed in continuous light, but if inoculated plants were given six hours of darkness for seven days after inoculation good symptoms and signs developed. Resistance to lettuce white mold has also been sought among 178 PIs in field studies. Five PIs were resistant, all of them having raised growth habit, so possibly no physiological resistance was involved. A conductivity assay was developed for measuring pathogen virulence. A leaf blight and vascular wilt of lettuce was found in the United States for the first time, incited by *Pythium tracheiphilum* which attacks the xylem in stem and root.

CHAPTER 9

Forest Pathology

Robert F. Patton

On February 10, 1959, a meeting of the seven members of the forest pathology staff was held. The agenda included such topics as the upcoming Wisconsin Conservation Department (WCD) Forest Insect and Disease Training School, a forest pathology seminar for the second semester, assistantship assignments, the annual report for 1958, budgetary procedures, and a variety of miscellaneous matters. This was typical of group meetings for administrative purposes held from about 1958 and on into the early 1960s. By 1960 the group had seven full-time members, including six faculty and one U.S. Forest Service researcher assigned to the Department of Plant Pathology, ten graduate research assistants, two civil service technicians, and a stenographer. We were operating two summer research field stations and maintained five vehicles. Our budget allocation of $55,300 from the Wisconsin Conservation Department was the largest in the history of the program, and the 1960–61 WCD budget of $176,500 for all forestry research projects in the Agricultural Experiment Station was the peak year for funding the University of Wisconsin–WCD cooperative forestry research program. At this time the department's forest pathology research group was almost certainly the largest concentration of researchers in forest pathology at any institution or research station in the country. How had such a program developed? This chapter reviews some of the highlights of the beginning and course of development of research in forest pathology in this department. It is primarily concerned with people and institutions, and with support and facilities for the research projects—a few highlights of some research topics are given, but a summary and evaluation of the research are not attempted here.

MANAGEMENT OF WISCONSIN'S FOREST RESOURCE

Wisconsin's commercial forests occupy 14½ million acres, about 43 percent of the land area of the state. Forest-dependent industries are the second largest manufacturer in the state and thus comprise a significant portion of the state's economy.

The early explorers in Wisconsin—Nicolet, Groseilliers, Radisson, and Perrot—had the impression of limitless wealth. But by the early 1860s, logging was proceeding at an alarming rate and in 1867 a committee of three leading citizens submitted their report to the legislature on the "disastrous effects of destruction of forest trees now going on so rapidly". The first really professional estimate was the 1898 report by Filibert Roth, of the U.S. Department of Agriculture (USDA), on forestry conditions of northern Wisconsin, submitted to the Forestry Commission that had been established by the legislature in 1897. In 1903 a state Forest Commission was created and in 1905, upon revision of the forestry law, a Board of Forestry was established. University officials were active on this board, including the College of Agriculture Deans W. A. Henry and H. L. Russell, until 1915, when it was abolished. In 1915 the aggressively expanding forestry program was declared unconstitutional because of a "fatal infirmity" in its establishment. As a result, a new Conservation Commission was organized with a division of forestry, and in 1927 the Conservation Commission was reorganized heading a state Conservation Department (WCD) which still later became the present Department of Natural Resources (DNR).

Two gigantic steps forward in management of the state forest resource were the passage of the forest crop law for private and county forests in 1927 and zoning legislation in 1929. These bills helped create an environment for forestry research and education that stems all the way back to Increase A. Lapham who in 1867 submitted suggestions for a bill that would include advising on scientific experiments to ascertain the best methods of growing and managing forest trees.

THE BEGINNING OF FORESTRY RESEARCH AT THE UNIVERSITY OF WISCONSIN

After the period of forest exploitation in the late 1800s and early 1900s, there was great interest in clearing the land of stumps and making farms, and Dean Russell was a great proponent of using this land for farms. But the widespread agricultural depression in the 1920s, the massive tax delinquency problem in the north, the difficulties of establishing farms on the clearcuts, and a growing interest in reforestation of the cutover lands led even Dean Russell to change his position. In the fall of 1927 a research program on timber-growing possibilities of the state, and the means for their efficient development, was initiated officially by the Wisconsin Agricultural Experiment Station, in cooperation with the U.S. Forest Service Lake States Forest Experiment Station and the Wisconsin Conservation Commission. Raphael Zon, director of the Forest Service Experiment Station, also served as professor of forestry on the staff of the University of Wisconsin and was in charge of all the forestry research in the state. Projects included weather and forest fire hazard, forest growth in response to swamp drainage, and productivity of woodlots and pine plantations in the scrub oak land of central Wisconsin.

THE ORIGIN OF THE UW–CONSERVATION COMMISSION COOPERATIVE FORESTRY RESEARCH PROGRAM

A cooperative program for forestry research between the University of Wisconsin Agricultural Experiment Station and the Wisconsin Conservation Commission began in 1933. This program has its origins in problems associated with forest nursery soils, and the first work under such an arrangement was done by S. A. Wilde of the Department of Soil Science, whose salary was paid for five months of the year by WCD for at least a couple of years. An invitation to WCD administrators and a number of university personnel in April 1934 from the Department of Soil Science to view the results of Wilde's experiments, including some work on causal organisms and chemical control of the damping-off disease, was received by Professor George W. Keitt and was surely seen by Professor A. J. Riker.

A BACKGROUND FOR FORESTRY RESEARCH IN THE DEPARTMENT

It was natural that research on tree diseases would follow soon after initiation of a forestry research program in the college, for L. R. Jones had close association with forestry and forestry research. He was an organizer and president of the Vermont Forestry Association, and the L. R. Jones State Forest of Vermont was named in recognition of his services to forestry. In 1925 he was appointed chairman of a special committee of the National Academy of Sciences on Forestry Problems in the United States, and his report suggested a stimulation of forestry research. A subcommittee was appointed on the status and needs of research in forestry, and there were two substantial accomplishments from his Committee on Forestry Research, which reported in November 1930: I. W. Bailey and H. A. Spoehr's book, *The Role of Research in the Development of Forestry in North America,* published in 1929, and the establishment of a grant of $25,000 annually to the National Research Council for research fellowships in forestry and agriculture. As chairman of the department, Jones apparently assigned to Riker responsibility for forest diseases—presumably Jones believed this to be a natural consequence of Riker's experience with trees and nursery problems through his experience on crown gall and hairy root, and also that such a responsibility would keep Riker on the staff.

INCEPTION OF THE FOREST PATHOLOGY RESEARCH PROGRAM

Forest pathology research at Wisconsin was initiated by Riker. Although he became known internationally for his leadership in forest pathology, there were no indications in his background and education, or in his early career, that he had any particular interest in forestry. Yet, once he took up the program, he moved it forward with an energy and decisiveness that resulted in its becoming a respected and highly-reputed program the world over.

Riker's education was in botany and bacteriology. He received his A.B. in 1917 in botany at Oberlin College, served as a bacteriologist with the Cincinnati Base Hospital unit overseas in World War I, took an A.M. in 1920 in botany and medical bacteriology at the University of Cincinnati, and obtained his Ph.D. in 1922 in plant pathology at the University of Wisconsin under Keitt. Except for a year of study in 1926–27 in London and Paris as an International Education Board Fellow, he served all of his career in this department from 1922 until his retirement in 1964. After his thesis research on crown gall, he continued work with bacterial diseases, including crown gall and hairy root of apple trees in nurseries. Perhaps it was a natural follow-up on this experience that led him to begin his work in forest tree diseases with a study of damping-off in forest tree nurseries.

THE INITIAL STIMULUS

The time was right—the college was already involved in forestry research—Wilde's work in forest nurseries set a good example—but what was the trigger that set Riker onto a major shift in emphasis in his research?

The initiative seems to have been provided by Fred G. Wilson of the Wisconsin Conservation Department, superintendent of the Cooperative Forestry Division. Wilson, who began his career in forestry in Wisconsin in 1911, served the Wisconsin Conservation Department as a forest ranger from 1911 to 1915 and in various capacities from 1930 until his retirement in 1952.

Wilson was familiar with university capabilities. He was the first extension forester at the university, serving from 1925 to 1930, when he returned to the WCD. While he was at the university he authored the important report of the Interim Committee on Forestry and Public Lands to the Wisconsin legislature in 1929, in which were included recommendations for forestry research and management. In 1933 the WCD employed Wilde to help with their nursery soils problems. By this time also WCD was funding their own program of "research" on pheasant breeding, and they had brought problems with fish rearing to the university and were considering research on fur-bearing animals. The emphasis on reforestation and the beginnings of state and county forest development led to discussions of research in forestry by the WCD—active in these discussions were Wilson and C. L. Harrington, superintendent of Forests and Parks. Wilson insisted that the WCD could not fund an adequate research program of its own, but instead should put money into the University of Wisconsin Agricultural Experiment Station. It was decided to consider research on forest tree diseases—damping-off was a problem in the forest nurseries, there were problems of establishment of new plantations, and the state was already engaged in a program of control of white pine blister rust. Apparently Wilson went to Riker, or was directed to Riker, and Riker agreed to help. Thus began the cooperative forestry research program between the College of Agriculture and the state Conservation Commission that has continued to this day.

I have found no record of the date of Wilson's contact with Riker. In a conversation I taped with Wilson on February 21, 1985 from which some of the statements above were drawn, he was vague about the date, but it must have been in late 1935 or early 1936. On the department's budget request for 1936–37 is listed an assistant (half time)—"to assist A. J. Riker on forest disease problems"—along with a typed note, "Confer Noble Clark".

THE BEGINNING YEARS—1936 and 1937

Records are sparse for this period, but from the flurry of activity that resulted in 1937, the year 1936 must have been one for consultation, making contacts, deciding upon projects, planning a field season, obtaining an assistant—all the decisions necessary in embarking upon a completely different area of research than had been followed previously.

Research on the Damping-Off Disease

Riker's first graduate assistant was Lewis F. Roth, who had just graduated from Miami University (Ohio) with a B.A. in botany in the spring of 1936. In reply to a query from Roth on the status of his application for an assistantship in this department, Keitt replied on April 20, 1936 that Wisconsin Alumni Research Foundation fellowships all had been assigned. Keitt must have mentioned this to Riker, for on April 22 Riker wrote to Roth indicating the prospect of an opening. Apparently a new assistantship for research on forest tree diseases was being requested. Roth visited Wisconsin in May 1936, and subsequent correspondence from Keitt, in Riker's absence, indicated that budget decisions by the Board of Regents were unusually prolonged. Finally, Roth was appointed as an assistant, beginning August 1, 1936 and his first full field season on the damping-off disease in the Central State Nursery (later named the E. M. Griffith Nursery) at Wisconsin Rapids was the summer of 1937. Travel funds for support of the project were sought and apparently obtained for 1936–37 and for subsequent years to about 1940 from the Wisconsin Conservation Commission. Roth continued on his assistantship for his first three years. In his fourth and final year, as the first ranking graduate student in the department, he was appointed department fellow for 1939–40. Some time after Roth arrived in Madison, Riker told him, "I've bitten off more than I can chew. I want you to help me chew it". That was the beginning of forest pathology research in this department.

With this start—one half-time assistant, an interest in beginning forest tree disease research expressed by the Conservation Commission through Wilson's contact, and minimal financial support for travel expenses from WCD for beginning the research—the stimulus was provided for defining projects and beginning research. Later, funds from WCD would be more substantial and provide a stable base on which the future program would develop and continue to the present.

White Pine Blister Rust Resistance

In the early 1930s, leaders in Wisconsin's white pine blister rust control organization were interested in why white pine blister rust infection occurred in some areas and not in others, and also why in some areas with a high incidence of blister rust some trees did not become infected. During the period 1935 to 1941, seven permanent pine infection study plots were established. T. F. Kouba, the USDA state leader, recalled in a taped conversation with me on March 7, 1985 that he determined to ask for help on this problem from the Department of Plant Pathology and was referred to Riker. This seems to have been in 1936 apparently soon after Riker's contacts with WCD, but an apparently unrelated instance. Riker agreed it was something he would want to look into, and with joint trips by Riker and Kouba to these infection plots, the project was underway by 1937.

Typical of Riker's conduct of his research programs was his immediate consultation with the "experts" in the field. He enlisted advice and cooperation from Carl Hartley, Lee Hutchins, and C. Audrey Richards of the USDA Division of Forest Pathology; H. N. Putnam, the USDA regional leader for white pine blister rust control; W. G. McKay of McKay's Nursery; and the Holton and Kunkel Co. of Milwaukee and later the D. Hill Nursery Co. of Dundee, Illinois, for preparing white pine grafts.

The first apparently resistant selections were made in 1938 and another group in 1939. Cones were collected and seed were sown in the Central State Nursery, which was under the supervision of Superintendent W. H. Brener. As the forest pathology program developed, Brener proved to be a sympathetic friend and supporter, and an invaluable cooperator, especially as we established a field station on the grounds of his nursery. Scions also were collected and grafts were made, first by Roth and subsequently by the Holton and Kunkel Co. Then a site for planting the seedlings and grafts had to be found. At Brener's suggestion the cooperation of F. G. Kilp, chief forester for the Nekoosa-Edwards Paper Co. (Nepco), was obtained, and Riker and Kouba located a suitable tract of land on Ten-Mile Creek in Wood County on Nepco's property. Kilp arranged to have the land leased to the state (WCD), and planting of the Blister Rust Nursery began in the fall of 1940. The project continued until 1964 when resistant materials were turned over to the U.S. Forest Service at the time that agency took up a development program for white pine blister rust resistance for the Lake States and Eastern Region of the United States.

First Annual Reports

In the Annual Report of the Agricultural Experiment Station (1938) for research up to November 30, 1937, the first published report of the forest tree disease project appears. During 1937 a preliminary survey of certain forestry problems was made by Riker in cooperation with the USDA and the Wisconsin Conservation Commission. The dying of oak trees in southern and western Wisconsin had been noticed for some time. Investigations started (possibly as early as 1936) at the University Arboretum in cooperation with G. W. Longenecker (Department of Horticulture) and the Public Works Administration, whereby areas were mapped to trace progress of the disease, were the beginning of research on the disease later to be known as oak wilt. The damping-off research by Riker and Roth in cooperation with Wilde and Brener included studies of factors affecting incidence and development as well as various control trials. Promising prospects were seen in the development of disease-resistant trees, especially white pine against the blister rust disease and poplars against decay and canker organisms. The possibilities of vegetative propagation of forest trees by cuttings with the aid of plant hormones was considered. Preliminary trials also suggested the use of wax emulsion sprays to increase survival of transplants in plantations.

By 1938, cooperation with C. Audrey Richards of the Forest Products Lab was well underway on the cause of the dying of oak trees, selections had been made of apparently resistant white pine trees in cooperation with Kouba of the USDA, and cuttings of a number of hybrid poplars had been imported from Maine, Michigan, and Canada and a promising local strain had been selected.

EARLY YEARS OF PROGRAM ESTABLISHMENT—TO 1940

Riker's Interest in Forestry Development

The initiation of a research program on forest diseases also marks the beginning of Riker's marked influence on the future development of forestry activities in the university. As a member of the Committee on Forestry, Riker had significant input in the preparation of the 1938 bulletin in the Science Inquiry series, *The University and Wisconsin Forestry.* This report recommended a program for forestry for the state, including disease and insect control. With research considered to be the function of the university, numerous subjects were suggested for attention, including forest and nursery tree diseases and tree improvement.

Continuing Progress

In 1938 Riker's disease project was identified as number 569 and was included for funding as a Bankhead-Jones federal project. When Roth was appointed departmental fellow, R. H. Gruenhagen was appointed to the released assistantship in 1938 to continue work on damping-off and to assist in the poplar project.

This was a period for trying to increase funding for the program as well as expanding the research efforts. In a letter to Wilson on April 10, 1939, Riker reported progress along lines discussed earlier with Wilson and Harrington of WCD, such as stimulation of seed germination with hormones, the damping-off work, use of wax emulsions to reduce transpiration from transplants, and cooperative work with Richards at the Forest Products Laboratory on the possibility that the oak dying was caused by a virus. Attention was directed also to a disease in the Coon Valley area on Scots and white pines caused by *Sphaeropsis ellisii.* Riker indicated also that he was attempting to prepare a statement of some forestry research problems the university might well consider. In May 1939 Riker submitted such a statement on the forest disease situation with the budget request to the dean for 1939–40. This statement drew on his progress reports for 1937 and 1938 and on his contributions to the 1938 report by the Committee on Forestry referred to above. Additional background on his suggestions for future work on hormones in vegetative propagation was given by his reference that this was based on a study he did at the California Institute of Technology in the winter of 1937–38.

His first graduate student, Roth, received his Ph.D. in June 1940. A second student, Lloyd J. Meuli, also received his degree at the same time and had joined Riker's forest disease program by a rather circuitous route. Meuli had received his M.S. in plant pathology in 1933 (under Jones), held a research assistantship under Richards at the Forest Products Laboratory, and then went on to a temporary appointment with the U.S. Forest Service at the Lake States Forest Experiment Station in 1934. When the position closed, he returned to Madison and in the fall of 1938 began work with Riker on use of hormones in cuttings, protection of plants against drought injury by wax emulsion sprays, the hybrid poplar project, and finally on the disease of pines caused by

Sphaeropsis ellisii (now known as *Diplodia pinea* or *Sphaeropsis sapinea*), which served as his thesis problem. All during this period WCD provided annual funds for travel expenses in the range of about $250–400, and labor and facilities at the Wisconsin Rapids nursery estimated at a value of $500.

THE 1940s—ESTABLISHING AND STABILIZING FUNDING

Not Only "What" But "Who" One Knows

This chronology of increased funding for Riker's forest tree disease projects exemplifies his masterful abilities in working with people in positions of importance and his persuasiveness in explaining the importance of the work and his needs for support and cooperation. The growth of the forest pathology program over the years was due in large measure to his qualities of leadership and insight which made it possible, with the help of many cooperators, for things to happen along lines he first defined.

Presumably through his earlier research on crown gall and hairy root on fruit trees in nurseries, he had already developed strong ties with nurserymen and the Wisconsin Nursery Association. Surely he had discussed his new projects with W. G. McKay, the president of McKay Nursery Co., for in a letter of November 29, 1940 to Governor Julius Heil and the Board of Regents of the University of Wisconsin, McKay discussed the importance of tree disease problems to Wisconsin forestry, mentioning Riker's work and indicating that it was limited because of insufficient funds. He stated also that "the Wisconsin Nurserymen's Association at the annual convention in Milwaukee on February 7, 1940 passed a resolution asking for an appropriation of $5000 annually to be used for the continuation and the enlargement of the work now started by Doctor Riker". Apparently Governor Heil forwarded this letter to the Conservation Commission. On December 20, 1940 McKay followed up on a conversation he had with Conservation Commissioner W. J. Aberg at the Madison Club, concerning research on trees in Wisconsin, with a letter to Aberg noting that Dean Christensen of the College of Agriculture was much in sympathy with Riker's undertaking and would appreciate an appropriation from the Conservation Department. On December 27, 1940 Wilson, apparently responding to correspondence turned over to him by Aberg, replied to Aberg, indicating that H. W. MacKenzie, director of the Wisconsin Conservation Department, believed that the WCD should actively support the request, to give protection to the state's forests and plantations as much as was possible and practicable. Wilson suggested that funding alternatives might be to work for a specific appropriation to the University Agricultural Experiment Station or to contribute WCD forestry department funds under their agreement for cooperation with the college. At the February 19, 1941 meeting of the Wisconsin Conservation Commission, Wilson was instructed to contact Riker, which he did on March 5. On March 10 Riker submitted a list of projects for authorization, and on March 12 Wilson submitted this list and reported to Director MacKenzie on the results of his discussions with Riker and Noble Clark, associate director of the Agricultural Experiment Station. The projects listed in the order of their priority were: 1) white pine blister rust resistance—selection, testing, and vegetative propagation; 2) root and butt rot of pine—with reference to the influence of planting methods and plantation care; 3) oak wilt—study the cause; 4) poplar canker—test promising poplars for resistance to canker and watersoaking; 5) cedar-apple rust—to provide a source of resistant trees for southern Wisconsin. At its March 19, 1941 meeting the Conservation Commission authorized the Conservation Department to allocate approximately $5800 for the University of Wisconsin for tree disease research. On April 4, 1941 Director MacKenzie stated in a letter to McKay that because McKay had initiated consideration of a more extensive program of research on tree diseases, MacKenzie was transmitting two pages from the minutes of the Conservation Commission meeting of March 19, 1941 so that McKay would know the official action of the Commission.

This action marked the beginning of annual allocations of funds for forestry research to the Wisconsin Agricultural Experiment Station from the Conservation Commission. This stable source of funding allowed long-term planning within the cooperative forestry research program, and made possible later expansion to projects in entomology, genetics, and a number of special areas in forestry, as well as the work in plant pathology and soils. These funds, in turn, came from the Wisconsin forestry mill tax, which for a long period provided a dependable source of income that permitted the development of forestry activities within the state by the Conservation Department.

Program Expansion

As a result of this first major allocation of funds by the WCD to the tree disease project, Berch Henry was appointed an instructor to assist Riker in research on tree diseases. After receiving his Ph.D. in June 1941 under Riker on a crown gall problem, Henry took responsibility for work on oak wilt, white pine blister rust, and a survey of root rot in pine plantations. By 1942 oak wilt was first named as a specific disease caused by a still unidentified fungus, and by October 1943, when Henry left on military leave, he had identified the fungus that caused oak wilt (naming the imperfect stage as *Chalara quercina*). From his cooperative work with Richards and C. S. Moses, he was able to suggest (in a 1944 publication) that localized spread of oak wilt might occur through root grafts.

In the meantime Gruenhagen accepted the assistantship vacated by Roth's appointment as departmental fellow, continuing work on damping-off and also diseases of poplars, particularly the

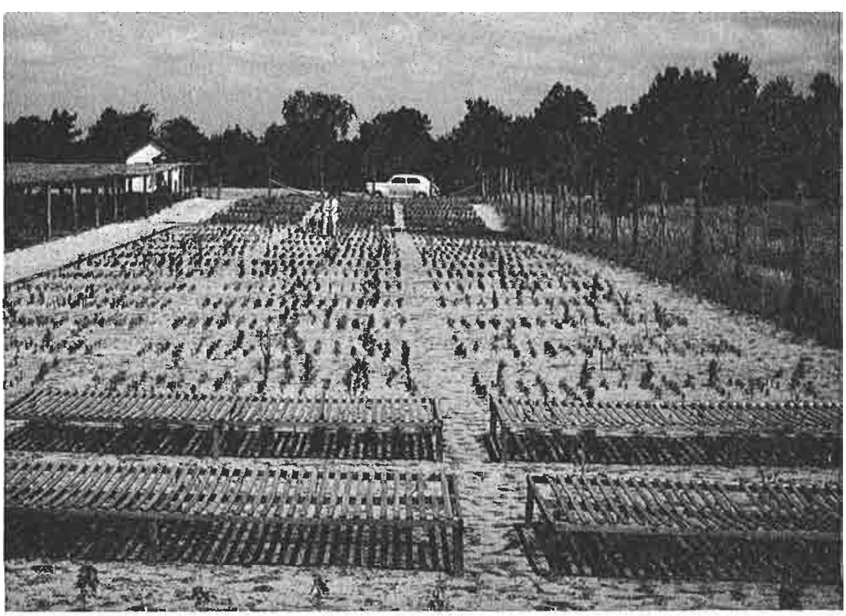


Figure 9.1 A. J. Riker sitting on weather instrument shelter in pine blister rust nursery, 1942.

Hypoxylon canker of aspen. Also, by 1942, resistance of red cedar to cedar-apple rust had been taken on as a project at the suggestion of Aldo Leopold. Planting of the Blister Rust Nursery was completed for the first major test of resistance to white pine blister rust.

At this time special summer salary appropriations had to be included in the budgets. Riker's summer work entailed direction of research on forest and nursery tree diseases and on crown gall, "including advisory relations and extension work of the department on forest and nursery tree diseases".

In 1944 the WCD budget continued at $5155. Director Ernest Swift of the WCD suggested this would have to increase but that expansion would have to wait until after the war (WW II).

Since 1941, jack pine and red pine trees in northeast Wisconsin had been dying from a malady in which there was an association of the Saratoga spittle bug and a fungus. A field laboratory was established for research on this problem in 1944 and 1945 near Phelps, Wisconsin. The research of Gruenhagen, Riker, and Richards on this problem, which they named "burn blight", identified the fungus as *Chilonectria cucurbitula.* Although the involvement of both an insect and a fungus led to considerable controversy between pathologists and entomologists over the cause of the problem, it probably was more important as a factor in the developing need for research on forest insects. By 1945 and 1946, considerations were being given to the expansion of the cooperative forestry research program. Riker's influence on forestry research again was expressed in 1945 in a letter to Noble Clark pressing for the hiring of an entomologist by the WCD on the same basis on which they had provided a pathologist (Henry, later replaced by Gruenhagen after award of his Ph.D. in 1944). The Coordinating Committee on Forestry Research in Wisconsin, set up to administer the UW-WCD cooperative forestry research program, at its first meeting on April 5, 1946 recommended that a forest entomologist be hired, effective July 1, 1946. In August, 1946, R. D. Shenefelt arrived as forest entomologist in the Department of Entomology. It was Riker who took him in early September on an orientation trip to northern Wisconsin and to meet Brener at the Griffith Nursery in Wisconsin Rapids.

In 1945 another recruit from Riker's crown gall program was John E. Thomas, appointed as instructor on July 1, 1945 for tree disease research, the use of chemical growth stimulants, and chemical weed control, a completely new field. This position delayed completion of his Ph.D. until June, 1947, when he became assistant professor. By 1945 Riker had two full-time pathologists built into his program, and for a while Gordon Grimm served as a research assistant.

Henry did not return to Wisconsin after his military leave, and resigned on April 8, 1946. This left an opening which was offered to Roth, but by that time Roth felt he was becoming established well enough at Oregon State University in Corvallis, and so he refused. This cleared the way for James E. Kuntz to change from a vegetable pathologist to a forest pathologist. Kuntz received his Ph.D. under J. C. Walker in 1945, worked for the Wisconsin Cabbage Seed Co. in Racine as a plant breeder and plant propagator and then, accepting an offer from Riker to join his program, became assistant professor on November 1, 1946. His immediate primary responsibilities were the projects concerned with oak wilt, the development of hybrid poplars for rapid growth and disease resistance, and the use of chemical herbicides for weed control in nurseries, plantations, and later forest firelanes. He pursued all of these projects vigorously for the major part of his career in the forest pathology program, and developed others also as the program grew.

For the 1946–47 year, the WCD budget for forest pathology received an increase to $13,300 in acknowledgment of the expanding needs, and this allowed the addition of two research assistants, Robert F. Patton who began on April 1, 1947 and Carl H. Beckman in June. Those assistantship appointments then resulted in our spending many, many hours together riding the buses between the campus and Badger Village, student housing units at the Ordnance Plant near Baraboo. Also, we were all, including Irvin Lloyd, a student assistant, soon engaged in helping Kuntz plant poplars on the Gugel, South Hill, and other farms on which Riker had requested some seventeen acres for forestry work. Two vehicles were available, on loan from the USDA. By now the WCD budget for forestry research was considered as stable as funds appropriated to the university by the legislature. Also in that year, 1947, Lee Hutchins, head of the USDA Division of Forest Pathology, was so impressed by the quality of Riker's program that he suggested Riker take a three or four week trip that summer at USDA's expense, to some of the major forest pathology laboratories and Forest Service experiment stations in the West, especially to discuss white pine blister rust resistance, and tree breeding and propagation. We incorporated slides from his trip in our photographic slide file, and they are still being used at the present time in classes and seminars in forest pathology. Our first technical assistant, Harold Clemens, was hired on the project this year. The disease projects were classified now under two numbers, 569 on forest tree diseases, and 608 for development of blister rust-resistant white pines. Oak wilt research was largely centered on efforts to control local spread. New strains of hybrid poplars were continually being imported and established by cuttings in test plantations. White pine blister rust resistance was largely centered around progeny testing at the Blister Rust Nursery and on methods for vegetative propagation, especially by rooted cuttings. Weed control in nurseries and forest plantings, including the poplar test plantations, by the use of newly developed chemical herbicides, was felt to be as important in establishment and growth of trees as disease control.

The next major addition to the cooperative forestry research program was tree improvement and forest genetics in 1948 under the supervision of R. A. Brink in the Department of Genetics. Since forest genetics was just beginning as a discipline within forestry, the decision was to bring in a forester who would develop a program in forest tree improvement and at the same time work toward his Ph.D. degree in genetics. In July, 1948, Robert G. Hitt arrived to begin this aspect of the work. With research in four major areas and a budget this year of $46,913 for forestry research, WCD assigned a liaison representative for coordination of the research program, and Alan Haukom was the first in this position.

In 1949 the USDA Division of Forest Pathology initiated a program of research on diseases that affect forest management in the Lake States. Research was to be in cooperation with the Lake States Forest Experiment Station of the U.S. Forest Service, and *Hypoxylon* canker of aspen was chosen as the first problem for study. To facilitate the work a Lake States Forest Pathology Advisory Committee was appointed, of which Riker was a member.

The latter part of the 1949–50 fiscal year brought another change in the forest pathology group with the resignation of Thomas on April 15, 1950.

THE 1950s—A PERIOD OF EXPANSION

The decade of the 1950s was a period of rapid expansion of the staff and research programs culminating in a peak in 1959 of some twenty researchers and the largest annual allocation of WCD funds of all time for tree disease research.

The period is epitomized by developments in the oak wilt project. By 1949 the causal fungus had been identified, but little was known of spread of the pathogen, although there seemed to be slow local spread attributed by the Wisconsin group to transmission through root grafts, and an unpredictable long-distance overland spread by unknown means. The disease seemed to be primarily a threat to forests and woodlots of the Upper Mississippi Valley region. But the year 1950 marked a change in attitude, and the disease suddenly became of national importance. Oak wilt was reported in Ohio, Pennsylvania, and Arkansas. The apparent southward spread into Arkansas seemed to threaten the large and economically important oak forests in the south central and southern areas. One article in a trade journal even reported its spreading at fifty miles per hour! The Division of Forest Pathology began a series of surveys to map its distribution. In 1951 the National Oak Wilt Research Committee was formed under the sponsorship of ten trade associations representing industries dependent upon oak. With the advice and assistance of an advisory committee of plant pathologists under Riker as chairman and Kuntz as secretary, the oak wilt committee charted an intensive three-year research program at a cost of about $210,000, designed to supplement research already underway. This made possible considerable expansion of the research program in the Midwest.

Riker's association with leaders in the oak industry led to a friendship with, among others, Samuel M. Nickey of Nickey Brothers, Inc. in Memphis, Tennessee. This, in turn, led to the donation by Mr. Nickey in a gesture of friendship and esteem for Professor Riker of the distinctive oak paneling which covers the walls of the A. J. Riker Conference Room in 594 Russell Laboratories as a memorial to Mrs. (Helen B.) Riker.

The local spread of the oak wilt fungus through root grafts, suggested by earlier work, was proved and reported by Kuntz and Riker in 1950, and the role of insects in long distance spread was reported by McMullen, Drake, and Kuntz in publications in 1955 and 1957.

In 1950 also, a grant from the Atomic Energy Commission for research on transmission of nutrients and fungi through root grafts permitted considerable expansion of the oak wilt project. Beckman was appointed a project associate and new research assistants were John G. Berbee, John R. Parmeter, and B. H. Osterhage (who withdrew from school on November 30). Flora Berbee also was employed as a summer assistant on oak wilt research.

Progress was continuing in other areas as well. Keith R. Shea entered as a new research assistant on *Hypoxylon* canker, and W. A. Porter, who had been working on environmental relations of different spore states of the white pine blister rust fungus under Riker, received his M.S. degree and returned to Victoria, B.C., to continue work there on white pine blister rust. The vacancy left by the resignation of Thomas was filled in September, 1950 by Patton, who was appointed an instructor with major responsibility for the white pine blister rust resistance project. This work somewhat delayed my continuing work on *Armillaria* root rot and on needle droop of red pine, but upon completion of the Ph.D. thesis in January, 1952, I became assistant professor. Perhaps a personal aside may be of interest here—for I think coincidence and serendipity often appear in research. As a junior in forestry at the University of Michigan, I visited Madison in the spring of 1939 on a field trip to the Forest Products Laboratory with Dow V. Baxter's class in forest products pathology. An almost incidental side trip was a quick view of a greenhouse full of grafted white pines for a project on white pine blister rust resistance—and if Riker's name was mentioned, I didn't recognize or remember it. Certainly there was no inkling then that one day it would be me filling a greenhouse with grafted white pines for that same project, as I did in the 1950s. Another addition to the group was Eugene P. Van Arsdel who began graduate work on white pine blister rust in February, 1951. The early contacts by Riker with Kouba, H. N. Putnam, and others in the blister rust control organization indicated that climatic effects were somehow important in white pine blister rust distribution. Van Arsdel completed his Ph.D. thesis on this topic in June, 1954, and after two years of military service, returned as a U.S. Forest Service employee, but stationed in the department to continue his studies of microclimate and blister rust infection as a member of our forest pathology research group. His work had a major influence in the subsequent recommendations for control of white pine blister rust, particularly in the Lake States region.

The final addition to the group in 1950 was Allan E. Troemner who began as a Conservation Aid I on March 15. Troemner served our group faithfully and dependably for over thirty-one years, much of this time as a Gardener II. Illness forced him to retire on June 30, 1981, and he died of cancer on October 17, 1981. He assisted at one time or another in essentially all of the forest pathology projects which were active during his period of service.

ASSOCIATED TOPICS OF CONCERN DURING DEVELOPMENT OF THE PROGRAM

Forest Pest Detection and Control

Considerable interest and discussion of needs for forest insect research and control resulted in the initiation of forest insect research, as noted above, but there was still a desire in forestry groups in the state for a forest insect control program—insect damage was much more obvious than the less spectacular losses resulting from diseases, and early attention was given to insect control. An early move was the transfer of Norbert B. Underwood from the WCD Division of Forests and Parks to the Division of Cooperative Forestry, effective January 1, 1950, to be a forester-entomologist stationed at Griffith Nursery. His assignment was the detection and control of insect infestations which theatened the forests. Following a conference on this topic sponsored by the WCD in October 1951 at Eagle River, a survey and control plan for forest insects was established in 1953 by Harrington, acting state forester of the WCD. This was under supervision of Superintendent of the Cooperative Forestry Division S. W. Welsh. In charge was Underwood, forest entomologist, still at Griffith Nursery. Forest entomologists, with responsibility also for pathology, were assigned eventually to four areas in the state. In 1956, Donald W. Renlund became the forest entomologist in charge and was headquartered in Madison. During this time our group had lobbied long and hard for pathology to be represented in this unit. In 1959 a new insect and disease control laboratory was built on WCD's Nevin Fish Hatchery grounds with space for forest entomologists and one forest pathologist. With encouragement from our group, Allen J. Prey took leave from his position as a forester with WCD, and began graduate work in this department on September 1, 1959. Before completing his work he returned to WCD, first classified as a forest entomologist and finally as the first forest pathologist. He received the M.S. degree in February, 1963 for his work under Kuntz on detection and appraisal survey procedures for the *Eutypella* canker of maple. During his years as forest pathologist with the unit he served almost as our extension forest pathologist, and from the very beginning of organization of this unit we have had very close and beneficial working relationships with all members of the group. Renlund retired as supervisor in February 1983 and Prey succeeded him as supervisor of Forest Pest Management in July 1983. In the meantime Jane Zarnstorff (now Cummings) did graduate work in the department, with her thesis problem related to forest nursery diseases supervised by Berbee. Cummings worked as a technician for Prey's group, and received her M.S. in 1983. She then replaced Prey as the forest pathologist in the forest pest management group in March 1984.

Field Stations and Laboratories

All of the early work in forest pathology entailed considerable travel and field work. Even though travel expenses in those days were low, so also were our budgets. (My travel expense records for the 1950s show charges for dinner less than $1.50 and lodging at hotels and motels no more than $2–$4!). Often we tried to stay at locations where there were WCD Ranger Stations. In those days many of the stations had a room with a few angle-iron bunk beds—and, if we were lucky, even sheets and hot water!

The first field laboratory was the temporary one established near Phelps for the research on the "burn blight" problem in 1944 and 1945.

Griffith Nursery at Wisconsin Rapids was the location for the first tree disease project, and it served as a center for much of our future research needs, including housing, laboratory and storage facilities, and experimental plots. In 1950, with the dismantling of the temporary housing units established at Camp Randall for the influx of veterans after World War II, Riker obtained several of these expandable "house trailers". These were moved by the WCD to a site provided by Brener at the north end of Griffith Nursery. After nursery personnel put them in place and provided electricity to each trailer, Berbee and Beckman supplemented their training in pathology by installing the water system. Surplus furniture was moved from the closing Badger Village site near Baraboo, and in May and June of 1951 the first occupants were the Beckmans, Berbees, and Pattons in three of the trailers. The fourth was used as a laboratory. We had cold running water, outdoor "facilities", and showers in the basement of the old sidecamp office building. A regular Saturday morning chore for several years was to take the trash to the dump near Nepco Lake and to re-fill the ice boxes with ice cut from Nepco Lake the previous winter by the nursery crew. This was packed in sawdust for use in cooling nursery stock lifted for the spring planting season. As the program grew, we ended up with seven trailers for married faculty and graduate students; the sidecamp office was used as the bachelor's quarters for from four to six graduate students and summer helpers. Gradually other facilities were added: an office, a workshop, various storage buildings, and a better laboratory than we had in Madison—and servicing all this was a fleet of five vehicles.

In the 1960s, and particularly after our move into Russell Laboratories in 1964, our projects and priorities began to change. The trailers began to deteriorate at an ever increasing rate—first one was removed, in 1973 two more, and by 1976 all but the trailer long used by Kuntz. Finally this was removed in 1981 to make room for a new packing shed for the nursery. The laboratory and shop are still available though used only sporadically.

When the station at Wisconsin Rapids was in its early years, and during the period of rapid expansion of the program, it was a favorite goal, along with the Blister Rust Nursery, oak wilt spread and control plots, and numerous other field experiment areas, for Riker to bring visitors on weekend "show-me" trips. These included cooperators and consultants from the USDA Division of Forest Pathology such as J. R. Hansbrough, Carl Hartley, and Lee Hutchins; forest pathologists such as Dow Baxter, Lake Gill, and Ralph Anderson; numerous officers in the white pine blister rust control organization such as Kouba, Putnam, J. Kroeber, W. Benedict, C. Wessela, and others; and a number of other visiting pathologists from across the nation and several foreign countries. Even Roth came wandering through the Blister Rust Nursery late one evening to see the change that had occurred since he had first helped Riker in its establishment!

In 1958 with the initiation of research on the maple "blight" outbreak, David R. Houston used laboratory facilities in the Goodman High School and later established a small nursery and an insect-proof screen house on Goodman Lumber Co. land in Florence county.

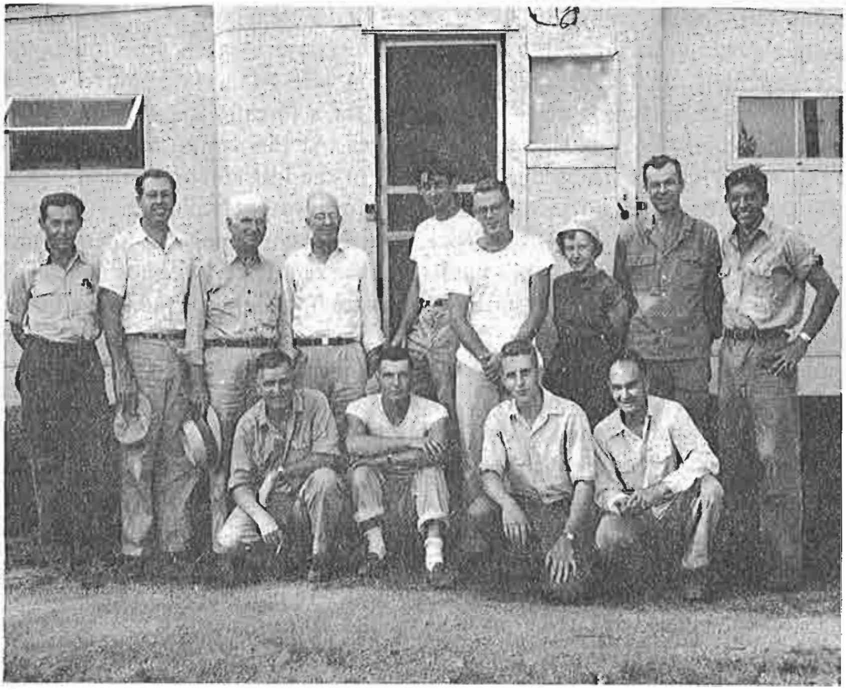


Figure 9.2 Forest pathology crew and visitors at field station, Wisconsin Rapids, 1953.
Back (L-R) R. L. Anderson, R. F. Patton, L. M. Hutchins, A. J. Riker, J. G. Berbee, D. Cruger, F. Berbee, C. R. Drake, J. E. Kuntz
Front (L-R) J. R. Hansborough, J. R. Parmeter, D. Minerva, A. E. Troemner

In 1959 another field station was converted from the old Star Lake Ranger Station situated on the site of the famous Star Lake plantation in Vilas County. The house became living quarters for research assistants Ronald E. Wall and Rodney C. De Groot, and the garage served as a laboratory for the two years when decay of aspen was being investigated in the area.

The other field laboratory still extant is at Kemp Biological Station. This beautiful site bearing several log buildings on Tomahawk Lake a few miles from Minocqua was deeded to the university by two sisters, Sally Spencer Greenleaf and Susan Spencer Small, on December 7, 1960. In the summer of 1961 a laboratory was established in the garage building by Kuntz and Houston. It was used first to aid in the completion of research on maple blight. Since then it has served as a valuable field laboratory for research on a number of tree diseases, including *Eutypella* canker of maple and *Armillaria* root rot.

Space Problems

Space seems to be a problem that inevitably must be faced with any research project and particularly as the program is expanding. By the 1950s space was a major concern for the entire cooperative forestry research program. There were numerous wide-ranging discussions among a variety of persons in authoritative positions. A conference of university and WCD officials on November 28, 1950 was called for discussion of the possibility of WCD supplying funds for urgently needed greenhouses. On December 30, 1953 Noble Clark contacted D. C. Everest of Marathon Corporation (a strong supporter of the cooperative forestry research program) and apparently received encouragement. In 1954 there was discussion with Alan Haukom, the research liaison representative of WCD, including even a suggestion for a forestry department, with offices and laboratories for new personnel as well as greenhouses. At the same time, however, there were discussions in forestry circles which finally resulted in the introduction in 1957 of a bill in the legislature for establishment of a research laboratory for forestry in northern Wisconsin, a rather competitive situation. Also in 1957, Dean Froker chaired a conference on forestry research facilities at the university with pulp and paper industry representatives, and they were shown space in T-17/T-18 which, it was indicated, might be adapted temporarily for the immediate needs. (We had requested space in T-18 as early as the budget message for the 1953–55 biennium.) This conference must have done the trick and we occupied T-18 in the spring of 1958. Aaron Bohrod, the college's Artist in Residence, and his studio were in the east end; Roy Nicholls of Veterinary Science and a fistulated cow shared space in the west end; and plant pathology occupied the middle. Forest pathology members included Berbee, Eugene B. Smalley, Houston, and Van Arsdel—we shared space with Paul Williams, Don Boone's students, and Gerald Thorne and his group of nematologists. About this same time, the "dog house" cold storage facility and equipment storage room was made available in cooperation with forestry and wildlife management in an old building at the far west end of the campus. By 1960 planning for the new Russell Laboratories was under way. When construction began in mid August 1962 on the site occupied by T-17/T-18, the forest pathology group from T-18 moved to space previously occupied by the University Extension Division in the basement of the Home Economics Building—no laboratory facilities, no gas, no plumbing, and for a while a very chaotic situation. But this all came to an end when we moved into Russell Laboratories in October 1964.

Seminars and Formal Courses

As our research group grew in size, and there was no formal course work in forest pathology, we felt an increasing need for a means of keeping abreast of forest pathology developments throughout the country and, indeed, the world. The first forest pathology non-credit seminar or discussion group was organized for the academic year 1953–54. Often a definite theme or topic was considered for the entire period, and usually a mimeographed syllabus was prepared. In the second semester of 1959–60, forest pathology was the topic of the department's regular seminar under the guidance of Patton. In 1963 we changed the format to a noon discussion group centered around research reviews by members of our own group or guests. After the move into Russell Laboratories, this activity has continued, with an occasional lapse, more or less regularly to the present time.

The history of courses in tree diseases goes back a long way. The first course seems to have been Plant Pathology 115—Diseases of Special Crops: b) Diseases of Timber, and Forest Protection, announced in the College of Agriculture catalog for 1913–14. This was offered by C. J. Humphrey as lecturer in the department, during the period that he was in charge of the Section of Pathology at the Forest Products Laboratory. This course became PP 119—Diseases of Timber and Forest Protection in 1916–17 and continued to 1925–26 when it was listed with the instructor as R. H. Colley. This offering continued until 1929–30, when Richards headed the section at the Forest Products Laboratory, also with an appointment as lecturer in this department. This course offering continued until 1935–36 when it was re-named as Fungus Deterioration of Forest Products. In 1952–54, R. M. Lindgren took over as the lecturer. The course was given by T. C. Scheffer in 1959–60, and also as PP 619 in spring 1964 and fall 1967. For the latter two offerings, because of federal "red tape", Scheffer provided the instruction and Patton served as course "administrator". It became PP 515 in 1972, but was not given again, and the course title was dropped in 1977.

In 1961 a new course was organized under Plant Pathology 113—Diseases of Forest and Shade Trees by Patton. This was first offered in 1961 and has continued since then on an every-other-year basis. In fall 1963 this became PP 613, and in fall 1969 it became PP 510—Forest Pathology, which it is at the present time.

A third course is Plant Pathology 500—Insects and Diseases in Forest Resource Management. This was first organized in 1971 by pathologist Berbee and entomologist D. M. Benjamin. This course (as well as PP 510) is jointly listed under the Department of Forestry and is the basic course in forest insects and diseases taken by the forestry students.

FOREST INSECT AND DISEASE TRAINING SCHOOLS FOR WCD

A series of forest insect and disease training schools was sponsored by the WCD for their field foresters, and members of the forest pathology and forest entomology research groups in the university were called upon as instructors. The first of these was in March 1953 and a series of eight of these was held annually, except for 1957, through 1961. In 1961 we participated in a seminar for industrial foresters in the Lake States. In 1970 a ninth school also was held. After 1961, the emphasis was changed more to on-site training of small groups of foresters in their local areas, and this instruction then was handled by the WCD pest management group.

DEPARTMENT OF FORESTRY ESTABLISHED

At the Wisconsin Commercial Forestry Conference held in 1928 in Milwaukee, the findings in the official report included a statement of support for forest research and that ". . . the natural course will be the establishment of a full-time course in Forestry as a part of the College of Agriculture, if not a College of Forestry". The report of the Committee on Forestry of 1938, however, did not affirm this view, and recommended an emphasis on forestry research, but stated, ". . . it would not be wise to establish a school of forestry now". With the increasing emphasis on forestry research up to the 1950s, growing attention was given to coordination of all the activity. On February 18, 1953 the report of the Special Committee on Forestry in the College of Agriculture, chaired by Riker, appeared, with the recommendation that a department of forestry be established to unify forestry research, extension, and associated teaching. The emphasis still, however, was on research and not toward establishment of a professional school or college of forestry. In 1954 a new Department of Forestry and Wildlife Management was created. In 1962 a separate Department of Forestry was established, in which all members of the forest pathology group in plant pathology held joint membership. In 1967 the School of Natural Resources was initiated within the College of Agricultural and Life Sciences, comprised of forestry, wildlife ecology, landscape architecture and a number of special centers. During the fiscal year 1967–68, Patton served as acting chairman of forestry.

Annual Reports

During the period of expansion in the 1950s and the first half of the subsequent decade, annual reports of tree disease projects were compiled into one summary report for the entire forest pathology program. This compilation served as the required annual progress reports both to the dean's office as well as to the WCD. But at this time we also sent out copies to numerous cooperators and interested personnel and agencies. The reports gradually increased in size and amount of detail, so that by 1960 our report comprised 60 pages. In 1966 the Department of Forestry began issuing a compilation of brief annual reports of all projects in the university's cooperative forestry research program, and this replaced our former, more detailed compilations of forest pathology projects only.

FACULTY, STUDENTS, AND ACTIVITIES IN THE 1950s

By the end of 1950, the faculty members were Riker, Kuntz, and Patton. Beckman was a project associate; research assistants were Berbee and Shea, and Troemner was our civil service technician. In 1951 Parmeter and Arnold F. Ross began graduate study on the oak wilt project, and Van Arsdel began his white pine blister rust studies. A grant to Riker and Kuntz from the Atomic Energy Commission was a boon to research on oak wilt. Charles R. Drake entered also on oak wilt in 1952, and after major epidemics had flared up again in 1950 and 1951 at Griffith Nursery, Berbee began work to control damping-off by seed pelleting. Radioactive tracers were being used by Beckman in a variety of experiments on movement of materials in the transpiration stream. Histopathological studies of Professor Burdean E. Struckmeyer in horticulture implicated tyloses in the mechanism of wilting in oak wilt. By January 1952 Patton had completed his Ph.D. thesis and was promoted to assistant professor. In June 1953 Don Minore began graduate work but did not complete his first year in plant pathology. Beckman also completed his Ph.D. in 1953 and left the project. Ross left to become a high school teacher without completing his work, but returned in the summers of 1960 and 1961 and received his M.S. in September 1962. In May 1954 Shea completed his Ph.D. and became assistant professor with major responsibility for carrying on the poplar improvement and disease resistance project. Van Arsdel completed his Ph.D. on microclimate and blister rust distribution, continuing on until September 1954, when he left to spend two years as a biologist with the U.S. Army. Funding for oak wilt now included regional federal funds, and a Regional Oak Wilt Research Committee was established. The late summer saw the first report of maple dieback in the Wausau area, and weed control trials were extended into pulpwood storage yards. James Hoffman was on an assistantship from July to September 1954, but resigned to accept a job. In September, James E. Nighswander began as Patton's first graduate student on a study of the eastern gall rust on jack pine. The WCD budget was continuing to increase slowly and had reached $30,808 for the 1955–56 year. After Van Arsdel completed his Ph.D., the project on microclimatic relations of white pine blister rust came under joint sponsorship of the U.S. Forest Service and the university's Agricultural Experiment Station; after completing his Ph.D. in 1955, Parmeter was hired by the U.S. Forest Serice to remain and continue the project. During the summer and fall of 1955 three new graduate students arrived: Houston and W. Robert Phelps to work on oak wilt, and Toshio Sasaki from the University of Tokyo to work on *Hypoxylon* canker of aspen. During the summer Violet Drake assisted Kuntz on oak wilt research in the laboratory at Wisconsin Rapids.

The year 1956 brought a new WCD research coordinator, Donald Mackie, and also a new Forestry Research Agreement between the Conservation Commission and the university, which indicated research support was to continue indefinitely on projects mutually agreed upon. The emphasis on mutual agreement was an omen of difficulties for us some years in the future! That summer we put Jan Houston and James Olson (from botany) to work at our lab at "the Rapids". Shea resigned from the faculty July 31, 1956 to become a forest pathologist for Weyerhaeuser, and Drake was awarded his Ph.D. that June. During the summer we began exploratory examinations of a new jack pine plantation decline, and Marcel Lortie from Canada began his graduate work with studies of the maple dieback problem. Ellis Cowling began research on the mechanisms of wood decay by fungal enzymes, a return to cooperation with the Forest Products Lab, whereby they funded a graduate assistantship with research supervision by Scheffer and academic supervision by Riker. In September 1956 Van Arsdel returned to the department on assignment by the Forest Service and Parmeter left for California.

The year 1957 brought two additions to the faculty. After the first appearance of Dutch elm disease (DED) in the state in 1956, special funds were appropriated by legislative action for a position on DED research and Smalley came as assistant professor on June 10, 1957. The vacancy in the poplar improvement project resulting from Shea's resignation was filled by Berbee, who returned to Wisconsin on July 1, 1957 after three years with the Canada Department of Agriculture at Fredericton, New Brunswick. Harland Burmeister began research on the jack pine decline problem, but resigned in February 1958.

In late 1957, from September through November, James and Helen Kuntz visited pathologists and forestry researchers in Europe on a trip to eleven countries, where they acquired information on forest pathology, tree genetics, and silviculture, and established contacts with scientists at leading universities and forestry research stations.

In 1956 and 1957 a sudden dying of maples in Florence County woodlands was noted, different from the maple dieback problem around Wausau, and finally termed "maple blight". The potential threat of this disease, the cause of which was unknown, to extensive stands of northern hardwoods in Wisconsin and adjacent Lake States prompted immediate attention of several cooperating research agencies. An Action Committee meeting in January 1958 took the first steps in organizing a cooperative research and survey program. The hardwood industry provided some financial support, the Lake States Forest Experiment Station coordinated the effort, and this department assumed responsibility for research to determine whether any pathogens were involved. Under guidance of Kuntz and Riker, Houston transferred from oak wilt, was appointed instructor on May 1, 1958, and began research in the Goodman area. The cooperative investigations later showed that insect defoliation was the principle factor in causation, but Houston showed that *Armillaria mellea* aggravated the condition of affected trees, increased immediate mortality, and accounted for most of the delayed mortality.

In 1958 Phelps received his Ph.D., Masako Sasaki helped on oak wilt research in the summer at the Wisconsin Rapids station, and we added several new graduate assistants: Thomas F. Geary (oak wilt), Albert F. Kais (DED), Richard G. Krebill (jack pine decline), Jerry W. Riffle (maple dieback) and Ronald E. Wall (aspen decay). During 1958 a twig dieback on red and jack pine in Bayfield County was first observed. This was probably the first appearance of *Scleroderris* pine canker. A new stringy bark canker of poplar was noted to be caused by a *Fusarium* species. Aerial surveys of the distribution of oak wilt had now disclosed a well-defined northern limit to the disease.

By 1959 our WCD allocation reached the all-time peak of $55,300. In this year three students completed Ph.D. degrees: Cowling, Nighswander, and Sasaki. New students were De Groot (aspen decay), V. M. G. Nair from India (oak wilt), Prey (*Eutypella* canker survey), and Peter A. Theisen, who spent only a summer and the fall semester, 1959, on gall rust research and then resigned to join the Forest Service. This year relocation of poplars on the old Gugel Farm was necessitated by sale of the university's Hill Farms and this went on through 1961. During later real estate development, some of the lots brought premium prices as "wooded" lots because of their location on our former hybrid poplar plantings! The year 1959 was a highlight also in Riker's developing interest in internationally dangerous tree diseases and particularly in ways of preventing their movement from one country to another. As a member of the International Union of Forestry Research Organization's (IUFRO) Working Group on Foreign Tree Diseases, he obtained a Haight Travelling Fellowship from the university and visited pathologists, foresters, forest geneticists, and quarantine officials in sixteen countries of Europe, Southeast Asia, and the South Pacific in the period August 18, 1959 to February 3, 1960. His observations shed light on critical international forest tree disease problems.

By the end of the 1950s a variety of research topics were in progress: oak wilt physiology and histopathology; control of local oak wilt spread by sodium arsenite and fumigants; evaluations of thirty superior lines of hybrid poplars, and variability in progenies from breeding trials; hybridization of eastern white pines with other related species to increase blister rust resistance; phenological and climatic influences on blister rust distribution; an on-site consultation with Ross Davidson from the USDA lab at Beltsville on the jack pine decline (root rot?) problem; indications of the relation of defoliation to maple "blight"; implication of a possible role of nematodes in maple "dieback" (with Thorne); and studies of cankers and decays in northern hardwoods and aspen.

A PERIOD OF CONSOLIDATION AND RETRENCHMENT—THE 1960s

With the beginning of a new decade at hand the forest pathology group continued to add new members. James B. Thornton was added to assist in the ever-increasing amount of work in the greenhouse, nursery, and field plots. Office work also was increasing, and we were able to include Mrs. R. A. (Gladys) Smith as a Steno III in our WCD Budget. In 1960, new research assistants were: Geoffrey C. Marks (aspen shoot blight), John D. Rogers (*Hypoxylon* canker of aspen), and Wayne W. Wilcox, who succeeded Cowling on the Forest Products Laboratory assistantship to develop optical techniques for locating and measuring the amount of cell wall dissolution in the wood decay process. This year De Groot completed his M.S. degree under Kuntz. The year saw the largest-ever WCD budget for cooperative forestry research ($176,500) in the college, and our largest annual forest pathology report. The project on weed control with chemical herbicides was now in cooperation with Theodore T. Kozlowski and had been moved to forestry and wildlife management for administration.

The beginning of this decade also saw a major change in emphasis by the WCD toward support of applied research on specific problems of current interest and away from long term basic research. A letter from Chief State Forester John Beale indicated that support for the white pine blister rust resistance project would be cut drastically to a maintenance basis ($2100). This drastic reduction in the WCD budget was the beginning of a steady decline. At the time of this writing in 1985 the program again is faced with further severe reductions because of the cuts in federal appropriations that are received by the state for forestry purposes. With curtailment of WCD's support for the blister rust resistance project there was also the "suggestion" for enlargement of the project on plantation diseases. At the same time the WCD indicated that it no longer wished to support the oak wilt and poplar improvement projects, although it was willing to provide some field assistance, land, and other facilities for basic research projects to which WCD funds were not directly allocated. This change in emphasis was a severe blow to our entire research program and meant major changes in the mode of operation and funding of our projects over the next several years.

Fortunately for the blister rust project, this cut in support came at the time when the project had reached a stage for evaluation and large-scale development. It appeared that the latter course was not within the university's financial capabilities, and we suggested that the U.S. Forest Service take it over. We summarized our results in several reports. Riker conferred with V. L. Harper, deputy chief of research in the U.S. Forest Service, and finally the Forest Service agreed to begin white pine blister rust resistance work in 1964 under the supervision of the Regional Office in Milwaukee, which is the situation at the present time. Thus we gave to the Forest Service essential resistant material we had accumulated since the project began, and the famous Blister Rust Nursery was abandoned. The Forest Service began a development program on a large scale, and Patton continued "back-up" basic research on the infection process and mechanisms of resistance.

Other developments in 1961 included the award of the Ph.D. degree to Houston and his promotion to assistant professor as he continued work on "maple blight"; receipt of the M.S. degree by Al Kais; and return of Prey to WCD. He became the first forest pathologist in the state's forest pest management unit. Riker reported to the 13th Congress of IUFRO in Vienna on recommendations for control of internationally dangerous tree diseases which came from his extensive trip the previous year.

In 1962 the NC-22 project on oak wilt terminated; the final report listed fifty-four Wisconsin publications on oak wilt between 1953 and 1961. Also, the WCD withdrew support of oak wilt research, and the work had to be continued on a reduced scale with other sources of funding. This was a big year for degrees: the Ph.D. to Geary, Krebill, Lortie, Riffle, and Wall; and the M.S. to Ross. New graduate students were Rodney Johnson (nursery transplant mortality), Denis Lachance (*Eutypella* canker), Dilbagh Singh (DED), and W. Thomas McGrath (gall rust on jack pine). An emergency concerning nursery transplant mortality, especially of red pine and spruce, peaked in July. With no general agreement as to its cause, Berbee volunteered to investigate it. With help from Johnson and Thornton he determined this to be the result of *Cylindrocladium* root rot, a new disease for our Wisconsin nurseries. This year also William D. Brener conducted under Kuntz's direction a survey of urban maple decline, which had been attracting increasing attention. Riker continued his study of internationally dangerous tree diseases, and with the aid of another Haight Travelling Fellowship and a grant from the Rockefeller Foundation he visited twelve countries in Latin America from November 27, 1962 to April 25, 1963. His interest in this area culminated with his and Kuntz's active participation in the Food and Agriculture Organization (FAO)/IUFRO Symposium on Internationally Dangerous Forest Diseases and Insects held in July, 1964 at Oxford, England.

In September 1962 Van Arsdel was transferred to the Forest Service Experiment Station in St. Paul, and along with Houston's resignation, this returned the faculty list to the core of five: Berbee, Kuntz, Patton, Riker, and Smalley.

The report for 1963 listed six major recommendations made by Riker from his Latin American trip. During 1963–64 we had a project assistant, Mrs. Davinderjit Bagga, for research on *Hypoxylon* canker with Berbee, and two postdoctorates, D. Kumar on root diseases with Patton and Nair on oak wilt, after he received his Ph.D. in 1964 under Kuntz. Two of our students received their Ph.D. degrees in 1963: Geoffrey Marks and Jack Rogers. Two new students were Carl G. Iverson (decay of aspen—Kuntz) and Thomas H. Nicholls (*Coleosporium* needle rust and white pine blister rust—Patton). Leo Haakenson was added to our civil service group as Seasonal Farm Laborer II to assist Smalley with his increasing elm collections at the Arlington Farm. The WCD affirmed that funds included in the budget for oak wilt should be reassigned as soon as possible. Progress was continuing on all projects—for example, by now Nekoosa-Edwards Paper Co. had substituted chemical herbicides entirely for mechanical preparation and maintenance of over 100 miles of firelanes on their forest properties, as a direct result of the work by Kuntz and his colleagues.

In 1964 forestry research was stimulated by the availability of funds from the new McIntire-Stennis Cooperative Forestry Research Program administered by the USDA. By 1967 Kuntz had an oak wilt project and Patton had one on plantation root rots. This new source of federal funding came at a time when WCD was having financial problems in the state. The forestry mill tax increase had failed to pass in a recent state-wide referendum and we were warned in April 1964 that cuts were possible and that no WCD funds could be expected for additional appointments or new projects. The state financial situation was reviewed with all forestry researchers by John Beale, chief state forester, who predicted a 10 percent cut for 1965–66. For the 1965–67 biennial budget requests, R. J. Muckenhirn, associate director of the Agricultural Experiment Station and our liaison with the WCD, emhasized the need for greater priority in departmental support for the forestry research staff. Efforts to reduce staff salaries on WCD funds were considered, and there was even the possibility that we would lose one of our civil service positions. This year, Thomas H. Rausch became the WCD liaison research coordinator and has continued his active support of the forestry research program to the present.

In June 1964, Riker retired to professor emeritus status, and the program was without the leader who had initiated it almost thirty years before. In spite of this, and our financial problems with WCD, we had a vigorous group: four faculty, three civil service technicians, one stenographer, two postdoctorates, and eight graduate research assistants. New students in 1964 were Bagga (*Hypoxylon*), Horace T. Bone (herbicides), Donald T. Myren (plantation root rot) and Walter C. Thies (*Cylindrocladium* root rot). In the fall of 1964 the university began its project with the University of Ife in Nigeria to develop its College of Agriculture, and Berbee was the first from our department to serve on that project (Chapter 24). During his tenure there he served for a while as acting dean of the college, taught courses in plant pathology and several other areas, began a research program, and assisted in many other ways in developing a faculty of agriculture. By this time Berbee's preliminary results on fumigation for control of *Cylindrocladium* root rot in the nursery were released by Prey of WCD for use by area nursery personnel. Fumigation of nurseries soon became a standard procedure, thus eliminating the need for seed pelleting, which had been introduced also by Berbee's research years before. When Berbee left for Nigeria, supervision of Thies and the continuing *Cylindrocladium* root rot project was assumed by Patton. Degrees awarded in 1964 were the Ph.D. to Nair and Wilcox and the M.S. to Nicholls.

In 1965 the funding for DED research was incorporated as a non-lapsing appropriation through the College of Agricultural and Life Sciences to the Departments of Entomology and Plant Pathology. The marked reduction predicted the previous year for the 1965–66 WCD budget did indeed occur, and the WCD budgets for forestry research were now entitled Supplements to the Forestry Research Agreement of 1956. When Arthur Kelman arrived as the new chairman for the department, he found he had to relinquish active research in, but not his interest and support for, forest pathology. He did supervise Rebecca Gettens, beginning in 1965, for the M.S. degree as the last of the students in pathology supported in the cooperative arrangement with the Forest Products Laboratory. David W. Johnson came on as a project assistant concerned with the infection process in white pine blister rust.

Going into the fiscal year 1966–67 Dean Pound noted that we were in a period of rapid technological advances and this meant a constant evaluation and review of programs. Forest pathology projects were listed under at least eight separate Experiment Station project numbers and included, for example, the following topics: oak wilt—host-parasite interactions on the microscopic level, and chemicals in disease control (Nair); DED—pathogenesis and significance of nitrogenous compounds (Singh); *Eutypella* canker of maple—life cycle, inoculations (Lachance); *Fomes igniarius* decay of aspen—biology of infection (Iverson); *Hypoxylon* canker of aspen—pathogenicity and variability of the pathogen (Bagga); poplar plantation evaluations (Kuntz and Lester, in Berbee's absence); *Cylindrocladium* root rot—epidemiology and control (Thies); herbicides in forest practice—effects on microorganisms in forest soils (Bone), and continued trials of effectiveness in nurseries, plantations, and firelanes; white pine blister rust—infection studies (Johnson, Esther Nelson, and Pritam Singh, a new postdoctorate); plantation root rots—*Polyporus tomentosus* in red pine (Myren), and growth of *P. tomentosus* in soil (Kumar, who left in June 1966); and eastern gall rust of jack pine—epidemiology, and also identification and distribution of the western gall rust in Wisconsin (McGrath). The year 1966 also saw the completion of the Ph.D. degree by Lachance.

In 1967 there was still no increase in the WCD budget, and WCD requested that all or a goodly portion of Gladys Smith's salary be transferred to state funds. McIntire-Stennis funds provided some of the salary for Kuntz and Patton, giving some relief to the strain on the WCD budget. In this year Iverson and McGrath received the Ph.D. degree and Gettens the M.S. New personnel included Kaare Venn from the Norwegian Forest Research Institute on a Kellog Foundation fellowship. Venn worked for one year with Kuntz to widen his research skills and experience in forest pathology. Graduate assistants were Johnson, now with Kuntz on *Eutypella* canker, and John Pronos on plantation root rots under Patton. Smalley had Paul Taylor as a graduate assistant in cooperation with biochemistry, and also Caroline Whitman, a project assistant, both on DED research; Smalley initiated cooperation in breeding of elms for resistance with the forest genetics specialist in the Department of Forestry in 1967, first with D. T. Lester and later with R. P. Guries. During 1967–68 Patton served as acting chairman of the Department of Forestry, and during part of this period had assistance in white pine blister rust studies by Pritam Singh and Mrs. Ambuja Pillai on postdoctorate appointments.

In 1968 Berbee returned to the department after completing a six-month study leave working on tree viruses at Oxford University, England, following the completion of his service in Nigeria. He initiated a research project on forest tree viruses, beginning with electron microscopy for detection of virus particles in sap from conifers, with Pillai as a postdoctorate. The oak wilt project had Nair as a research associate; after Nair joined the faculty of the University of Wisconsin–Green Bay, he continued his cooperation with Kuntz on various aspects of oak wilt and later, along with some of his students, on histopathology of butternut canker. Oak wilt research also benefited at this time from the cooperation with Irving Sachs of the Forest Products Laboratory, as well as work by Selma Sachs as a part-time project assistant. This year Dilbagh Singh returned just long enough to receive his Ph.D. degree. New graduate assistants were Everett M. Hansen (white pine blister rust), John T. Kliejunas (*Eutypella* canker), David O. TeBeest (oak wilt) and James C. Ward, a non-degree student with Kuntz from the Forest Products Laboratory, whose work led him into a study of bacterial wetwood of hardwoods. We were still having WCD budget problems—in the first three months all WCD funds were either committed (salaries) or gone, and with $8.91 left in our operations budget we still had nine months to go! At this time, Kuntz had an instructional improvement grant for Plant Pathology 300, and he had Robert Nelson as a teaching assistant—this was not forest pathology, although there were benefits in both directions.

The end of the decade, 1969, brought continuing progress on all projects. The budget negotiations with WCD were now being handled largely through Associate Dean Stephen Smith, School of Natural Resources, although we still had our annual budget meetings with Tom Rausch and sometimes other representatives of the WCD. New directions appeared in several projects: Patton began to study needle diseases in conifer plantations; Berbee began cooperation with the Forest Products Laboratory in pulping characteristics of his poplar hybrids and consideration of poplar silage forestry; the first attention was given to butternut canker; and Kuntz started work on black walnut root rot in the nursery. In time, butternut canker and diseases of *Juglans* species became the major emphasis in Kuntz's program. Two students obtained their Ph.D.'s this year: Myren and Thies. John Pronos was called to military service in November, during the Viet Nam war, but returned in 1971. New graduate assistants were Patrick Fenn (oak wilt), Alan R. Gotlieb (forest tree viruses), and Henry L. Gross, on leave from the Canadian Forestry Service to improve upon forest disease survey procedures and impact assessment through his research on the sweet-fern rust of jack pine. Two students, Andre Lalonde and David H. Reynolds, began but later resigned.

THE 1970s—STEADY PROGRESS, BUT A DECLINE IN BUDGET

The year 1970 was notable largely for some temporary staff changes. The Kuntzes went to Nigeria on September 1, where Jim served as chairman of the Plant Science Department at the University of Ife. William MacDonald came from Iowa State University on a postdoctorate appointment to supervise Kuntz's projects, and Edson C. Setliff joined Patton's research program on plantation root rots. Bone completed his Ph.D.

In 1971 the Department of Natural Resources (DNR, formerly WCD) budget was still $37,120, essentially the same for the seventh consecutive year. The publications account was eliminated and there was further stress on individual budgets. Kuntz was still in Nigeria, and on August 31 the Pattons left for Cambridge University, England, on a study leave. Setliff continued Patton's program. During the year, Ph.D's were awarded to Johnson and Kliejunas. When MacDonald left for a permanent job in West Virginia in mid year, Kliejunas then continued as a project associate on Kuntz's projects to June 30, 1972. New graduate assistants were Asimina Gkinis from Greece (DED) and Soetrisno Hadi from Indonesia (*Cylindrocladium* on white pine). Flora Berbee grew hybrid poplar plants freed from viruses by their development from stem-tip callus cultures in Jack Berbee's poplar project.

In 1972, budget restrictions again began to be felt throughout the state. The DNR budget received a 2 percent reduction in the forestry research program. Also, Governor Lucey proposed a 5 percent productivity cut for the university for the 1973–75 biennium. The DNR proposed a cut of $50,000 in the 1973–75 forestry research budget, which meant a "double whammy" to forestry research through cuts both in DNR and regular state funds. The outlook for the future was aptly described in a quotation included in one of Dean Pound's letters to the faculty: "Optimists say the 1970s will be bad; the 1980s will be worse". Regardless of the financial prospects, the Kuntzes and the Pattons happily returned in the fall from their overseas stays. Another returnee was Pronos after his military service, and he began research on *Armillaria* root rot in pine plantations resulting from conversion of low-grade oak stands. Hansen completed his Ph.D. even before Patton's return, but Setliff continued on his postdoctorate work, now concerned with brown spot of pines in the cooperative project with the U.S. Forest Service and Al Kais of the Southern Forest Experiment Station. A new graduate assistant this year on DED research was Wayne Nishijima.

Our DNR budget took a steep dive in 1973, down to $22,911, and the overall forestry research budget was only $85,000, quite a change from the $176,000 in the peak year of 1960! With reductions in available funds, the DNR screened projects even more rigorously than in the past, but our recommendations seemed to be well in accord with their perception of their needs. The forest pathology group prepared a report on its status for the plant pathology departmental Long-range Planning Committee, the first of several that subsequently were requested for program reviews or future planning. New graduate research assistants were Michael A. Albers (mycorrhizal protection against root rot) and David Pengelly (began on oak wilt, but later transferred to the Water Resources program). Dorene Setliff worked as a research associate on Patton's white pine blister rust project, but the Setliffs left in April when Ed accepted a position at the Cary Arboretum in New York. Kuntz initiated research on urban forestry problems, establishing a maple nursery at Arlington Experimental Farms, and authored a fact sheet with Gayle Worf on urban maple decline. Mrs. Smith could no longer be supported with DNR funds, and she became one of the department's secretaries on state funds. Fortunately, the possibility of losing either Troemner or Thornton did not materialize. Research on Dutch elm disease was making good progress and was helped for several years by grants from the Elm Research Institute. Large-scale trials of fungicidal control by sprays or tree injections were conducted in cooperation with Milwaukee and adjacent municipalities. Smalley's 'Sapporo Autumn Gold' resistant elm became available for trials on a small scale and would be available commercially in 1975 through assistance from the Wisconsin Alumni Research Foundation (WARF).

In 1974 three students received Ph.D. degrees: Gotlieb, Hadi, and TeBeest, who remained with Kuntz's projects until March 1975. Jerry Davis from the University of Wisconsin–LaCrosse was working as a postdoctorate with Smalley, and Russell Spear joined Patton's program as a specialist in January. A revised memorandum of understanding (October 16) between the Natural Resources Board and the University of Wisconsin System came into effect, and again we met with John Beale and DNR staff on research priorities.

By 1975 the trailers at the Griffith Nursery were deteriorating and had about outlived their usefulness. Much of the other space had to be vacated, but we retained the laboratory, and the Kuntzes still occupied their trailer on an occasional basis. This year Fenn received the Ph.D. degree, and three new graduate research assistants entered: Charles M. Kenerley (*Sirococcus* shoot blight, but resigned after one semester); Robert R. Martin (poplar viruses); and Vincent O. Otoide from Nigeria (*Armillaria* root rot in aspen sprouts). Susanne Jutte, a visiting scientist from the Netherlands at the Forest Products Laboratory, worked with Kuntz on the histopathology of butternut canker. This year a new damping-off disease was appearing in the nurseries, and the fumigation treatment usually applied to control damping-off and seedling root rots apparently was ineffective.

The next four years, through 1979 and the end of the decade, was a period for steady research progress, with no major crises to affect the program. In 1976, Ph.D. degrees were earned by Gross and Pronos and M.S. degrees by Albers and Otoide. New research assistants were Steven R. Bassett (urban maple decline) and John Castello (poplar viruses). The variation seen in tissue-cultured subclones of poplars raised the question of feasibility of using tissue culture to achieve increases of genetically identical stock for tree improvement purposes. In 1977 two more Ph.D.'s were awarded: Gkinis and Nishijima, both from Smalley's DED program. Peter V. Blenis arrived from Canada to begin work under Patton's supervision on the cooperative research program on *Scleroderris* pine canker that was organized by the U.S. Forest Service North Central Forest Experiment Station under Darroll D. Skilling and Thomas H. Nicholls. Other new students were Jane Cummings (previously Zarnstorff) and Jeffrey G. Wischer on nursery disease problems with Berbee, and Gale McGranahan on elm leaf spot disease under Smally cooperating with Guries in forestry. This year S. H. Mai was a postdoctorate on Smalley's DED program. During these years Kuntz was decreasing his emphasis on oak wilt, with some attention to the significance of wounds in spread of oak wilt among white and bur oaks and to continuation of trials on control by chemotherapy. At the same time his interest in the diseases of *Juglans* species was increasing, especially with research on butternut canker and several diseases of black walnut. Castello received his Ph.D. for his work on tobacco mosaic virus in poplar in 1978. This year was also when that tongue-twisting appellation was first applied by Nair and Kuntz to the butternut canker pathogen, *Sirococcus clavigignenti-juglandacearum,* although it was not officially published until the following year. Nicola Luisi (from Italy) was a visiting scientist working with Kuntz on butternut canker. In 1979 Martin completed his Ph.D. on a potyvirus from poplars, and Bassett finished his work on the impact of urban maple decline for the M.S. degree. New research assistants were Michael J. Drilias (collar rot in maple decline), Scott R. Simmons (the new damping-off disease—*Fusarium?*), Lewis P. Orchard (resistance to butternut canker), and Ned A. Tisserat (epidemiology of butternut canker). Also, Kuntz supervised Barbara Stephan in forestry (use of tissue-cultured poplars in urban forestry). Smalley introduced his 'Sapporo Autumn Gold' resistant elm to England and Austria in cooperation with Pitney Bowes, Ltd. through their sponsorship of the "Elms Across Europe" program, and assisted Prince Philip in the planting of one of the elms on the grounds of Windsor Castle. In the white pine blister rust resistance project, Patton and Spear were defining some of the elements of the reduced-needle-lesion-frequency type of resistance.

THE 1980s—THE PROGRAM IN A STATE OF FLUX

The size of our program remained more or less unchanged for twenty years after the retirement of Riker. Numerous well-recognized contributions were made to the understanding and management of forest diseases of Wisconsin. Students went on to make their continuing contributions in the profession according to the tradition of our department. In 1980 Jeanne A. Martin received the M.S degree in forestry, with a thesis on the development of needle lesions in white pine blister rust, supervised by Patton in cooperation with Guries. New students were Glen R. Stanosz (*Armillaria* root rot in aspen) and Eleanor F. Clark (DED). In 1981 three students graduated with M.S. degrees: Simmons, Stephan, and Wischer. A major loss to the group came in October 1981 through the death of Troemner, who had worked in all aspects of our research program for over thirty-one years. This year Patton and Spear identified *Mycosphaerella laricina* as the cause of a new needle disease of European larch in the state, and Drilias and Kuntz identified *Phytophthora* *citricola* as the cause of collar rot of maple, and a possible factor in the urban maple decline syndrome. During 1982 three Ph.D.'s were awarded: Blenis, McGranahan, and Tisserat. Incoming students were Melissa Marosy (*Scleroderris* pine canker) and Janet MacFall (mycorrhizae and control of conifer seedling root rot). On a temporary basis, Troemner's position was upgraded to a specialist classification, and Vicki Radke, who had received her M.S. recently under Craig Grau, was hired until July 1985. A lively addition to the group was Chen Mo-Mei, a visiting scientist from the Chinese Academy of Forest Science in Beijing, sponsored by Smalley. She was a great help to Smalley in his arrangements for a study trip to the People's Republic of China in 1983, from April 22 to August 28. His studies emphasized diseases and problems of elms as he traveled to eight major locations and attempted (unsuccessfully) to detect Dutch elm disease in China. Further progress in DED research was his release of Regal, a new resistant elm cultivar. The large-scale national research program on Scleroderris pine canker culminated also in 1983 in a symposium at Syracuse University where the Wisconsin research was summarized by Blenis (now at University of Alberta) and by Patton and Spear. Orchard received his Ph.D., and Zarnstorff her M.S. degree.

The biggest change in the program since the retirement of Riker came at the end of 1984 when Kuntz officially retired. The word "officially" is used advisedly, since Jim's announced intentions of continuing research on walnut diseases and his activities up to the time of this writing show little evidence of retirement. Since the department decided *not* to fill his position with another forest pathologist, the forest pathology program has returned almost to the same size it was soon after Kuntz accepted Riker's invitation to join it in 1946. Early in 1984, Tisserat left to become an extension plant pathologist in Kansas and Clark completed her M.S. requirements in August. Clark was replaced in Smalley's program on DED by Robert H. Proctor, a student from British Columbia, Canada. Karen Nakasone, after a B.S. at the University of Wisconsin–Madison in 1975 and an M.S. at Arizona in 1977, became a taxonomist in the Center for Forest Mycology Research at the Forest Products Laboratory, and in 1984 began taking coursework for the Ph.D. requirements on a part-time basis.

As this chapter is being written, halfway through 1985, it has been essentially fifty years since Professor Riker began forest pathology research in this department. The first twenty-five years were a period of growth, of building, of expansion—the last twenty-five have been more a period of consolidation and continuing progress and then the beginnings of retrenchment. And yet another period of change is in the offing—no doubt the next twenty-five years will be of still different character.

The group now consists of three faculty members (Berbee, Patton, and Smalley), five graduate research assistants, one part-time graduate student, one specialist, and two civil service field assistants. The present group is here entirely because of the foresight and abilities of A. J. Riker. I can think of no more apt way to describe his relationship to the program than to use the time-worn cliché—he was the right man, in the right place, at the right time.

CHAPTER 10
Field Crops

Deane C. Arny

Before the establishment of the Department of Plant Pathology, there was recognition of the importance of various plant diseases. In the area of field crops, for example, R. A. Moore as "agriculturist" in 1901 pointed out the widespread prevalence of smut in oats, often at 20 to 40 percent infected panicles, and showed with trials that a twenty minute soak of the seed in a formaldehyde solution (one pound in fifty gallons water) would eliminate the smut in the subsequent crop (1901 *Agricultural Experiment Station Annual Report*).

Shortly after the establishment of the department, the 1911 *Annual Report* indicated that the "fungus leaf blight of barley (caused by *Helminthosporium*) known as blade blight caused losses ranging from 25 to 75 percent". The next year, Aaron G. Johnson, then a half-time research assistant, reported that the systemic leaf stripe *(Helminthosporium gramineum)* was the most severe of the barley leaf blights, but that there were two other local diseases that he called "European blotch" *(H. teres)* and "American blotch" *(H. sativum)*. The formalin seed treatment used for covered smut of barley and for oat smut also controlled leaf stripe. A modified hot water seed treatment eliminated smuts and reduced leaf stripe from 20 to less than 1 percent—and, thus, was recommended for a special seed plot. During the summer of 1911, a student, "either Orton or Taubenhaus," was assigned to make a survey of the relative amounts of loose and covered smuts of barley.

Under the guidance of R. A. Harper of botany and L. R. Jones, A. B. Stout had been working on *Sclerotium rhizodes* on *Calamogrostes canadensis* and other grasses, and a research bulletin on the disease was published in 1911. In the summer of 1911, Stout was hired to study diseases of cereals and grasses. The study was "to include a general survey as to the occcurrence and causes of grain diseases and certain grass diseases, giving attention to the leaf blight of oats and other grains *(H. avenae?)*, should this disease appear".

In the 1912 to 1913 *Annual Report,* it is indicated that alfalfa leaf spot was noted frequently and that it was the only disease of importance on alfalfa. In that same year, a note on barley blight investigations suggests that U.S. Department of Agriculture (USDA) support for Johnson on this project was being requested. In the next year, he is listed as an instructor, and travel expenses on the barley project are listed at seventy-five dollars plus ("much more if cooperative with USDA"). In 1914 to 1915 the cooperative relations for Johnson with the Bureau of Plant Industry on barley diseases became effective. He was to teach the plant pathology laboratory course (PP I) and to prepare, with Jones, a popular bulletin on grain diseases (no record of such a bulletin has been found). Johnson received his Ph.D. in 1914 with a thesis on "*Helminthosporium* diseases of barley". He had received his M.S. at Purdue with J. C. Arthur and had earlier worked with Trelease at Washington University in St. Louis.

In 1916, W. H. Tisdale as a research assistant reported that resistance to flax wilt (material probably obtained from Bolley of North Dakota) was inherited as a dominant but that apparently more than one factor was involved. Tisdale noted that in the greenhouse the disease was more severe in flats near heat pipes than in those away from the pipes. He received his Ph.D. in 1917 for his studies on flax wilt. In 1916, Jones, with Johnson and C. S. Reddy, reported on a new bacterial blight of barley and other cereals *(Bacterium translucens)* and F. Coerper began investigations on these diseases in cooperation with E. F. Smith's office in the USDA in addition to her library duties.

Fred R. Jones received his Ph.D. in 1917 with his thesis on "A study of certain alfalfa and clover diseases" and began working for the Cotton, Truck and Forage Crop Disease Investigations Division of the USDA on the pathology of legumes, especially clover. One of his first projects involved the use of the temperature tanks to study the effects of soil temperature on nodulation development in alfalfa, red clover, and cowpea. E. B. Fred, of bacteriology, furnished the inoculants. Jones also was involved for a short time with a study of crown wart of alfalfa in California. In 1924, F. R. Jones discovered the very serious bacterial wilt of alfalfa *(Corynebacterium insidiosum)* in fields in northern Illinois and southern Wisconsin. Throughout his career, F. R. Jones worked on various disease (and at least one insect) problems in alfalfa and clovers. He was involved in later years along with R. A. Brink and L. F. Graber in the development of the important bacterial wilt-resistant variety Vernal.

C. Elliot received her Ph.D. in 1918 with her thesis on "Bacteriosis of oats". She then moved on to Washington with the USDA, to continue working with bacterial diseases of plants.

Beginning in 1918 A. G. Johnson began half-time work in Washington, D.C., and half in Madison, with USDA funds paying three-quarters of his salary. He was to be in charge of a fungi imperfecti project. In that same year J. G. Dickson was appointed agent (half time) with the USDA with the understanding that the university would "appoint him for one-half time service at the same pay for instructional and investigational work in plant pathology". His USDA responsibilities were in "cereal pathology, on grain rust, corn scab and wheat scab investigation". Dickson had a minor in plant pathology with majors in plant physiology with J. B. Overton and agricultural chemistry with Tottingham, and received his Ph.D. in 1921.

In 1918, a USDA Cereal Disease Laboratory was established in the department with Johnson in charge. The chief concerns were the cereal ascomycetes and imperfects. The following year the personnel and responsibilities were listed as follows (Newsletter):

A. G. Johnson—government cereal pathologist in charge—*Helminthosporium* problem.
J. G. Dickson—first assistant—*Fusarium* investigations of wheat and corn.
H. W. Albertz—Ph.D. 1926 (agronomy)—corn disease investigation.
D. Atanasoff—taxonomic phases of *Fusarium* diseases of cereals.
Mrs. L. K. Bartholomew—soil temperature effects on oat smuts.
M. T. Binney—M.S. 1918—seed treatment and supervision of field plots.
L. S. Cheney—field survey of rusts in grains and grasses.
E. M. Gilbert—Ph.D. 1914 (botany, plant pathology minor)—overwintering of rusts.
E. D. Holden—seed treatment and agronomic phases of *Helminthosporium* studies.
Helen Johann—taxonomic phases of *Fusarium.*
W. L. Plaenert—general supervision of greenhouse and field work.
Edith Seymour—M.S. 1920—rusts of grains and grasses (overwintering germination tests)—now transferred to take-all problem in St. Louis.
Grace Wineland—seed treatment and certain phases of the *Fusarium* problem.
C. W. Woodworth—flax breeding with special reference to resistance.
M. C. Zelmer—assistant in the take-all problem.

Later in 1919 a note on the cereal lab included:

R. W. Goss—Ph.D. 1923—take-all problem with H. H. McKiney.
C. S. Reddy—Ph.D. 1923—bacterial diseases of corn.
Edith Seymour—transferred to the oat smut problem with Mrs. Bartholomew.
Atanasoff—returned to Bulgaria.
Binney—employed by Albert Dickenson Seed Co. of Chicago.
G. W. Weber—Ph.D. 1922—did field work with Cereal Department last summer [probably with *Septoria* on oats].
Goss and McKinney have established a large (several square rods) cage for take-all studies. The surface was sprinkled with soil and wheat stubble from take-all fields in Illinois. Winter wheat was then planted in order to observe possible development of the disease.

In about 1918 two federal Adams Fund projects were initiated, both under the leadership of L. R. Jones. Project 12 was on "Cabbage diseases and their control" and Project 13 "Influence of soil temperature upon seedling infection with fungus or bacterial parasites". In the latter project special emphasis was to be given to studies of grain smuts, blights, and scabs, but studies on flax wilt, tobacco root rot, onion smut, onion pink root, and potato black scurf were to be continued. For a number of years part of Dickson's salary came from this project with Jones continuing as leader.

In the early spring of 1919 there was an outbreak of a new wheat disease in Madison County Illinois, and several other areas in Illinois and Indiana. McKinney (M.S. 1920) was appointed by the USDA to conduct research at the University of Wisconsin. The new disease was diagnosed as take-all by the authorities in Madison and in Washington including N. A. Cobb who had experience with the disease in Australia.

To McKinney the disease syndrome differed markedly from that described for take-all. It was clear to him that a mistake had been made and suggested the name "rosette". Jones advised strongly against his trying to resist the "bureaucrats in Washington". Washington finally decided to designate the disease as "so-called take-all". With the appearance of true take-all in several wheat areas, differences were too obvious and the name became wheat rosette (eventually known to be caused by wheat [soil-borne] mosaic virus).

McKinney was able to demonstrate that rosette could be controlled by drenching the soil with formaldehyde, treating with steam, or by means of immune wheats. However, a controversy arose over inclusion bodies that were found in the diseased wheat tissue. The prevailing opinion was that these were protozoa. S. Eckerson of the University of Chicago was hired by the new Boyce Thompson Institute for Plant Research, but while the new laboratories in New York were built she located at the University of Wisconsin, teaching plant microchemistry and conducting research on diseases of cereals. One of her first efforts involved microscopic examinations of living tissue of diseased wheat plants brought to her by McKinney. Eckerson and others were confident that the bodies were protozoa. In spite of considerable resistance from L. R. Jones, E. F. Smith and others, McKinney, Eckerson and R. E. Webb suggested in 1923 that while the intercellular bodies might be living organisms they did not resemble any plant parasite known and that they did resemble cell inclusions of unknown nature in certain animal virus diseases.

Jones disapproved of McKinney's ideas and approaches on several of the wheat rosette episodes, but finally had to agree with McKinney, who was called into Washington in 1923 to continue his work with virus diseases of cereals.

In 1923 Dickson published his well-known paper on the effects of soil temperature on seedling blight of wheat and corn caused by *Gibberella saubinetii.* In wheat, a cool weather plant, blight was favored by relatively high temperatures, but in corn, a warm weather plant, blight was more severe under cool temperatures, thus, "seedlings become susceptible when they are unable to respond favorably to the environment". In 1922, L. R. Jones had received funds from the university Research Committee for studies on root rot of cereals. This was to be used for summer salary for Eckerson who, in immediate association with Dickson, was working on the nature of resistance. E. J. Kraus of botany and K. P. Link of agricultural chemistry were also involved in this work. Dickson, Eckerson, and Link suggested that same year that increased carbohydrates and thickened cellulose walls at favorable temperatures for plant growth could be responsible for reduced susceptibility.

In 1926, a summary of work done under Project 13 was published by Jones, James Johnson, and Dickson. A list of diseases studied with graduate student or staff involved, is as follows: flax wilt—W. H. Tisdale; seedling blight of cereals by the *Fusarium* stage of *Gibberella saubinetii*—Dickson and B. Koehler; *Helminthosporium* diseases of wheat and barley—McKinney; *Helminthosporium* diseases of rice—G. O. Ocfemia; take-all of wheat—McKinney and R. J. Davis; cereal smuts (oat loose smut)—Bartholomew and E. Jones; corn smut—E. Jones; and development of legume root nodules—F. R. Jones and W. B. Tisdale.

Paul Hoppe joined the cereal program as an assistant in 1925 studying the behavior of disease-resistant characters in certain selfed strains of corn and their hybrids. He later was employed by the USDA, and was associated with the Department of Plant Pathology for the rest of his career. In the 1930s and early 1940s, Hoppe did a great deal of survey work on the prevalence of kernel molds in various parts of the corn belt. He perfected the rolled-towel cold test for determining the response of corn seed lots under cold soil conditions, the effectiveness of seed treatment materials, and the adequacy of treatment applied to seed by seed producers. He also surveyed soils for their seed-rotting potential—primarily due to various *Pythium* species present. Hoppe was involved in testing inbreds and hybrids for stalk rot and *Helminthosporium turcicum* reaction. An interesting observation that he made in the mid 1960s (with D. C. Arny and J. W. Martens) was that corn seedlings inoculated by means of ground leaf material were more susceptible to frost damage than noninoculated plants. This phenomenon he reproduced in the growth rooms and it was later shown to result from the presence of ice nucleation-active bacteria present in the ground leaf material.

H. Johann was located in the department from 1919 to the early 1940s. She was employed by the USDA as a mycologist to work on corn diseases. She had had some training under G. Reed at Washington University in St. Louis. In 1924, she was a participant in a *Fusarium* taxonomy gathering hosted by the Departments of Botany and Plant Pathology on our campus. Others present were H. W. Wollenweber from Germany, C. D. Sherbakoff from Tennessee, O. A. Reinking from Central America and A. A. Bailey from the Pathological Collection of the USDA in Washington. Johann worked on the corn diseases fungi *Pythium, Penicillium,* and *Diplodia,* and on the histology of corn kernels in relation to resistance and susceptibility to kernel rots.

In about 1925 the Purnell Project 9 "Improvement of yield and uniformity of corn and a study of the methods whereby this can be effected" was initiated with the Departments of Agronomy, Plant Pathology, Agricultural Chemistry, and Genetics cooperating with the USDA, Bureau of Plant Industry. Professors Leith, Brink, Dickson, and Link were the leaders. Resistance in corn to disease and unfavorable weather conditions, primarily cold soil temperatures, was of considerable interest. A. D. Dickson, younger brother of J. G. Dickson and an assistant in plant pathology on this project, made a study of the respiration coefficient of disease-resistant and -susceptible inbred lines of corn as his Ph.D. thesis work. In the 1931–32 plant pathology budget N. P. Neal appeared as a half-time assistant with the other half carried by genetics. Later, he was also carried partly by agronomy. Neal eventually became the leader of the project with salary support from agronomy and genetics.

During the 1920s several Ph.D.'s in the field crop area were granted. These with their dates and thesis subjects are as follows: D. Atanasoff, 1920—*Fusarium* blight of cereals; F. T. McFarland, 1921—studies on the genus *Claviceps;* W. G. Stover, 1921—soil temperature and seedling blights of corn; W. H. Davis, 1922—spore germination of *Ustilago striaeformis;* G. F. Weber, 1922—*Septoria* diseases of cereals; G. O. Ocfemia, 1923—black bundle disease of corn; R. J. Davis, 1924—*Ophiobolus graminis* and take-all of wheat; R. B. Streets, 1924—wilt disease of flax; C. W. Hungerford, 1925—the life history of stripe rust, *Puccinia glumarum;* B. Koehler, 1925—Scutellum rot disease of corn; P. M. Simmonds, 1928—seedling blight and root rot of oats caused by *Fusarium culmorum;* and R. G. Shands, 1929—winter injury in wheat.

There was a problem with pigs fed with barley shipped to England and Germany from the 1928 crop in the Midwest. Accusations were made that the death of some pigs was due to the presence of *Gibberella* infection in the grain. There was also the suggestion that the infected grain would bring a new disease problem to grain growing in Europe. The problem of payment for the grain was finally settled by arbitration. The grain had been shipped in good faith, as there was no provision in the grading procedure for detecting the presence of the fungus infection. Dickson was sent in 1930 by the USDA and the university to study the problem—not to make excuses, but to determine if the fungus was already present in Europe. He was in Europe from February to November, 1930. He found the organisms in herbarium specimens and grain in England and Russia. Dickson also traveled extensively in Russia in order to collect wheat, rye, and barley that could have value as sources of disease resistance. Several collections of *Triticum timopheevi* were particularly valuable in this respect. It was a strenuous trip, as Dickson indicated that he lost forty pounds. The Russian trip was made in cooperation with N. I. Vavilov and A. A. Jaczewski of Leningrad.

R. G. Shands, following undergraduate work at Clemson, South Carolina, obtained his Ph.D. in 1929 with a joint major between agronomy and plant pathology. During his graduate days he worked under Dickson and Leith of agronomy on winter hardiness in wheat, but also was involved in the small grain breeding program with Leith. Upon obtaining his degree, he was employed by the USDA to do research in agronomic problems, especially breeding for disease resistance in the small grains. For a number of years, he conducted trials on resistance to scab in barley and wheat. Plants were grown on the old East Hill Farm in so-called "scab cages"—a framework covered with cloth which could be kept wet and under which corn stalks infected with *Gibberella* were placed on the ground between rows of plants. Unfortunately, little in the way of resistance was found. However, from his breeding program, Moore barley, Blackhawk and Timwin winter wheats, and Henry, Russell and Lathrop spring wheats with resistance to rusts and mildew were developed.

H. L. Shands followed his brother "R. G." in the small grain breeding program with again a joint major. After receiving his Ph.D. in 1932 with his study on the barley stripe fungus, *H. gramineum,* he was appointed assistant in plant pathology and agronomy to work on barley loose smut and stripe control. He eventually replaced Leith as the state-supported small grain breeder in the Department of Agronomy. Disease resistance was important in the program as were yield, straw strength, and grain quality. A number of outstanding oat varieties were produced, beginning

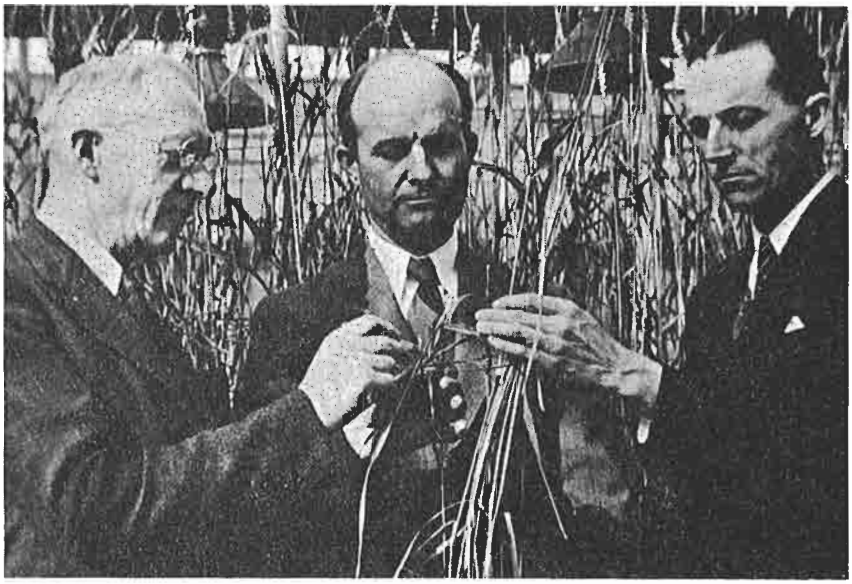


Figure 10.1 B. D. Leith, R. G. Shands and H. L. Shands, circa 1935.

with Vicland in the 1940s with crown rust and smut resistance. As disease problems shifted, a number of improved varieties followed. This tradition has been continued by R. A. Forsberg in agronomy with cooperation by plant pathology.

As a result of the shipments of the 1928 barley crop to Europe there was renewed interest in barley scab resistance, as indicated by the work of R. G. Shands, and work also was initiated on the toxicity of scabbed grain and on the toxic principle. In the early 1930s A. D. Dickson, working in Link's laboratory, attempted to identify the emetic principle in the scabbed grain. Professor Bohsted of animal husbandry was involved in animal trials with feeding and injections.

With the reinterpretation of the Volstead Act in 1933, there was pressure from Wisconsin's malting and brewing industry for information on the malting characteristics of current barley varieties and for the development of improved varieties. The high yielding Pedigree 38, or Wisconsin Barbless, barley, was developed by Leith and others during prohibition days. The original cross, Lion x Oderbrucker, was made in 1917. Lion brought smooth awns and moderate resistance to the stripe disease, *Helminthosporium gramineum.* After many years of selection, Ped 38 showed improved yield and disease resistance, but its malting quality was unknown and the variety was not readily accepted by the maltsters. Under the guidance of J. G. Dickson, H. L. Shands and T. Haberkorn began setting up small-scale malting tests as a part of the breeding program for improved malting quality. In 1934–35, a U.S. Maltsters Industrial Fellowship Fund was initiated to support this program. From these beginnings, the Barley and Malt Laboratory was established in the basement of Moore Hall; A. D. Dickson eventually was in charge with support from industry and the USDA. Since Ped 38 was looked upon with disfavor by the industry, a large-scale pilot project was set up to compare the standard Oderbrucker (Pedigree 5–1) with Ped 38 under commercial malting and brewing conditions, and L. M. Josephson was hired to oversee the production of the grain. The high yielding ability of Ped 38 is indicated by the fact that for every four acres needed to produce Ped 5–1 only three acres were needed to obtain the same production of Ped

38. There also was a Work Project Administration project during the 1930's giving assistance in the research on grain quality.

As an illustration of the scope of the barley quality work, the following program outline from 1940 is of interest: "A. D. Dickson is continuing research on enzymes and carbohydrate substrates, H. L. Shands (state) and R. G. Shands (USDA) are making selections from hybrids from quality studies. J. G. Dickson and H. L. Shands are completing a study on malting methods and physiology especially in relation to more suitable methods for evaluating barley. B. A. Burkhart supervises the routine analyses in relation to the barley and malt studies." The USDA Barley and Malt Laboratory on Walnut street was built in 1949. A. D. Dickson was for many years a "collaborator" in the Department of Plant Pathology.

Ph.D.s granted to students under Dickson during the 1930s were: T. J. Fajardo, 1930 (thesis title unavailable); A. S. Dahl, 1931—snow mold on turf grasses; L. W. Boyle, 1932—anatomical studies of flax growing in flax-sick soil; W. L. Gordon, 1932—relation of environment to development of *P. graminis* f. sp. *avenae;* A. L. Smith, 1932—reaction of corn strains to infection by *Diplodia zeae;* W. H. Tharp, 1932—development, nature, and function of the semi-permeable membrane in barley kernels; A. J. Ullstrup, 1934—variability in *Gibberella saubenetii;* C. E. Yarwood, 1934—the diurnal cycle of development of *Erysiphe polygoni;* B. B. Bayles, 1936 (agronomy)—influence of environment during maturation on disease and yield of wheat and barley; J. H. Torrie, 1938—inheritance in oats to smuts, crown rust, and stem rust; D. H. Bowman, 1939—sporidial fusion and infection of corn by *Ustilago zeae;* B. J. Sallans, 1939—the use of water by wheat plants infected with *H. sativum;* W. M. Bever, 1940—studies on hybridization and genetics of *Ustilago hordei* and *U. nigra.*

O. F. Smith received his Ph.D. in 1934 with his thesis on the influence of low temperature on seedling development in inbred lines of corn. He was subsequently hired by the USDA Division of Forage Crops and Diseases, but stationed in Madison, to study various clover diseases, particularly on red clover. Red clover was an important forage crop in Wisconsin, second only to alfalfa, but it had a number of disease problems. The Department of Agronomy was interested in breeding improved cultivars. Among the diseases Smith worked on were powdery mildew and *Stemphyllium* leaf spot. In 1941, Smith was replaced by J. L. Allison (Ph.D. from Minnesota) who became assistant professor on a joint cooperative basis. About half of his salary came from the university, the rest from USDA. He continued work on diseases of red clover and breeding for resistance to powdery mildew and anthracnose and also on a number of grass diseases, particularly *Helminthosporium* on brome grass.

In 1946 Allison was moved to Beltsville to become pathology leader in the Division of Forage Crops and Diseases. He was replaced by Earle W. Hanson who came as a full-time federal employee to work on clover pathology and breeding. Hanson had worked on wheat diseases with Stakman and the wheat breeders at St. Paul and had received his Ph.D. at the University of Minnesota in 1942. Hanson's interests were varied and his contributions added considerably to the knowledge of diseases of forage legumes, in general, and red clover in particular. He also cooperated in work on grass diseases with E. Nielsen and D. C. Smith of agronomy. Students who worked with Hanson, along with their thesis title, were as follows: R. A. Kilpatrick (with Dickson), 1951—root and crown rots of red clover; N. D. Fulton, 1954—studies on root rot of red clover in Wisconsin; J. E. Halpin, 1955—pathogenicity of species of *Pythium* on forage legume seedlings; L. K. Edmunds, 1958—spring blackstem on small-seeded forage legumes; C. C. Chi, 1959—*Fusarium* species and the wilt and root rot of red clover; J. P. Martin, 1959—northern anthracnose of red clover (*Kabatiella caulivora*); G. M. C. Latch, 1960—stem diseases of sweet clovers, R. D.

Berger, 1962—growth sporulation, pathogenicity, and survival of *Cercospora zebrina;* E. S. Martinez, 1963—growth, sporulation, pathogenicity, and dissemination of *Leptosphaerulina briosiana;* D. L. Stuteville, 1964—virus diseases of sweet clover; and J. R. Stavely (with Backus), 1965—the pathogenicity of *Erysiphe polygoni* on *Trifolium pratense.*

Hanson also cooperated with Brink in alfalfa breeding after F. R. Jones passed away. During the time that he was involved with the breeding programs with legumes and grasses, Hanson also served as the campus coordinator for USDA administration. Upon his return from Nigeria in 1971 Hanson became involved with cooperative extension, and for several years was largely responsible for the disease clinic in the department.

In 1943, Deane C. Arny received his Ph.D. with H. L. Shands and J. G. Dickson, and was appointed as instructor jointly between argronomy and plant pathology. Arny continued his work in the inheritance of reaction to stripe (*Helminthosporium gramineum*) in barley and in testing varieties and selection to the stripe disease. With the growing of resistant varieties, such as Pedigree 38, stripe is no longer found in Wisconsin barley fields. In the early 1940s Ped 38 became increasingly hard hit by spot blotch (*H. sativum*), which eventually caused its downfall. Production of malting barley moved farther west where weather conditions were more favorable. Several aspects of seed treatment problems in small grains were worked on in cooperation with C. C. Leben. A number of new diseases or new strains of organisms became problems during Arny's tenure, among them Victoria blight of oats to which Vicland was highly susceptible; *Septoria* blight of oats; barley yellow dwarf virus in both oats and barley; strains of loose smut virulent on oat varieties previously resistant; northern corn leaf blight; yellow leaf blight; southern corn leaf blight; eyespot; northern leaf spot; Goss' blight and wilt; maize dwarf mosaic; white line mosaic; and *Verticillium* wilt of alfalfa. Students working with Arny over the years have studied a number of problems in small grains, corn, and several other crop plants. These have been: A. R. Mohajir—inheritance of resistance to loose smut of barley; W. P. Skoropad—nature of resistance to barley stripe; G. G. Orlob and A. C. Pizzaro—barley yellow dwarf virus; J. W. Martens—potassium and chlorine and stalk rot of corn; C. J. Rodrigues—*Mycena citricolor* on coffee; P. T. Onesirosan—*Corynespora cassicola* on tomato; and J. Lindemann—snap bean cropping patterns, populations of *Pseudomonas syringae* and brown spot disease.

During the 1940s a number of students received their Ph.D. degrees under Dickson. In several cases, H. L. Shands or Neal of agronomy served jointly as major professor. L. M. Josephson, C. W. Schaller, M. J. Thirumalachar and J. F. Schafer studied various aspects of smuts on barley and grasses. E. C. Stevenson and E. L. Moore worked on stalk rot and low temperature effects in corn in cooperation with Neal. Arny, C. Wang, R. W. Earhart, and M. N. Grant were involved with *Helminthosporium* and *Septoria* diseases of cereals. D. W. Chamberlain, G. W. Bruehl, and J. F. Carter considered various diseases of grasses. C. T. Fang studied *Xanthomonas translucens* (with Riker), M. D. Whitehead looked at seed-borne organisms of cereals, and G. E. Geeseman (with Torrie and Brink) studied the inheritance of resistance to downy mildew in soybean.

Early in the 1950s *Septoria* leaf blotch and particularly the stem rot (dark stem) phase had become severe on the oat crop in the north central region. The leaf spot phase of *Septoria* on oats and other cereals had been studied in the early 1920s by G. F. Weber (Ph.D. 1922), but had been of little importance since then. As a response to the resurgence, and with some pressure from D. Western of Quaker Oats Company (infection was showing up as purple discoloration of the kernels), H. C. Murphy established a USDA position in the department to study the disease and its control. Although the position apparently was not official until 1954, A. L. Hooker (Ph.D. 1952)

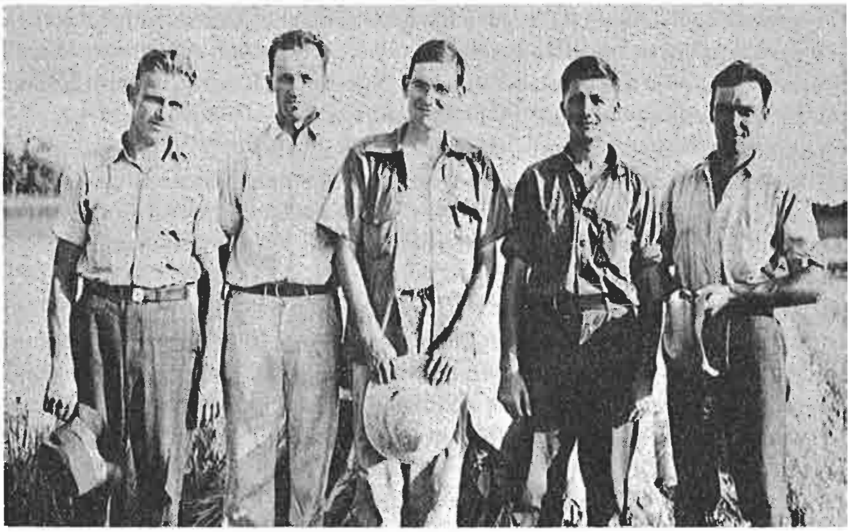


Figure 10.2 The small grain breeding crew, West Hill Farm, Madison, 1940.
L-R W. Pegler, H. L. Shands, D. C. Arny, C. Schaller, V. Hack

started work on the disease and its causal organism in 1952. He held the post as an assistant professor although he was paid by USDA. Hooker moved to Iowa State University in 1958 and he was replaced by L. Wood who had received his Ph.D. from the University of Minnesota. In 1962 Wood became extension pathologist at South Dakota State and was replaced by Richard D. Durbin. However, the position was moved away from *Septoria* on oats and evolved into leadership in the pioneer USDA laboratory concerned with disease resistance.

In 1958, M. Kauffman was brought to the department by the USDA to study grass diseases in cooperation with D. C. Smith and Nielsen of agronomy in a breeding program on brome grass, orchard grass, and timothy. With Kauffman's departure in 1962, the position was closed. However, in 1968, Douglas P. Maxwell, trained at Cornell University under D. F. Bateman, was employed by the department to work with the grass and legume forage diseases. Maxwell has studied the effects of leaf spots on forage yields and nutritive value. Several of Maxwell's students studied the nature and inheritance of resistance to *Phytophthora megasperma* in alfalfa. These were J. A. G. Irwin, S. A. Miller, and M. J. Havey. Others, such as G. M. Murray and M. A. Khan, studied resistance to fungus and virus diseases in red and other *Trifolium* species. V. Armentrout studied changes in organelles and enzymes during germination of conidia of *Botryodiplodia* species.

Dickson's work in later years is perhaps best summarized by the projects of his various students. R. A. Kilpatrick (with Hanson), W. C. McDonald, and J. B. Lebeau studied crown and root rots of red clover and alfalfa. A. L. Hooker, E. L. Hendrick and I. J. Thomason (with D. C. Smith) were concerned with seedling blight of corn or brome grass. M. Futrell (with R. G. Shands), R. L. Kiesling, G. J. Green, G. R. Grimm, S. Lund (with H. L. Shands), R. D. Tinline, N. Armolik, R. V. Clark, and G. Templeton studied various aspects of fungal diseases on small grains, such as powdery mildew, stem rust, smuts, *Septoria* blotches, spot blotch, and storage deterioration. P. N. Drolsom was concerned with *Helminthosporium turcicum* on sudan grass and P. S. Knox-Davies with the same organism in relation to corn. A number of students studied various aspects of *Puccinia sorghi* and related species. These were E. Schieber, P. M. Le Roux, A. L. Flangas, R. Syamananda, R. W. Berry, B. H. Lee, and M. S. Pavgi. From 1950 to 1959 Dickson was involved in several "expeditions" in Mexico and South and Central America. Following his retirement he served as consultant in Alaska making an inventory of grass species and their diseases. He also served as an advisor to a brewing company with barley production in Spain and the Philippines. It was on a survey trip for the brewing company in the Philippines that he was killed in an airplane crash.

Work in the field crop disease area has also been carried on by the several persons involved in extension. R. E. Vaughan was concerned with all crops, of course, but tested and made recommendations on seed treatments of small grains—first formaldehyde and later the mercury dusts—and leaf and stem rusts, and finally the Victoria blight of oats. Earl Wade also had responsibility for all crops in the beginning. One involvement of his with field crop diseases was the carrying out of a demonstration project in Rock County on the eradication of buckthorn hedges and bushes in order to reduce the early infection of oats by crown rust in nearby fields. D. Peterson, then weed specialist in agronomy, was also part of this project. Unfortunately, only a few farmers have made use of this method of reducing the damage from crown rust.

The pressure of extension problems led to the appointment of a second extension specialist in 1963. Upon his appointment, Gayle Worf picked up the area of field crop diseases. In 1968 he identified the yellow leaf blight, *Phyllostica* sp., on Texas male-sterile corn hybrids—the first indication in this country that these hybrids were particularly vulnerable to disease. On the basis of this, at least one of the large seed companies began to return to producing seed with normal cytoplasm by the detasselling method. The following year Worf observed the eyespot disease, and with the help of Eugene B. Smalley identified the cause as *Kabatiella zeae,* which had been described in northern Japan several years earlier. With the southern leaf blight epidemic of 1970, Worf and Arny became involved in a number of efforts—fungicide trials, overwintering of the fungus, and numerous educational activities. A grant from the Wisconsin Bankers Association supported some of these efforts. Fungicide applications gave control, but were not economic. The very rapid return to normal cytoplasm by seed companies gave control of the disease.

Upon his return from Nigeria in 1971, Hanson assumed the extension aspect of field crop diseases and Worf (after some soul-searching) moved into ornamentals and turf. Hanson was involved in estimation of disease losses in field crops, seed-borne infections in several crops, and other areas. For several years he had primary responsibility for the plant disease clinic.

When Hanson retired in 1976, Craig Grau took over the field crop extension area. Grau received his Ph.D. at Minnesota and had postdoctoral experience at North Carolina State University. Along with his extension activities he has become involved in his own research in a number of areas, along with that of his students. In soybeans, Grau has determined that there are a number of races of the *Phytophthora* root rot fungus present in Wisconsin soils and P. Tooley has studied the rate-reducing resistance to the same fungus. Other soybean diseases under consideration have been: brown stem rot—A. Mengistu; *Sclerotinia* stem rot—V. Radke; and brown leaf spot—M. Mbaga. In alfalfa several problems have been worked on. *Verticillium* wilt was discovered in Wisconsin in 1980 (with Arny and P. Delwiche as a postdoctoral associate), anthracnose has become increasingly important (with M. A. Hansen), *Phytophthora* root rot is a continuing problem (with S. Nygaard), and *Aphanomyces* infection appears to be part of the poor establishment problem and selections for resistance has been possible (with E. Holub). Cooperative work has been with E. Gritton, E. Oplinger, and D. Rohweder of the Department of Agronomy.

In addition to his work with Dutch elm disease, Smalley has been involved with a number of studies on mycotoxins which develop in moldy grain and hay, both in his own projects and those of his students. D. Cullen worked with mycotoxic fusaria in corn (as is also A. Al-heeti presently), P. Still with mycotoxins and abortion in dairy cattle, W. Marasas with *Fusarium tricinctum* in corn, and C. Rabie with aflatoxin production in grain. As a postdoc, R. Caldwell has been working with *Penicillium* and *Aspergillus* on corn in the Biotron. Some of Smalley's work has been in cooperation with workers from other departments, for example the "slobber" factor from moldy hay with F. Strong of biochemistry.

Under the guidance of Arthur Kelman, J. R. Hartman and J. I. Victoria have studied methods of evaluating the reaction of corn lines to the bacterial stalk rot bacterium, *Erwinia chrysanthemi*. In a joint project M. D. Woodward (with John P. Helgeson) and L. J. Corcuera (with Christen D. Upper) studied the relationship of DIMBOA and related compounds to growth of the stalk rot bacterium in corn and corn extracts. Susan Hirano served as a postdoc in this program.

When S. H. Ou retired from the International Rice Research Institute in the Philippines he came to the department in 1978 to revise his book on rice diseases. He also developed a cooperative project with the International Rice Research Institute on the nature of the variability of the rice blast fungus, *Pyricularia oryzae,* with Arny and Paul H. Williams. Isolates were collected from the rice growing areas of the world and H. Leung studied the cytology and genetics of the fungus for his Ph.D. research. Students of Albert H. Ellingboe are continuing some aspects of this work.

As indicated earlier, the observation by Hoppe of the increased frost sensitivity of corn plants inoculated with ground leaf material from *H. turcicum* infected plants started us on the road to the understanding of a new and exciting phenomenon—ice nucleation-active bacteria and frost sensitivity. Hoppe reproduced the increased susceptibility in the growth room and studied several environmental effects—light vs. dark, length of freezing time, time between application of leaf powder and freezing, etc. At the time, it was considered the *H. turcicum* infection was the modifying factor. This was shown not to be the case by Upper, Arny, and Vojtik, and S. Lindow was brought in as a research assistant to determine what it was in the powder, or in extracts of the powder, that was responsible for the effect. No active material or compound in the powder could be found. However, platings of an extract that had become cloudy in storage gave bacterial isolate number thirty-one which was ice nucleation active and produced the increased frost sensitivity when sprayed on plants. The isolate was determined to be a strain of *Pseudomonas syringae.* At about the same time, but entirely independently, workers in Wyoming, in looking for the source of ice nuclei in the atmosphere that were responsible for precipitation, had found isolates of *P. syringae* from decaying leaf material which were ice nucleation-active. It became evident that epiphytic ice nucleation-active bacteria were almost universally present on plants in the field, and that their management could be used to reduce frost damage. Here in the department, the ice nucleation activity has become an important tool in studies by Hirano, Upper, and Douglas Rouse on the epidemiology of pathogenic epiphytic bacteria, particularly through the use of the tube freezing test on individual leaves or leaflets to give a rapid estimate of the size of the bacterial populations present on the leaves.

Near the end of the first seventy-five years of the department, the experience and expertise of Ellingboe was brought in to continue activities in the area of field crop diseases. Ellingboe, who had worked with field crop diseases at Michigan State University for a number of years, became available after the genetic engineering company, International Plant Research Inc., met with fiscal insolvency. He served as a visiting professor until Arny retired in 1984. His current research efforts are on the genetics of host-parasite interaction and the identification of the primary gene products involved. Corn rust and rice blast are currently being used as model systems. He is also interested in the management of genes in resistance breeding programs.

CHAPTER 11

The Seed Potato Program

Steven A. Slack and Henry M. Darling

At first glance, most people think that it is unusual to find a seed potato certification program housed and functioning within a university department. In actual fact, one-third of the program directors in the United States are university faculty with the remaining directors evenly divided between state agriculture departments and crop improvement associations. These differences exist because potato improvement programs originated and have been maintained through state rather than federal auspices in the United States. The University of Wisconsin has played an active role in the development of the Wisconsin potato industry, especially the seed potato industry, from the outset.

EARLY HISTORY

Potatoes are beset by many disease problems. Some of the pathogens, for example viruses, that cause these diseases are systemic within the plant and may be maintained from generation to generation in the vegetatively propagated stocks. Prior to 1900, the "degeneration" of stocks through the accumulation of viruses was attributed to the continued asexual propagation of potatoes. Dutch and German agriculturists, however, established that the degeneration symptoms of leaf curling and rolling, crinkling, and blotching were infectious and that affected plants retained these symptoms from one season to the next season. They found that careful monitoring of stocks to remove the affected plants permitted them to maintain the initial stock vigor indefinitely. Similar studies

Figure 11.1 Spraying potatoes in the early years.

on the maintenance of crop vigor by selection was also underway at the University of Wisconsin by E. S. Goff (horticulture). These early studies culminated in the formal establishment of crop improvement associations and seed potato certification programs.

In Wisconsin, seed improvement was pioneered by J. G. Milward (horticulture). He stressed clonal selection to increase and maintain stock vigor and to minimize varietal mixture problems. He also promoted the adoption of uniform names for potato varieties. His efforts led to the establishment of a Wisconsin Seed Improvement Association in 1905. Coincidentally, L. R. Jones of Vermont visited Europe in 1904 to study potato diseases. As detailed elsewhere in this book, Jones later moved to the University of Wisconsin and was instrumental in establishing the Department of Plant Pathology.

The early potato work by Jones provided the impetus for a former student, W. A. Orton of the U.S. Department of Agriculture (USDA), to visit Germany in 1911 to observe potato diseases and to study the system of seed inspection and production initiated by O. Appel. Upon his return to the United States, Orton promoted the concept of pure seed programs. The need for these programs was recognized officially with the passing of the National Plant Quarantine Act of 1912 which prohibited the importation of potatoes from areas harboring black wart (*Synchytrium endobioticum*) or powdery scab (*Spongospora subterranea*). In 1913, Jones, Orton, W. Stuart (USDA), and Harry L. Russell (dean of agriculture, University of Wisconsin) delivered papers on seed potato improvement to the growers comprising the Wisconsin Seed Improvement Association. The association decided to support a formal certification plan through the University of Wisconsin with Milward in charge to produce standard potato varieties that were true-to-type and to produce stocks free from injurious levels of tuber-borne diseases. This was the first seed potato certification program in the United States. The Potato Association of America was also founded in 1913 and the efforts of this group to promote improved seed programs provided the stimulus for rapid expansion in many areas. By 1922, twenty-two states were inspecting about 24,500 acres of seed potatoes.

The concept of seed potato certification, especially in these formative years, was largely one in which the University of Wisconsin provided the technical information and direction on which a sound program could be built. Certainly, the regulatory role has always been important, but it has not been the focus for program development. The Department of Plant Pathology was involved in the program from the outset. J. C. Walker, the first inspector trained in plant disease work, made field inspections in 1914. John W. Brann followed Walker in 1915 and worked with Milward for many years. Walker continued to support aspects of the program throughout his career. Brann was appointed 50 percent in horticulture and 50 percent in plant pathology in 1915, but he was budgeted entirely in plant pathology by his retirement in 1947. Others in plant pathology that have made significant research and/or administrative contributions include Earl K. Wade, George W. Keitt, Arthur Kelman, Gustaaf A. de Zoeten, and Glenn S. Pound. Pound later became dean of the College of Agricultural and Life Sciences and continued the strong support of the college for this program. Two persons, R. W. Hougas and R. L. Hughes, deserve special mention at this point because they were key administrative persons in the college during a period of growth and change and were influential in helping to structure the program into its current form. In other departments, G. H. Rieman (horticulture), R. K. Chapman (entomology), and K. Berger (soil science) made continuing contributions that enhanced the over-all program. Lastly, extension personnel in the college who have and continue to make important program contributions include J. A. Schoenemann (horticulture), D. Curwen (horticulture), L. K. Binning (horticulture), J. A. Wyman (entomology), K. A. Kelling (soil science), and Walter R. Stevenson (plant pathology).

FOUNDATION PROGRAM ESTABLISHMENT

The seed potato program was revised significantly in 1941 with the initiation of a foundation seed project by the College of Agriculture in the form of a basic seed farm to be operated by the college. The groundwork for this project was established in 1939 and 1940. Initially, J. McLean was hired to direct the seed program in 1939; but, as can be determined from earlier letters, the inability to immediately solidify this position in the college budget led to his departure for Colorado after one year. Henry Darling succeeded McLean in 1940 and remained as program director until his retirement in 1976. Darling was originally from Wisconsin, but he took his Ph.D. at the University of Minnesota in plant pathology and horticulture and spent four years (1936–40) as an assistant professor at Auburn before he returned to Wisconsin. Although the hiring of McLean and Darling in the Department of Plant Pathology was viewed at that time by many individuals as a shift in program emphasis primarily to recognize a greater regulatory role by the Seed Certification Agency, it was the decision to initiate a unique Foundation Seed Farm (State Farm) operated by the college to supplement the existing certification project that has left its lasting impact on the North American potato industry. Darling demonstrated clearly the value of clonal selection and disease elimination in the production of basic seed stocks to enhance seed uniformity and yield. He also demonstrated that, through university involvement, technology could be readily and effectively transferred to enhance the quality of seed potatoes, for example, the application of indicator hosts and serological tests to detect latent viruses in potato stocks.

The first State Farm crop consisted of twelve acres and was comprised of the cultivars Chippewa, Cobbler, Katahdin, Red Warba, Russet Rural, Sebago, and White Rose. This crop was produced on the Mabel Piehl farm about five miles south of Three Lakes, Wisconsin. The Piehl farm was purchased for $10,000 in 1946. This site served as the State Farm until 1984. In that year, the State Farm was moved to a site six miles west of Rhinelander, Wisconsin. The new site is a 1,000-acre tract of land with about 400 tillable acres surrounding a 40-acre spring-fed lake. This farm is isolated from other potato production areas in the state and has fertile sandy loam soils ideal for growing potatoes. The land was obtained by the University of Wisconsin from Starks Farms in 1979 in exchange for stocks held through a bequest by a pioneer seedswoman, Miss Lelah Starks, upon her death in 1952. This farm was dedicated on July 6, 1984, by Dean Leo M. Walsh as the Lelah Starks Elite Foundation Seed Potato Farm. The dedication marked the completion of the primary building on the farm, a $293,000 potato storage facility with a laboratory, greenhouse, and farm office, and commemorated the first potato crop on the new farm. In contrast to 1941, the first crop on this State Farm was sixty-three acres comprised of sixteen principal cultivars (more than thirty cultivars are evaluated annually) which produced 1.2 million pounds of potatoes for the Wisconsin seed potato industry. It is important to note that the State Farm is operated on revenue generated from the sale of these seed potatoes to participating seed growers and that the Board of Directors of the Seed Improvement Association acts as an advisory board for the seed potato program.

The growth in acreage and seed production at the State Farm has paralleled the growth of the Wisconsin seed potato industry. In this period, state acreage entered for certification rose from about 2,000 acres to about 12,000 acres per year. Seed potatoes now represent 15–20 percent of Wisconsin's total potato acreage annually. Although there are several reasons for the growth of the Wisconsin seed potato industry over the past forty years, a consistent source of disease-free basic seed for the industry has been a major factor.

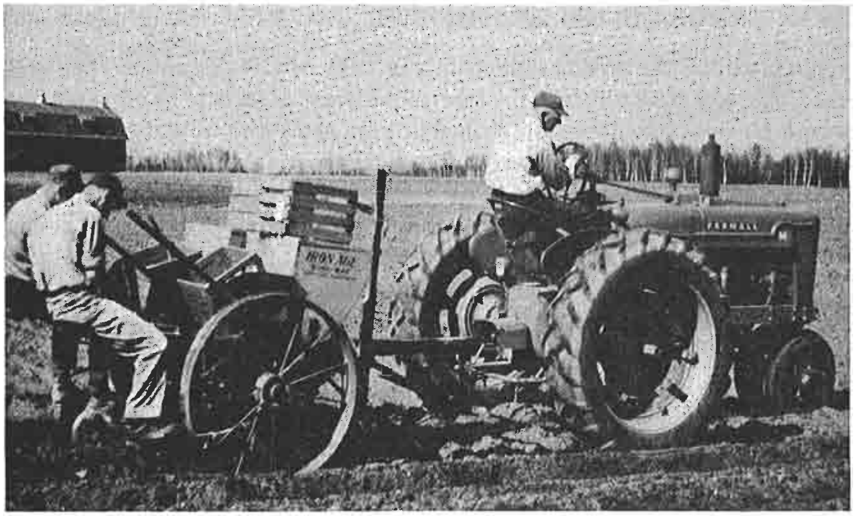


Figure 11.2 Planting tuber units on the foundation seed farm.

State Farm production practices have been based on sound seed production and pathology principles with emphasis on the elimination as well as control of tuber-borne diseases. The isolated location of the State Farm, which is about ten miles from any other potatoes, is ideal for this purpose. Field and storage sanitation procedures are followed rigorously to enhance crop quality. As a standard practice, potato tubers are planted as four-cut tuber units, that is, each seed tuber is planted as a unit of four sequential seed pieces with an in-row skip between units. This method of planting enhances visual detection and elimination of weak or diseased units by roguing. If one plant in a tuber unit exhibits symptoms of a tuber-borne disease, all four plants are rogued. Disease dissemination is controlled by strict cultural practices which include using disinfectants when cutting seed for planting, using pre-emergence herbicides, cultivating and hilling fields when plants are emerging to prevent direct equipment contact with plants, and providing four-row spray/irrigation alleys to prevent direct equipment contact with plants later in the growing season. The latter two practices were instituted originally to prevent the spread of viruses by mechanical means, but, in practice, they also prevent the spread of fungal and bacterial pathogens as well. The spray program has been designed to control air-borne fungal pathogens and vectors of potato pathogens such as aphids and leafhoppers. Field sanitation procedures are complemented by disinfestation of storage facilities and equipment. Disinfectants are used to sanitize the warehouse and grading equipment and a dip tank is used to soak pallets between storage seasons. All seed is stored in wooden pallets that can hold about one ton of potatoes. The pallets permit close supervision over the segregation of the numerous potato cultivars and lines.

In the past ten years, a nuclear class seed stock program has been initiated in which all seed stocks originate with pathogen-tested plantlets maintained *in vitro*. The development of this aspect of the state farm program has been a primary thrust of the current program director Steven A. Slack, who joined the Department of Plant Pathology in 1975. Nuclear stocks are generated as *in vitro* pre-nuclear stocks each year (Table 1). Tubers are recycled from the previous nuclear plot or are introduced as new *in vitro* stocks (new cultivars or regenerants from the thermotherapy and meristem-tip culture program). Each plant from which the pre-nuclear stocks are established are tested annually for the presence of potato spindle tuber viroid, the viruses S, X, Y and leafroll, and the bacteria *Erwinia carotovora* and *Corynebacterium sepedonicum.* New stocks are also tested for the potato viruses A and M. Each plant in the nuclear plot is again tested in mid-season for these same viruses. At this time, random samples are also collected from the clonally increased stocks and tested for the presence of potato viruses. These tests are used primarily to detect latent virus infections, for example, the viruses S and X do not incite distinct symptoms in North American cultivars under Wisconsin conditions and some cultivars do not develop symptoms upon infection with some of the other potato viruses. Tests include cDNA hybridization and polyacrylamide gel electrophoresis assays for the spindle tuber viroid, enzyme-linked immunosorbent assays and latex agglutination tests for the viruses, and isolation on selective and non-selective media coupled with serological tests for the bacteria.

The growth and quality of the State Farm is, of course, the result of the direct efforts of several people and the support of the College of Agricultural and Life Sciences administration and of the Wisconsin seed potato growers. Individuals who have contributed directly to the State Farm include J. Weber (started in 1941 and later joined Red Dot, now Frito-Lay), C. Muensch, E. Rydzewski (1945–83), L. Sorenson (1949–79), W. Guyant (1953–80), R. Slattery (1974–81, he joined Frito-Lay as Weber's replacement), J. Peek, S. Schroepfer (1966–83), K. Bula (1979–present), R. Hafner (1980–present), D. Gakovich (1981–present), C. Kostichka (1981–present), N. Biesik (1982–present), and W. Junion (1984–present). Rydzewski served ably as farm manager until he was replaced at retirement by Biesik. Similarly, Sorenson and Guyant worked as field inspectors and assisted with numerous tasks at the State Farm until their retirement and replacement by Bula and Hafner, respectively. Schroepfer was replaced by Junion as a seed potato technician at the State Farm when Schroepfer was forced to retire due to a medical disability. In newer positions, Slattery was hired as assistant program director and was headquartered in Antigo until he joined private industry and was replaced by Kostichka, and Gakovich was hired to oversee the tissue culture and pathogen-test program. Other individuals who contributed significantly to early program development include Earl Wade (see Chapter 6), E. Jones (joined Red Dot and now directs the New York seed potato certification program), and R. Self (research on the relationship of the aster yellows causal agent and purple top wilt disease of potato).

CURRENT CERTIFIED PROGRAM

Seed potato certification in Wisconsin and the United States generally represents a voluntary agreement between the seed grower and the certifying agency. Chapter Ag26 of the Wisconsin Administrative Code constitutes the regulations under which the program operates. Although the University of Wisconsin has been delegated the authority for certifying potatoes in Wisconsin, the state Department of Agriculture, Trade, and Consumer Protection has the responsibility for promulgating rules. The latter department is also responsible for shipping point inspections of seed potatoes.

Seed growers submit application forms to participate in the program each year. These forms include a listing of cultivars to be grown, classification and source of seed lots, acreage, and field maps for inspectors. The changes in acreage and cultivars during the past forty years are shown in Table 2. A minimum of two field inspections for growing plants and one tuber inspection at harvest or storage are made. In addition, storages must be certified as clean prior to the initiation of harvest and storing of potatoes. All seed plots meeting field and tuber inspection standards also must be winter tested to be eligible for certified seed tags. The winter test is conducted at Homestead, Florida. A 400-tuber sample from each seed lot is treated with Rindite (7:3:1 mixture of ethylene chlorohydrin:ethylene dichloride:carbon tetrachloride) to break dormancy prior to shipment and planting of the samples in November. Samples are evaluated in January and, except for the shipping point inspection, this evaluation constitutes the final certification step. Following completion of the summer inspection process, a crop directory is published that lists the acreage by seed grower of all cultivars that have met certification standards and a Foundation seed list is distributed after completion of the winter test. These publications are important to the potato industry because they serve as a source of independent information on availability of cultivars of certified seed. The cost of certification agency services and salaries are covered by fees charged to the participating seed growers.

The flow of seed lots in Wisconsin is shown in Table 1. On average, about 95 percent of the seed lots in Wisconsin originate on the State Farm. Seed growers may obtain seed lots from other sources as long as the lots meet Wisconsin foundation seed class standards. Currently, there are two basic classes of seed in Wisconsin—foundation and certified. By 1986, a limited generation scheme will be in effect for foundation class seed that will restrict to four the maximum number of years that seed can be propagated in this class. Recertification of certified class seed still will not be permitted. Seed classes are determined by disease and cultivar mixture tolerances and seed grades are determined by quality and size of tubers to be shipped. Field tolerances for the seed classes in Wisconsin are shown in Table 3. Since 1941, the rejection rate has steadily decreased (20.0% for 1941–65, 9.2% for 1966–75, and 3.3% for 1976–84). A major reason for seed lot rejections in the 1941–65 period was bacterial ring rot caused by *Corynebacterium sepedonicum*. This bacterial disease has been a major problem throughout North America since its introduction in 1931. Although the "zero tolerance" regulation has managed to limit the destructive effects of this disease, it has not eliminated it from the industry and severe destructive disease outbreaks still occur. Since it was started in 1941, the State Farm has made a significant impact to reduce disease incidence in Wisconsin by supplying seed stocks known to be free from the ring rot pathogen. In recent years, the major reasons for rejections in Wisconsin have been cultivar mixtures and miscellaneous reasons (for example, 2 percent of the acreage was rejected in 1984 because growers applied a sprout suppressant that was desirable for commercial marketing but made the potatoes unsuitable for use as seed). During this period, the strictness of tolerances either has remained constant or has become stricter. The decrease in rejection rates is related to a consistent source of disease-free basic seed stocks and technological advances (improved machinery, systemic insecticides, herbicides, etc.).

The fundamental quality of a seed program resides in the integrity of the inspection staff and their ability to work with and generate respect from potato growers. When this interaction is successful, strict standards can be applied and met consistently in an industry. Some of the specific standards that have helped monitor seed quality in Wisconsin are as follows:

1. Certified seed potato growers must enter their entire potato acreage for certification.
2. Certified seed potato growers must plant their entire potato acreage with foundation class seed.
3. Only certified seed potato growers with a record of no bacterial ring rot for two consecutive years may produce foundation class seed.
4. All potatoes entered for certification undergo a minimum of two field inspections and a tuber inspection at harvest or in storage.

Figure 11.3 Wisconsin certified seed potato tags.

5. All potatoes meeting field and tuber inspection standards must be winter tested to be eligible for certified seed tags.
6. All potato storage facilities must be inspected and approved prior to filling with certified seed potatoes.
7. All certified seed potatoes must be graded in accordance with Wisconsin certified seed grade standards before official tags can be attached. Seed shipments must be tagged properly to be certified seed shipments.

FUTURE OUTLOOK

Future prospects for the Wisconsin seed potato industry appear bright. The potato is an important food staple nationally and internationally and indications are that the size of the entire potato industry in Wisconsin will increase by the year 2000. In 1984, Wisconsin was the fifth largest seed-producing state on the basis of acreage and produced 6 percent of the seed potatoes certified in the United States. Approximately 120 million pounds of certified seed potatoes are shipped to commercial growers annually, with shipments reaching into nearly every state south and east of Wisconsin as well as supplying many of the seed potatoes needed within the state. Although seventeen states certified seed potatoes in 1984, 84 percent were produced in six states.

It is likely that a strong demand for certified seed will continue. There is little question that the potato industry will undergo dramatic changes in the next twenty-five years. The current technological boom in the biological sciences will continue to change the face of the potato industry, but the concept of a potato immune to all major diseases and meeting all the horticultural requirements of the industry still seems remote. The United States potato industry is a highly developed industry with specific market requirements. These requirements can only be met as long as a constant source of the needed volume of certified seed is available to fulfill commercial industry needs. The procedures by which seed potatoes are produced and evaluated will continue to be modified, however, as technological advances occur. Seed industries that remain competitive will be those that are able to evolve and grow with these changes. We think that the close association that the seed potato industry in Wisconsin has maintained with the University of Wisconsin–Madison will prove to be beneficial in that evolution.

TABLE 1
Seed potato increase system in Wisconsin

Increase year	Seed class	
	Growth chamber	
Pathogen testing *in vitro* propagation	Pre-nuclear stocks ↔	Pre-nuclear stocks (*in vitro* maintenance)
	↓ Field increase	
0	Nuclear stocks	
	↓	
1	Elite I Foundation	
	↓	
2	Elite II Foundation	
	↓	
3	Elite III Foundation*	*Sold as Elite Foundation with white tags
Produced on Elite Foundation Seed Potato Farm	↓	
Produced by seed growers	↓	
	Foundation	
Recertify if meet summer and winter tolerances	↓	
	Foundation**	**Sold as foundation or certified *class* seed. Either class may meet blue or yellow tag *grade* requirements when shipped.
	↓	
	Certified** (cannot recertify)	
	↓	
	Commercial usage	

TABLE 2
Ten year comparisons of potato acreage certified in Wisconsin, 1944–1984

Cultivar	1944	1954	1964	1974	1984
Abnaki				1	
Antigo			31	19	
Atlantic					1,460
Belchip					1
Belrus					84
Cascade				7	
Catoosa			2		
Cherokee		183	18		
Chipbelle					1
Chippewa	820	478	81	19	
Cobbler	346	127	13	1	
Denali					84
Early Gem			417	212	200
Early Ohio		8		7	
Green Mountain	59	1	1	2	
Hudson					31
Katahdin	462	128	140	169	44
Kennebec		126	497	214	37
LaChipper			24	259	270
LaSoda		209			
Langlade					169
LaRouge			6	1	64
Merrimack			1		
Monona				289	617
Nampa				7	
Norchip				531	209
Norgold Russet			70	213	660
Norland			210	710	1,189
Oneida					1
Ontario		58	159	127	553
Plymouth			1	1	
Pontiac	64				
Pungo			3		
Red Beauty			4		
Red LaSoda			203	380	198
Red McClure		25			
Red Pontiac	64	406	292	56	25
Red Triumph		10			
Red Warba	41	60	5	1	
Redsen					145
Rhinered					100
Rural New Yorker		10	4		
Rushmore			5	5	
Russet Burbank	37	375	1,250	769	1,160
Russet Rural	99	75	9		
Russet Sebago		291	539	180	36
Sebago	239	468	464	172	4
Sequoia	19				
Seminole				61	

TABLE 2 *Continued*
Ten year comparisons of potato acreage certified in Wisconsin, 1944–1984

Cultivar	1944	1954	1964	1974	1984
Shurchip				6	
Sioux				30	
Snowflake			11		
Superior			872	3,981	2,714
Targee				4	
Triumph	474	9	2	1	
Viking			26		
Waseca				1	
White Rose	40	1			
White Rural	10				
Wischip				35	
Miscellaneous*		23		1,202	1,287
Totals	2,714	3,071	5,360	9,676	11,343

*Denotes advanced selections and Frito-Lay numbers

TABLE 3
Field tolerances for certified and foundation seed potato classes in Wisconsin.

Disease or Cultivar mixture	Certified (%)	Foundation (%)
Leafroll	1.0	0.25
Mosaic	1.0	0.25
Spindle Tuber	1.0	0.10
TOTAL	3.0	0.25
Bacterial Ring Rot	0.0	0.0
Varietal Mixture	0.1	0.0

CHAPTER 12

A Brief History of Virology

Robert W. Fulton

In the first decades of the Department of Plant Pathology at the University of Wisconsin, research on virus diseases lagged behind research on diseases caused by fungal or bacterial pathogens. This may have reflected a general disinterest in virus diseases, the causal agents of which were almost complete mysteries. One wonders, also, whether there may have been a widespread acceptance of E. F. Smith's dictum that "if you want to waste your time, work on a virus disease". It is perhaps unfortunate that he chose peach yellows to work on, since it was nearly a half century before the nature of the causal agent was established. And then it was not a virus!

The first Ph.D. granted for research on a virus was to S. P. Doolittle, in 1918, for investigations on cucumber mosaic. He actually brought the problem with him, having worked on the disease at Michigan State University before coming to Wisconsin. Not that there was any lack of the disease on cucumbers in Wisconsin.

The lack of solid information on the nature of plant viruses at that time is difficult to imagine now. There were diverse views of what the causal agents might be; some of these views seem bizarre now. One idea which received considerable attention seems to have originated in the observations of L. O. Kunkel in Hawaii that protozoa were involved. This idea was pursued by R. Nelson at Michigan State University who reported the presence of amoeba-like bodies in cells of bean infected with bean mosaic virus. At the same time, in the early 1920s, a new wheat disease had appeared in Illinois, and H. H. McKinney was hired by the U.S. Department of Agriculture to conduct investigations on it at Wisconsin. McKinney made the significant observation that the disease was soil-transmitted, and found that the stunting was accompanied by a mottling of the leaves. He also found amoeboid bodies in cells of infected wheat. Nelson's work had been received with a good deal of enthusiasm by some of the more experienced plant pathologists. McKinney disagreed with Nelson on the pathogenic nature of these bodies, pointing out that the internal structure did not resemble that of a protozoan. Doolittle and McKinney published a note pointing out that the bodies Nelson described also occurred in cells of healthy beans and had been described many years before by Haberlandt.

That about ended the protozoan theory at Wisconsin, although Kunkel pursued the idea for some years; F. O. Holmes was hired by him at the Boyce Thompson Institute as a protozoologist. Nevertheless, the cytological aspects of virus diseases received attention at Wisconsin for a number of years. T. E. Rawlins studied the cytology of tobacco mosaic virus-infected tobacco in James Johnson's laboratory. Parenthetically, it should be pointed out here that Johnson was a professor of horticulture, although he had received a Ph.D. in plant pathology. He became interested in viruses early in his career, and many of his students did their research on virus diseases by means of an arrangement with the Department of Plant Pathology. The departmental chairman usually handled the administrative details, while the research was done in the Department of Horticulture. I. A. Hoggan, also in Johnson's laboratory, described intracellular inclusion bodies in virus-diseased solanaceous plants, including potato.

Much significant information on viruses was published by Wisconsin people in the decade of the 1920s. There were, at the beginning of the decade, two rather divergent ideas about viruses. One held that all "mosaic" diseases had the same causal agent; the other held that "mosaic" diseases had a specific causal agent for each host species. One of the accomplishments of the decade was the establishment of the concept of viruses as distinct entities, with differing properties and host ranges. Some of this work was done by M. N. Walker, who found that cucumber mosaic virus also could infect solanaceous plants. Unfortunately, he missed the opportunity to differentiate this virus from tobacco mosaic virus infection of tobacco.

A significant part of the work at Wisconsin on virus properties and differentiation was done in Johnson's laboratory. One of his students who made significant contributions to an understanding of the properties of viruses was M. Mulvania, a "refugee" from the antievolution turmoil in Tennessee. Johnson himself became convinced that viruses should be identified on the basis of their properties, rather than by the type of symptom they caused.

It was in the 1920s that the relationship of virus diseases to "running out" of potato varieties began to receive attention. As was the case with other types of disease, the effects of environment received considerable attention. Johnson investigated the effect of temperature on several virus diseases. C. M. Tompkins pointed out the effect of temperature on symptoms of certain virus diseases of potato, an observation important to the developing potato certification scheme. Johnson described in 1925 the transmission of a virus from apparently healthy potatoes to tobacco. This was potato virus X, then present in essentially all potatoes in this country. The observation received considerable attention, for, as Johnson pointed out, one explanation might be that it was some part of the potato protoplasm itself that multiplied in tobacco. I doubt that Johnson really believed this, although he never dropped the idea. H. H. Whetzel coined the term "viroplasm" for the supposed pathogenic part of the potato protoplasm.

Several other significant observations resulted from the discovery of the "healthy potato virus". One was that viruses might be present in plants without causing symptoms. The other was that not all viruses caused mosaic symptoms. It also gradually became apparent during this decade that the host range of any one virus might include many species, and that certain of these were useful as indicators of specific viruses. Johnson investigated the use of differential hosts in identifying viruses, and also pointed out differences among viruses in such properties as thermal inactivation point, dilution end point, resistance to drying, etc. This led to his attempts to classify or differentiate viruses on the basis of host range and properties.

The decade of the 1930s was one of many advances in the knowledge of plant viruses. Many new viruses were described and Johnson attempted to instill some order into the situation by standardizing nomenclature. Interest in the subject was stimulated. For many years, the American Phytopathological Society had a committee on virus nomenclature and classification, and this met once or twice during the annual meetings. These meetings, or at least the ones I attended, usually wound up in disorder late at night with very little accomplished. The Wisconsin group, however, tended to support Johnson's proposal of using the host name plus a numeral to designate specific viruses. Otherwise, virus nomenclature was rather a shambles. New viruses were sometimes described with as many as three different names, in an effort to conform to at least one of the many systems of nomenclature that had been proposed.

The importance of recognizing the presence of more than one virus in a diseased plant came to the fore in the 1930s and various methods were exploited for separating mixtures of viruses. One such method was the specificity of insect transmission. I. A. Hoggan made contributions to the study of aphid transmission, and K. L. Koch pointed out that rugose mosaic of potato was the result of infection by two viruses, only one of which was transmitted by aphids. Both these investigations were in Johnson's laboratory. W. B. Allington investigated the differential effect of various chemicals on different viruses *in vitro*, a method which, unfortunately, was not really practical.

In the 1930s, virus diseases were still not a popular subject for research among graduate students. One of my recollections, in telling someone that I was working on viruses, was his somewhat derisive reply that I was then going to be a leaf rubber.

In 1939, Keitt and Clayton published evidence that the sour cherry yellows disease was caused by a virus. At the time, the idea that viruses could infect woody as well as herbaceous plants seemed somewhat "far out". It was the beginning, however, of considerable work that was to come later on viruses of fruit trees.

Russell H. Larson, who had received his Ph.D. degree working on clubroot, began to work on potato viruses in the 1930s, first with potato yellow dwarf, and then expanding to detailed studies of other potato viruses in the 1940s and 1950s. He supervised nearly fifteen students before his death in 1962.

The investigations of virus diseases of different crops, and the differentiation and description of the causal agents, which had begun in the 1930s, continued and expanded in the 1940s. Vegetable pathologists under J. C. Walker described and differentiated viruses of bean (R. G. Grogan), pea (Donald J. Hagedorn), and turnip (F. J. LeBeau).

Types of research on plant viruses broadened in the 1940s. Glenn S. Pound did a thesis on the effects of environmental factors on virus diseases of crucifers.

Research on inactivation of viruses had begun in Johnson's laboratory in the 1930s in relation to the survival of tobacco mosaic virus in soil. He followed this up in the 1940s and differentiated between inhibition of infectivity and inactivation. Other studies on virus inactivation included that of James E. Kuntz on inactivators in spinach juice and that of N. Utech on inactivators produced by microorganisms.

In the late 1940s, J. Duain Moore, George W. Keitt, and J. S. Boyle published on the mechanical transmission of a virus from necrotic ringspot-diseased cherry to cucumber. This was the beginning of a series of investigations of viruses of fruit trees by Robert W. Fulton and his students in later years.

Several additions to the departmental staff in the 1940s markedly influenced the direction of virological research and the numbers of students involved. Pound returned to the department from the state of Washington in 1946 and began, with his students, a series of investigations on environmental effects on virus multiplication, including such factors as temperature, mineral nutrition, and the like. Pound's interest in crucifer viruses, their relationships, and behavior also continued and provided problems for a number of his students.

Hagedorn became a permanent member of the department in 1948. He and his students were instrumental in working out details of many of the most important pea virus diseases.

In the decade of the 1950s, there was a great deal of emphasis on virus diseases in the department (Fig. 1). Pound, as chairman of the department, negotiated the purchase of a Spinco Model L ultracentrifuge, at that time one of the most sophisticated centrifuges available. This opened the way to types of research not previously possible. Students used the instrument almost constantly, and its availability greatly broadened the type of research done in the department on plant viruses. Centrifugally purified preparations became commonplace in many investigations. Use of the centrifuge led directly to the use of serology in studying plant viruses. This was an area in which United States virologists lagged behind their British counterparts for a number of years, but it became an essential part of plant virology.

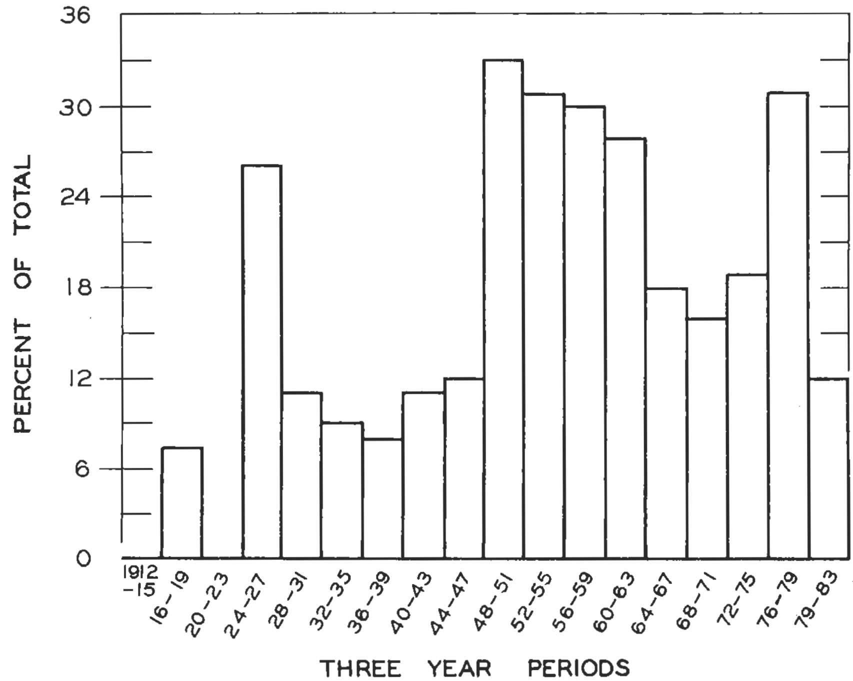


Figure 12.1 Numbers of Ph.D. degrees granted (or work on virus problems as a percentage of total Ph.D.s given each three year period.

Another development in the 1950s that seemed to stimulate interest in viruses was the offering, in 1958, of a course in plant virology. This was organized by Pound, who gave the lectures, and Fulton, who had charge of the laboratory work. The course was for some time numbered PP 106, but later PP 706. In the beginning, it was required of all students. The first class, in the spring of 1958, had an enrollment of thirty-five students, all of which were fitted into the pathologium for the laboratory part of the course. Even by bringing in extra tables, there was not space to seat thirty-five students. This problem was solved by making three of the enrollees teaching assistants. As such, they had no need of desk space and spent laboratory periods on their feet.

It should be pointed out in connection with this course that A. Steinmetz and, later, W. Reiner were essential in providing the thousands of plants needed, each at exactly the right time for specific class exercises.

The class also used the Spinco ultracentrifuge, housed at that time on the second floor of the Horticulture Building in a small room that served as a virology laboratory. The congestion when the class undertook virus purification was something to behold. Fortunately, it occurred for only about two weeks in the late spring of even-numbered years.

When the course was first given, Pound lectured for one hour at 7:45 every Monday morning. The second hour was spent in the pathologium, as were two-hour sessions on Wednesday and Friday mornings. In 1968, with Pound in the dean's office, an additional lecture was given on Wednesday morning. The course then consisted of two lecture sessions and three laboratory sessions, all for three credits. I was braced for complaints from students about this, but never received any.

In 1955, Robert W. Fulton was appointed to the department on NC-14 Regional Project funds to work on stone fruit viruses. He had been in the Department of Horticulture since 1946 working on tobacco diseases, including viruses. In succeeding years, the purification of a number of stone and pome fruit viruses was accomplished. This led to the preparation of antisera which aided the detection and identification of these viruses. When the stone fruit viruses were found to be multicomponent, work was broadened to include tobacco streak virus. A number of viral genes were found located on one or the other of the three components of the virus.

Other staff members, in the late 1950s and 1960s, became involved in virus projects: Albert C. Hildebrandt studied the behavior of viruses in tissue culture, and virus diseases of ornamentals; O. P. Sehgal worked on strawberry multiplier disease under the direction of Donald M. Boone; A. R. Gottlieb, R. R. Martin, and J. D. Castello described virus diseases of birch and poplars under the direction of John G. Berbee; and A. C. Pizarro and D. T. Gordon were involved with barley yellow dwarf and barley stripe mosaic viruses under the direction of Deane C. Arny.

Of considerable influence in the upsurge of research on viruses in the 1960s and 1970s was the move into Russell Laboratories in the fall of 1964. Gone were the cramped cubbyholes that served as laboratories in the Horticulture Building. Students and staff had room to work comfortably, and growth chambers were available which gave much better control of environmental conditions than was possible in the greenhouses.

The virology program of the department lost a stimulating staff member when Pound left to become dean of the College of Agriculture in 1964. Some of his work on vegetable viruses had been turned over to R. J. Shepherd, who became a member of the staff in 1959, after obtaining his Ph.D. under Pound. He took a position in 1961 at the University of California at Davis.

An addition to the virology program was the appointment of Gustaaf A. de Zoeten in 1967. He had obtained his degree at Davis, California, under T. A. Shalla, and then did a productive postdoctoral appointment with D. E. Schlegel at Berkeley, California. de Zoeten organized innovative research on some fundamental virological problems, including virus movement and multiplication of pea enation mosaic virus. He took over supervision of the electron microscope facility, and was responsible for developing it into a very useful and efficient facility.

It is to be regretted that it has not been possible to mention all of the 110 students who have written theses involved in virus research over the past decades. To do more than list them would have made an unnecessarily long exposition. Such a list begins in 1918 with Doolittle and ends in 1985 with T. Zinnen. All 110, it should be remembered, contributed to producing a research climate which was stimulating to work in. Their beliefs, skepticisms, questions, and wild ideas contributed in intangible ways to the progress of virology in the department.

CHAPTER 13

Mycological Anastomoses at Wisconsin

John G. Berbee

According to the seventh edition of Ainsworth and Bisby's *Dictionary of the Fungi* (1983), major developments in the knowledge of mycological aspects of plant pathology constitute a significant component in the history of mycology during the twentieth century. Staff members of the Department of Plant Pathology and their graduate students have contributed to that mycological knowledge. The purpose of this chapter is to summarize in historical perspective mycological contributions of the department during the period from 1910 to 1985. The genesis of the department happened within a mycologically rich environment.

ORIGINS IN THE DEPARTMENT OF BOTANY

Long before the Department of Plant Pathology was established in 1910, the Department of Botany at the University of Wisconsin was recognized as a center of excellence for mycological teaching and research. This reputation was achieved primarily through the research of R. A. Harper and his graduate students, initially at Wisconsin and later at Columbia University, on fungal cytology and morphology, which was of fundamental and historic significance for the entire field of mycology. Mycologists who later joined the scene included E. M. Gilbert, M. P. Backus, J. J. Davis, H. C. Greene, and in the area of fungal physiology, B. M. Duggar and P. J. Allen. As a consequence of that strong mycological setting, Birge Hall Library accumulated an extensive collection of mycological literature and the Cryptogamic Herbarium of the department acquired, through the dedicated efforts of Davis and later of Greene, one of the largest collections of plant parasitic fungi in the United States. Plant pathology staff members and graduate students had full access to those mycological resources and, for the asking, had available to them the advice and counsel of outstanding mycologists and fungal physiologists.

Several of the mycologists and fungal physiologists of the Department of Botany had either courtesy appointments or budgeted part-time appointments in the Department of Plant Pathology. The part-time budgeted appointments generally were made to handle specific assigned teaching responsibilities (Plant Pathology 101) within the department and for the most part were not long maintained. The formal courses in mycology and in fungal physiology were the sole responsibility of the Department of Botany. Many of the students in those courses, however, were plant pathology majors. Details relating to those mycology courses appear elsewhere in this volume (Chapter 17).

In addition to teaching the advanced mycology courses, which up until the mid 1950s were required for virtually all plant pathology Ph.D. students, one or more of the mycologists or fungal physiologists served on most of the graduate student committees in the Department of Plant Pathology. Thus, for many years, the mycologists of the Department of Botany contributed importantly to the training of plant pathology graduate students.

After about 1960, however, interest in and emphasis on the mycological component of plant pathology graduate student training declined dramatically. It was largely replaced by increased emphasis on biochemistry, physiology, quantitation and, most recently, molecular biology. By 1985, the department's only mycological requirement for doctoral students was one undergraduate, one-semester introductory course dealing with fungi. Given the probability that fungi continue to cause over 90 percent of the plant losses attributable to pathogenic agents, this de-emphasis of mycological training may have been overdone.

Although mycologists and fungal physiologists made a major contribution over the years to the training of plant pathology graduate students, there is little historical evidence that they collaborated actively in research programs within the Department of Plant Pathology. Of over 200 Ph.D. theses examined that dealt with fungal pathogens, assistance from mycologists was acknowledged in relatively few cases. In anywhere from one to several theses, however, assistance was acknowledged from Gilbert, Backus, Davis, Greene, Whittingham, Allen, K. B. Raper (Department of Bacteriology), and Harold H. Burdsall (Forest Products Laboratory). I found no example of a case where a mycologist of the Department of Botany had joined a plant pathology graduate student in the publication of a Ph.D. thesis. However, the fungal physiologist, Allen, did participate in the publication of at least one plant pathology thesis.

In retrospect, the record does not appear to reflect adequately contributions actually made by botany staff, particularly Backus, to the research efforts of many plant pathology graduate students. Backus gave extensive help, advice, and counsel on mycological questions routinely without any apparent desire for or expectation of publication credit. The record suggests that he received much less credit than he deserved and earned for his many mycological contributions to graduate research programs in plant pathology. Perhaps there is some compensation for this possible collective oversight in the virtual consensus among all who took his advanced mycology courses that Backus was an outstanding teacher.

All of the botany staff members referred to above had their own high-quality mycological research programs in the Department of Botany. A complete review of that work is beyond the scope of this undertaking. Only those mycological activities that related to work in the Department of Plant Pathology are considered herein. It is worth noting, however, that Gilbert, Backus, and Whittingham each supervised botany doctoral students working on classical plant disease problems and that Allen's work involved a whole stable of botany graduate students in investigations dealing primarily with host-parasite interactions.

After the retirement of Backus in 1971 and the premature death of Allen in 1976, no mycologist able and willing to teach advanced mycology courses was available in the Department of Botany. As a consequence, in 1974 an arrangement was made for Burdsall and Michael J. Larsen of the U.S. Department of Agriculture (USDA) Forest Service Center for Forest Mycology Research, Forest Products Laboratory, to teach two advanced mycology courses during alternate years in the Department of Plant Pathology. They were appointed as adjunct professors of plant pathology in 1974 and since then have served as the primary mycological resource persons for the Department of Plant Pathology. These appointments have enhanced cooperation between the Department of Plant Pathology and the Forest Products Laboratory and have tended to increase the accessibility of the Mycology Herbarium, of the fungal culture collection maintained by Francis Lombard, and of specialized mycological literature at the Center for Forest Mycology Research. Burdsall has collaborated with students of John G. Berbee, Donald M. Boone and John E. Mitchell in describing new fungal species.

MYCOLOGICAL STUDIES IN THE DEPARTMENT OF PLANT PATHOLOGY

In attempting to evaluate the mycological accomplishments of the department, the fact that records of those accomplishments are scattered through a vast literature presented a problem. Based on the assumption that the content of graduate student dissertations reflects the overall research activities of the department through the years, all available graduate student theses dealing with fungal diseases were examined in the hope of acquiring the desired historical perspective.

Exclusive of dissertations produced jointly with other departments, 480 doctoral theses were generated in the Department of Plant Pathology during the period 1912 through 1983 (Table 1). Fifty-four percent (260) of these theses dealt with fungal problems while 22, 16 and 3 percent dealt with viral, bacterial, and nematode problems, respectively; the remainder (5 percent) dealt with miscellaneous subjects such as tissue culture or abiotic disorders.

During the first three decades, about 70 percent of the theses dealt with fungi. With increasing interest developing in viruses, starting in the 1940s, and in bacterial pathogens during the 1970s, the proportion of theses dealing with fungi declined significantly from 1940 through 1979. The apparent increase in emphasis on fungal pathogens during the early 1980s is not based on a large enough sample to justify a conclusion that the trend toward decreased emphasis on fungal problems has been reversed.

Of the 260 dissertations dealing with fungal diseases, 136 contained mycological contributions. The remainder focused on host reactions, chemical control, disease resistance in the host plant, or on some other nonmycological aspect.

Mycological investigations over the years involved eighty-seven fungal species in fifty-three genera contained in nineteen orders and in three classes of the Deuteromycotina (Table 2). Within each of twelve orders only one fungal species was investigated: Plasmodiophorales (*Plasmodiophora brassicae*), Saprolegniales (*Aphanomyces euteiches*), Mucorales (*Rhizopus stolonifer*), Clavicipitales (*Claviceps*), Diatrypales (*Eutypella parasitica*), Ophiostomatales (*Ceratocystis fagacearum*), Polystigmatales (*Glomerella cingulata*), Rhytismatales (*Coccomyces hiemalis*),

TABLE 1

Percentages by decade of doctoral dissertations dealing with fungi, viruses, bacteria, and nematodes

Years	Theses	KIND OF PATHOGENIC AGENT				
		Fungi	Viruses	Bacteria	Nematodes	None[a]
	(#)	(%)	(%)	(%)	(%)	(%)
1912–19	20	70	5	15	5	5
1920–29	41	68	12	15	3	2
1930–39	46	70	11	15	0	4
1940–49	55	60	20	10	0	9
1950–59	102	55	36	4	2	5
1960–69	115	51	23	10	10	5
1970–79	71	37	24	31	1	7
1980–83	30	57	15	28	0	0
1912–83	480	54	22	16	3	5

[a] A miscellaneous grouping of theses including those dealing with tissue culture and abiotic stress factors.

Sphaeriales (*Hypoxylon mammatum*), Agaricales (*Mycena citricolor*), Exobasidiales (*Exobasidium vaccinii*), and Agonomycetales (*Rhizoctonia solani*). Two species belonged in the Aphyllophorales (*Phellinus pini* and *P. igniarius*).

Two genera in each of the following orders received study: Erysyphales (*Erysiphe polygoni* and *Shaerotheca* spp.); Hypocreales (*Gibberella saubinetii* and *Nectria galligena*); Uredinales (*Cronartium quercuum* and *C. ribicola*, and *Puccinia glumarum, P. polysora, P. sorghi*, and *P. graminis avenae*); and Ustilaginales (*Ustilago striaeformis, U. zeae, U. hordei*, and *Urocystis* spp.).

In the Peronosporales, *Pythium irregulare* and *P. debaryanum, Phytophthora palmivora* and *P. megasperma*, and *Peronospora parasitica* were studied.

In the Helotiales, genera and species investigated included *Gremmeniella abietina, Pseudopeziza ribis, Sclerotinia laxa, S. fructicola*, and *S. sclerotiorum*.

Ten fungal species in seven genera in the Dothidiales were investigated: *Apiosporina morbosa, Leptosphaerulina briosiana, Mycosphaerella pinodes, M. citrullina, Pyrenophora bromi, P. graminium, Ophiobolus graminis, Sphaerulina rubi, Venturia inaequalis*, and *V. pirina*.

In the Deuteromycotina, sixteen species in three genera of the Coelomycetes and twenty-two species in ten genera of the Hyphomycetes were investigated.

In reviewing the mycological work accomplished during the past seventy-five years, it was interesting to note that in 65 of the 136 studies with a mycological component, no further investigations of the mycological aspects of the disease problem apparently were undertaken. In very few cases were mycological investigations extended to two or three further studies. There are, however, some exceptions.

The fungi that have been studied most intensively in the department include: *Plasmodiophora brassicae* by L. R. Jones, J. C. Walker, Russell H. Larson, Paul H. Williams, and their associates; *Aphanomyces euteiches* by Donald J. Hagedorn, Mitchell, and their graduate students; *Fusarium oxysporum* f. *pisi* by Walker and Hagedorn and their coworkers including W. C. Snyder; *Venturia inaequalis* by George W. Keitt, Boone, and their colleagues; and *Ceratocystis fagacearum* by A. J. Riker, James E. Kuntz, and their coworkers.

Descriptions of New Species and Races

Although not officially on the faculty, Fred R. Jones of the USDA was housed in the department throughout his career and during the early 1920s. C. Dreschler, also of the USDA, was assigned temporarily to Madison to collaborate with Jones. Jones and Dreschler managed to isolate the very elusive fungal pathogen that caused pea root rot, and in 1925 Dreschler described it as a new species, *Aphanomyces euteiches*. In 1982, W. F. Pfender and Hagedorn determined that a host-specific race of the same pathogen, f. sp. *phaseoli*, was the cause of bean root rot in Wisconsin; the pea root rot pathogen was designated f. sp. *pisi*.

In 1944 B. W. Henry described *Chalara quercina*, the anamorph of the fungus causing oak wilt, as a new species.

In 1979, V. M. G. Nair, C. J. Kostichka, and Kuntz described *Sirococcus clavigignenti-juglandacearum*, the incitant of butternut canker, as a new species.

In 1980, Burdsall, H. C. Hoch, M. G. Boosalis, and E. C. Setliff described *Laetisaria arvalis* as a new species, a candidate biocontrol agent against *Pythium* sp. and *Rhizoctonia* sp..

During the period from 1960 to 1982, Boone and his students undertook extensive investigations of the fungal pathogens of cranberries. The taxonomic status of several fungal species was evaluated critically and two new species were described. In 1974, S. Tontyaporn confirmed the validity of *Exobasidium vaccinii* as a separate species from *E. oxycocci.* In 1982 G. J. Weidemann, Boone, and Burdsall described *Phyllosticta elongata* as a new species replacing *P. vaccinii* as the anamorph of *Botryosphaeria vaccinii.* In her thesis in 1982, K. J. Brown described *Physalospora albovaccinii* as a new species distinct from *P. vaccinii.*

In addition to descriptions of new fungal species, several fungi were discovered for the first time in the United States by departmental staff. Examples include the mycorrhizal fungus *Hebeloma arenosa,* found by Berbee in 1969 and later described as a new species by L. R. Hesler, and *Mycosphaerella laricina,* reported on larch by Robert F. Patton and R. N. Spear in 1983. Additionally, there are innumerable examples of departmental staff reporting the first appearance in Wisconsin of known pathogenic fungi.

Fungal Morphology

Many of the initial investigations of fungal diseases at Wisconsin have included descriptions of fungal morphology. Although collectively these descriptions constitute a significant contribution to mycology, much of the work that has been done in this area could properly be termed routine but necessary. The work of J. D. Rogers and Berbee (1964) on the developmental morphology of perithecia of *Hypoxylon mammatum* is an example of some of the more detailed work in the area of fungal morphology that has been done in the department.

During more recent years, electron microscopy has been used by J. R. Aist (1971) on the zoospores of *Plasmodiophora brassicae* (Table 2), by H. C. Hoch and Mitchell (1972) to determine ultra-structural changes in zoospores of *Aphanomyces euteiches* during sporogenesis, and by Douglas P. Maxwell, V. N. Armentrout, and L. B. Graves (1977) to study microbodies in pathogenic fungi. Scanning electron microscopy has been employed by Patton and his coworkers to show the infection process of several fungal pathogens on conifer needles as is exemplified by the work by Patton and Spear (1978) with *Scirrhia acicola* on pine needles.

Fungal Physiology

During the period from 1910 to 1985, fungal physiology questions that have been addressed routinely by plant pathologists at Wisconsin have involved the nutritional requirements of fungal pathogens in culture; effects of environmental variables on the development of fruiting structures and on spore production both in culture and on the host plant; and factors affecting the release, dissemination, longevity, and germination of spores.

Other physiological work has involved investigations of various fungal metabolites of significance in disease physiology. These studies include investigation of soft-rotting enzymes produced by *Rhizopus stolonifera* (1958), toxins produced by *Fusarium oxysporum* f. sp. *lycopersici* (1927), auxins and enzymes produced by *Ceratocystis fagacearum* (1962, 1975), auxins produced by *Pythium debaryanum* (1972), and mycotoxins produced by fusaria (1981) (Table 2).

The work at Wisconsin in the area of fungal physiology that has perhaps had the most far-reaching practical significance involved investigations of effects of temperature and moisture on the life history of *Cronartium ribicola,* the cause of white pine blister rust. E. P. Van Arsdel and associates (1956) established the precise environmental conditions required for the production of telia and basidiospores, the vulnerability of the fragile basidiospores to adverse environmental impacts, and the specific environmental conditions required for basidiospore germination and infection of pine needles by the pathogen. This classical work has provided the basis for developing the effective and economical, nonchemical measures currently being used to control blister rust of eastern white pine.

Population Dynamics of Soil Fungi

During the period from 1949 through 1971, Backus had a continuing program involving a series of botany graduate students that dealt with populations of soil fungi as related to soil and vegetation. Their work constituted a major contribution both to systematic mycology and to soil microbiology. It is presented in a series of botany doctoral dissertations and publications. An efficient system of sorting soil fungi for their quantification was developed by M. Christensen (1969), working with Backus, and is presently being used to advantage in the Department of Plant Pathology in the quantification of leaf surface fungi by John H. Andrews and coworkers.

In the Department of Plant Pathology, relatively little work has been done on the population dynamics of soil fungi. Work by R. G. Pratt and Mitchell (1975) on the recovery of *Phytophthora megasperma* from soil and by A. A. Reyes and Mitchell (1962) on the population dynamics of fusaria in the rhizosphere are among examples of recent studies in this area.

Natural Variability and Genetics of Fungi

Although resistance breeding, especially of vegetable crops and forest trees, has been a major thrust of the department over the years, much greater emphasis generally has been placed on the genetics of host plant resistance than on the genetics of the pathogen. Nonetheless, various studies have demonstrated variability in cultural characteristics or in pathogenicity of several fungal plant pathogens. These have included investigations of variability in *Fusarium oxysporum* f. sp. *conglutinans* (1930), *Pseudopeziza ribis* (1934), *Coccomyces hiemalis* (1934), *Venturia pirina* (1940), *Glomerella cingulata* (1947), *Sclerotinia fructicola* (1948), *Helminthosporium sativum* (1956), and *Plasmodiophora brassicae* (1960) (Table 2).

Further work has clarified the genetic bases for variability in *Glomerella cingulata* (1949), *Helminthosporium sativum* (1954), and *H. turcicum* (1959). Other investigations have clarified the genetic bases for variability in *Ustilago hordei* (1940), and in both *Puccinia sorghi* and *P. polysora* (1958 and 1959) (Table 2).

The most significant work that has been done in the department on natural fungal variability has involved the fusarial wilt pathogens. This work dates back to 1916 when L. R. Jones and his coworkers developed the cabbage variety Wisconsin Hollander, with resistance to *Fusarium oxysporum* f. sp. *conglutinans*. Many investigations involving this pathogen, and also *F. oxysporum* f. sp. *lycopersici*, were undertaken during subsequent years.

During much of this period, H. W. Wollenweber of Germany was the world's leading authority on the taxonomy of the fusaria. In 1931, Wollenweber published his famous monograph on the fusaria and in 1935, co-authored a major book on the subject with O. A. Reinking. Meanwhile, various workers with expertise in the fusaria had been expressing the view that, because of the extreme variability of entities recognized by Wollenweber as species, the taxonomy of the fusaria should be revised to decrease the number of recognized species.

At Wisconsin, intensive investigations of the pea wilt pathogens *(F. oxysporum* f. sp. *pisi,* races 1 and 2) had gotten underway. W. C. Snyder had come to Wisconsin to work with Walker on this problem and in 1933 published his important paper on the variability of the pea wilt pathogen with reference to variability in other species of *Fusarium*. The work established that fusaria causing different wilt diseases, that had been designated as separate species by Wollenweber, exhibited overlapping cultural characteristics to the extent that the advisability of simplifying the then-existing nomenclature of these entities became apparent. In 1934, an international meeting was convened in Madison, Wisconsin, to deal with problems in the taxonomy of the fusaria. Among those present at that meeting were: Wollenweber, Reinking, C. D. Sherbakoff, H. Johann and A. Bailey.

Figure 13.1 The International *Fusarium* meeting, 1934.
L-R Wollenweber, Bailey, Reinking, Sherbakoff, Johann

Meanwhile, Snyder had moved on to the University of California-Berkeley, where he and A. N. Hanson completely revised the genus *Fusarium* and reduced the number of species in the genus to those that can be reliably described on the basis of consistent morphological differences.

Induced Variation in Fungi

During the late 1930s, the focus in the area of fungal variability at Wisconsin gradually switched from the fusaria to intensive investigations of the variability and genetics of *Venturia inaequalis,* with emphasis on induced variability in the pathogen.

What follows is a story about a light, about penicillin, and about induced variability in fungi. In 1932, Daniels and Heidt developed the capillary mercury vapor lamp. German-born A. Hollaender came to the United States in 1921, became naturalized as a United States citizen in 1927, obtained his A.B., M.A., and Ph.D. (1931) degrees at the University of Wisconsin, and concurrently served as an assistant in physical chemistry (1929–31). From 1931 to 1933 he served as a Natural Research Council Fellow in Biological Sciences in the Plant Physiology Laboratory of the University of Wisconsin Department of Botany. In collaboration with J. F. Stauffer, Hollaender equipped and adapted the Daniels-Heidt lamp to permit controlled ultraviolet (UV) radiation of biological materials.

During this period, Duggar was among the leading plant virologists (as well as internationally recognized for his work in fungal physiology, bacteriology, and plant physiology), and in collaboration with Hollaender demonstrated that tobacco mosaic virus withstood 200 times the UV energy values that were lethal to the bacterium *Serratia marcescens.* Using the same equipment, A. E. Diamond and Duggar (1940) induced mutations of *Rhizopus suinus* by UV radiation. Thus, by 1940 it had been demonstrated that dramatic changes in fungi could be induced by sublethal UV radiation of fungal spores.

In 1929, Fleming reported the discovery of penicillin and in 1938 the compound was isolated in pure form by H. Florey and E. B. Chain. The first of the "miracle" drugs thus became available—but not in supply adequate to meet requirements during the 1939–45 war years. Consequently, ways of increasing the production of penicillin soon were to become a high priority item for the Allies of World War II.

During the war years, improvements in penicillin production came in several steps. The first industrially produced penicillin was obtained by surface culture methods. In 1943, Raper and D. F. Alexander (USDA Northern Regional Research Laboratory) discovered penicillin-producing strains of *P. chrysogenum* that could be grown in submerged culture, including the high-yielding strain 1951 B25. At the Carnegie Institution, mutagenic treatment (X-ray) of this strain yielded the "super-strain", X-1612.

In the fall of 1943, Backus was asked by the War Production Board to initiate a program to improve penicillin production by developing superior strains of the fungus. Backus initiated the program in 1944. In his own hand-written words: "My motive has been to make possible contribution to the war effort and to speed, if possible, the time when penicillin may be available for civilian use".

Prior to joining the University of Wisconsin Departments of Botany and Plant Pathology faculty, Backus had acquired his Ph.D. degree under Gilbert and had had a postdoctoral experience with B. O. Dodge, who discovered heterothallism in the Ascomycetes (1927) and contributed significantly to the concept that fungal characters are inherited. Consequently, at the time he was appointed to the faculty, Backus had state-of-the-art knowledge of the then newly emerging discipline now known as fungal genetics.

Initially Backus proposed, among other things, to produce the teleomorph of *Penicillium chrysogenum* and then to evaluate ascospore-derived colonies for penicillin production. But consequent to mounting evidence that variation in fungi could be induced by UV radiation without the disruptive chromosomal damage associated with X-ray treatments, Backus decided to focus on the production and evaluation of UV-induced mutants of the fungus. Collaboration with Stauffer, who had the light, then was initiated. This collaboration yielded the UV-induced mutant strain X1612 of *C. chrysogenum* widely known as Wisconsin Q176, which gave up to a four-fold increase in penicillin production. Cultures of Q176 were furnished by Backus, without condition or consideration, to penicillin-producing companies throughout the world. Through the efforts of the American Friends of China, a culture of Q176 even ended up in a cave in China where it was anticipated, unrealistically in retrospect, that penicillin could be produced. The penicillin project of Backus and Stauffer was to continue for another decade and led to the discovery of a pigmentless mutant of *P. chrysogenum* that yielded much more penicillin than did X1612.

Shortly after the war (1946), C. Auerbach and J. M. Robson demonstrated that fungal variability could be induced in *Penicillin notatum* by nitrogen mustard. Thus, shortly after the end of World War II, the stage was set for fundamental investigations of induced variability of fungal plant pathogens.

In the Department of Plant Pathology, this approach constituted in part a methodology for seeking explanations for the extent of natural variation in the pathogenicities of fungal plant pathogens. O. H. Calvert and coworkers (1949) successfully induced, with nitrogen mustard, cultural and pathogenic variability in *Phoma lingam* that mimicked much of the natural variation of the pathogen. In 1952, E. C. Gasiorkiewicz and coworkers, in their efforts to explain the natural variability of *Pyrenochaeta terrestris,* reported that different mutants induced by nitrogen mustard had both greater and less virulence that did parent cultures from which they were derived. They concluded that any extant strain of *P. terrestris* may mutate spontaneously to produce more virulent strains. Unfortunately, no further work was done at Wisconsin on the variability of either one of these pathogens.

In the Department of Plant Pathology the plant pathogen that has received the most attention in investigations of genetic variability in pathogenicity is *Venturia inaequalis*. In 1938, Keitt and D. H. Palmiter reported heterothallism and genetic variability in this pathogen. Additional controlled crosses yielding genetic analyses were reported by Keitt and M. H. Langford in 1941. This work established that the fungus was hermaphroditic but self-sterile, and comprised of plus and minus compatibility types. Thus, the groundwork for genetic studies of *V. inaequalis* was laid (Chapter 7).

Further work by Keitt, C. C. Leben and J. R. Shay (1943) established that differential virulence in the pathogen to two different apple varieties was determined at two different loci with no evidence of linkage between the two. Subsequently, Boone and associates reported eleven additional genes at different loci controlling virulence to different varieties of *Malus* spp., and demonstrated that an avirulence gene at one locus generally was epistatic to any virulence alleles at other loci in cases where two or more pathogenicity genes controlled virulence to an apple variety.

After about 1956, the work of Boone and associates predominated in the further development of the *Venturia* story. Induced mutants of the fungus were generated by exposure to UV radiation and to nitrogen mustard. Many morphological and color mutants and 107 nutritionally deficient mutants were produced. Many of the nutritional mutants were subjected to genetic analyses and to pathogenicity tests with and without the specific nutrient deficiency of each mutant supplied at the site of inoculation. This exhaustive experimentation indicated that the product of a single gene conferring virulence in the pathogen on a specific apple variety probably did not involve a nutritional factor, as was originally hypothesized. But as a consequence of genetic analyses involving mating type, mutant characters, and virulence or avirulence in the fungus, more than twenty-five genes were tentatively located in relation to their centromeres and many of them were tested for linkage. Thus, over the years a wealth of genetic information on the *V. inaequalis*-apple system was accumulated.

The work done on this sytem from 1941 to 1968 by Keitt, Boone, and their graduate students constituted the most significant mycological contribution of the Department of Plant Pathology during the first seventy-five years of its history. Thanks to their efforts the department had assumed, for a very considerable period of time, a position of leadership in the field of fungal genetics.

[Meanwhile Hollaender, who adapted "the light" for biological experimentation, went on from Wisconsin to become recognized as one of the world's leading biophysicists.]

PROGNOSIS

This chapter has dealt with approaches plant pathologists at Wisconsin have taken in their efforts to achieve an understanding of the fungi that cause plant diseases with the goal of meeting the needs of their clients—the growers, farmers, and foresters of the world. During the period covered, new kinds of equipment, including the ultraviolet light and the electron microscope, along with dramatic new discoveries, such as heterothallism in the Ascomycetes, have resulted in sporadic leaps forward followed by much necessary and productive backing and filling. Although a great deal of progress had been made, we are only beginning to achieve an understanding of the fungi.

In the years ahead the goal will remain essentially unaltered, but discoveries already in place and others yet to be conceived will be exploited in a continuing effort to achieve that goal. In the Department of Plant Pathology, Sally A. Leong and her associates are employing the tools of the molecular biologist to clone fungal genes and hopefully to identify their products. If the promise of this new technology can be realized, an entirely new understanding of the fungi, and of ways to manipulate them to the advantage of humankind, may be at hand.

TABLE 2
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi*, seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
Myxomycota			
Plasmodiophoromycetes			
Plasmodiophorales			
Plasmodiophora			
P. brassicae	J. Monteith, Jr. (1924)	L. R. Jones	Temperature and moisture effects
P. brassicae	F. L. Wellman (1928)	L. R. Jones	Life history
P. brassicae	W. L. Seaman (1960)	R. H. Larson	Variations in pathogenicity
P. brassicae	J. R. Aist (1971)	P. H. Williams	Cytology and kinetics of zoospores
Eumycota			
Mastigomycotina			
Oomycetes			
Saprolegniales			
Aphanomyces			
A. euteiches	R. T. Sherwood (1958)	D. J. Hagedorn	General biology
A. euteiches	J. L. Cunningham (1961)	D. J. Hagedorn	Behavior of zoospores
A. euteiches	M. W. Temp (1966)	D. J. Hagedorn	General biology
A. euteiches	H. C. Hoch (1972)	J. E. Mitchell	Ultrastructure zoosporogenesis
A. euteiches	H. S. Bhalla (1973)	J. E. Mitchell	Biology of oospores in soil
A. euteiches	W. F. Pfender (1981)	D. J. Hagedorn	f. sp. *phaseoli* and f. sp. *pisi* distinguished
A. euteiches	K. M. Kobriger (1982)	D. J. Hagedorn	Soil inoculum potential
Peronosporales			
Pythium			
P. irregulare	L. F. Roth (1940)	A. J. Riker	Environmental influences
Pythium spp.	C. Yang (1964)	J. E. Mitchell	Effect of nutrition on growth and reproduction
P. debaryanum	K. Yoshi (1972)	D. J. Hagedorn	Production of IAA in culture
Phytophthora palmivora	O. A. Reinking (1922)	L. R. Jones	Description on coconut and cacao
P. megasperma	R. G. Pratt (1974)	J. E. Mitchell	Distribution and biology in soil

TABLE 2 *Continued*
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi,* seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
Peronospora parasitica	M. W. Felton (1942)	J. C. Walker	Life history
Zyzomycotina			
Zygomycetes			
Mucorales			
Rhizopus stolonifer	D. N. Srivastava (1958)	J. C. Walker	Soft rotting enzymes
Ascomycotina			
Clavicipitales			
Claviceps	F. T. McFarland (1921)	L. R. Jones	Life history
Diatrypales			
Eutypella parasitica	D. Lachance (1966)	J. E. Kuntz	Life history
Eutypella parasitica	J. T. Kliejunas (1971)	J. E. Kuntz	Developmental morphology
Dothideales			
Apiosporina morbosa	H. G. McMillan (1919)	L. R. Jones	Life history
Leptosphaerulina briosiana	E. S. Martinez (1963)	E. Hanson	Life history
Mycosphaerella pinodes	W. W. Hare (1943)	J. C. Walker	Life history
M. citrullina	W. F. Chiu (1948)	J. C. Walker	Life history
Pyrenophora bromi	P. W. Chamberlain (1943)	J. G. Dickson	Life history
P. gramineum	H. L. Shands (1932)	J. G. Dickson	Infection studies
Ophiobolus graminis	R. J. Davis (1924)	J. G. Dickson	Life history
Sphaerulina rubi	L. K. Jones (1922)	G. W. Keitt	Life history
Venturia inaequalis	D. H. Palmiter (1932)	G. W. Keitt	Natural variability
Venturia inaequalis	J. R. Shay (1943)	G. W. Keitt	Inheritance of mutant characters
Venturia inaequalis	C. C. Leben (1946)	G. W. Keitt	Nutritional study
Venturia inaequalis	D. M. Boone (1950)	G. W. Keitt	Inheritance of induced mutations
Venturia inaequalis	R. L. Pelletier (1953)	G. W. Keitt	Amino acid nutrition
Venturia inaequalis	H. A. Lamey (1954)	G. W. Keitt	Nutrition and genetics of induced mutants
Venturia inaequalis	D. M. Kline (1956)	G. W. Keitt	Pathogenicity of induced mutants
Venturia inaequalis	H. S. Bagga (1966)	D. M. Boone	Genetics of pathogenicity
Venturia inaequalis	L. S. Leu (1967)	D. M. Boone	Genetic control of anastomosis
V. pirina	M. H. Langford (1940)	G. W. Keitt	Heterothallism and variability
Erysiphales			
Erysiphe polygoni	C. E. Yarwood (1934)	J. G. Dickson	Diurnal cycle
Erysiphe polygoni	J. R. Stavely (1965)	E. Hanson	Factors affecting pathogenicity
Sphaerotheca spp.	D. L. Coyier (1961)	A. C. Hildebrandt	Life history

TABLE 2 *Continued*
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi,* seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
Helotiales			
Gremmeniella abietina	P. Blenis (1982)	R. F. Patton	Life history
Pseudopeziza ribis	E. C. Blodgett (1934)	G. W. Keitt	Life history
Sclerotinia laxa	E. C. Calavan (1945)	G. W. Keitt	Life history
S. fructicola	K. S. Thind (1948)	G. W. Keitt	Variability and nutrition
S. sclerotiorum	H. C. Newton, Jr. (1972)	L. Sequeira	Life history
Hypocreales			
Gibberella saubinetii (=zeae)	A. J. Ullstrup (1934)	J. G. Dickson	Variability in pathogenicity
Nectria galligena	E. M. Lortie (1962)	J. E. Kuntz	Life history
Ophiostomatales			
Ceratocystis fagacearum	C. H. Beckman (1953)	A. J. Riker	Nutrition in culture
Ceratocystis fagacearum	T. F. Geary (1962)	J. E. Kuntz	Production of cellulases, pectinases, auxins
Ceratocystis fagacearum	P. Fenn (1975)	J. E. Kuntz	Production of IAA
Polystigmatales			
Glomerella cingulata	J. O. Andes (1947)	G. W. Keitt	Variability
Glomerella cingulata	F. B. Struble (1949)	G. W. Keitt	Inheritance of variability
Rhytismatales			
Coccomyces hiemalis	R. O. Magie (1934)	G. W. Keitt	Variability of monosporic cultures
Sphaeriales			
Hypoxylon mammatum	R. H. Gruenhagen (1944)	A. J. Riker	Life history
Hypoxylon mammatum	J. D. Rogers (1963)	J. G. Berbee	Developmental morphology of perithecia
Hypoxylon mammatum	D. K. Bagga (1968)	E. B. Smalley	Physiology
Basidiomycotina			
Hymenomycetes			
Agaricales			
Mycena citricolor	C. J. Rodrigues (1965)	D. C. Arny	Environmental influences
Aphyllophorales			
Phellinus pini	C. E. Owens (1934)	L. R. Jones	Cultural characteristics
P. igniarius	R. E. Wall (1962)	J. E. Kuntz	Variations in varieties
Exobasidiales			
Exobasidium vaccinii	S. Tontyaporn (1974)	D. M. Boone	Taxonomy
Urediniomycetes			
Uredinales			
Cronartium quercuum	J. E. Nighswander (1959)	R. F. Patton	Life history

TABLE 2 *Continued*
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi*, seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
C. ribicola	E. P. Van Arsdel (1954)	A. J. Riker	Environmental effects on life history
C. ribicola	E. M. Hanson (1972)	R. F. Patton	Basidiospore germination
Puccinia glumarum	C. W. Hungerford (1925)	L. R. Jones	Life history
P. graminis avenae	W. L. Gordon (1932)	J. G. Dickson	Environmental effects on uredia, telia
P. sorghi	P. M. LeRoux (1954)	J. G. Dickson	Spore germination
P. sorghi	A. L. Flangus (1958)	J. G. Dickson	Genetics
P. sorghi	R. Syamananda (1958)	J. G. Dickson	Light and temperature affects
P. sorghi and *P. polysora*	E. Schieber (1959)	J. G. Dickson	Genetics
P. sorghi and *P. polysora*	M. S. Pavig (1960)	J. G. Dickson	Morphology, cytology, taxonomy
Ustilaginomycetes			
Ustilaginales			
Ustilago striaeformis	W. H. Davis (1922)	L. R. Jones	Life history
U. zeae	D. H. Bowman (1939)	J. G. Dickson	Sporidial fusion and cytology
U. hordei	W. M. Bever (1940)	J. G. Dickson	Genetics
U. hordei	J. F. Shafer (1950)	J. G. Dickson	Life history
Ustilago and *Urocystis*	M. J. Thirumalachar (1948)	J. G. Dickson	Survey
Deuteromycotina			
Coelomycetes			
Botryodiplodia theobromae	V. N. Armentrout (1976)	D. P. Maxwell	Organelle changes during conidial germination
Ceuthospora lunata	M. R. Schwartz (1981)	D. M. Boone	Life history
Colletotrichum			
C. lagenarium	M. W. Gardner (1917)	L. R. Jones	Life history
C. circinans	J. C. Walker (1918)	L. R. Jones	Life history
C. pisi	S. Ou (1945)	J. C. Walker	Life history
C. graminicola	G. W. Bruehl (1948)	J. G. Dickson	Life history
C. gloeosporioides	G. C. Marks (1963)	J. G. Berbee	Life history
Diplodea pinea	L. J. Mueli (1940)	A. J. Riker	Life history
Phoma lingam	M. P. Henderson (1914)	L. R. Jones	Life history
Phoma lingam	O. H. Calvert (1948)	J. C. Walker	Induced variability
Phyllosticta solitaria	E. J. Kohl (1930)	G. W. Keitt	Life history
Phyllosticta spp.	G. J. Weideman (1980)	D. M. Boone	Taxonomy of species
Pyrenochaeta terrestris	A. M. Gorenz (1948)	J. C. Walker	Life history
Pyrenochaeta terrestris	E. C. Gasiorkiewicz (1951)	R. H. Larson	Induced variability

TABLE 2 *Continued*
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi,* seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
Septoria			
—on Rubus	E. W. Roarke (1918)	G. W. Keitt	Life history
—on cereals	G. F. Weber (1922)	A. G. Johnson	Taxonomy, life history
S. passerini	G. J. Green (1953)	J. G. Dickson	Life history
S. glycines	M. T. Mmbaga (1980)	D. C. Arny	Life history
Sirococcus clavigignenti-juglandacearum	N. A. Tisserat (1982)	J. E. Kuntz	Life history
Hyphomycetes			
Alternaria solani	R. D. Rands (1917)	L. R. Jones	Life history
Alternaria solani	E. D. Jones (1953)	H. M. Darling	Variability in pathogenicity
A. porri	H. R. Angell (1928)	J. C. Walker	Life history
Alternaria	S. M. Saad (1969)	D. J. Hagedorn	Life history
Aspergillis spp.	C. J. Rabie (1965)	E. B. Smalley	Toxic metabolites
Cercospora zebrina	R. D. Berger (1962)	E. Hanson	Life history
Cladosporium carpophilium	G. W. Keitt (1914)	L. R. Jones	Life history
C. fulvum	C. B. Sumner (1931)	J. C. Walker	Life history
Corynespora cassiicola	P. T. Onesirosan (1973)	D. C. Arny	Life history
Cylindrocladium scoparium	W. G. Thies (1969)	R. F. Patton	Biology
C. floridanum	S. Hadi (1974)	J. G. Berbee	Environmental effects
Fusarium			
F. culmorum	P. M. Simmonds (1928)	J. G. Dickson	Life history
F. oxysporum f. sp. *apii*	T. C. Ryker (1934)	J. C. Walker	Life history
F. oxysporum f. sp. *conglutinans*	W. B. Tisdale (1920)	L. R. Jones	Life history
F. oxysporum f. sp. *conglutinans*	E. C. Tims (1924)	J. C. Walker	Life history
F. oxysporum f. sp. *conglutinans*	L. M. Blank (1930)	J. C. Walker	Variability
F. oxysporum f. sp. *lini*	W. H. Tisdale (1917)	L. R. Jones	Life history
F. oxysporum f. sp. *lini*	R. B. Streets (1924)	L. R. Jones	Life history
F. oxysporum f. sp. *lycopersici*	E. E. Clayton (1920)	L. R. Jones	Life history
F. oxysporum f. sp. *lycopersici*	H. H. Haymaker (1927)	L. R. Jones	Life history
F. oxysporum f. sp. *pisi* race 1	M. B. Linford (1927)	L. R. Jones	Life history
F. oxysporum f. sp. *pisi* race 1	W. C. Snyder (1932)	J. C. Walker	Cultural variability
F. oxysporum f. sp. *pisi* race 2	W. J. Virgin (1940)	J. C. Walker	Life history
F. oxysporum f. sp. *pisi* races 1 and 2	G. L. Worf (1961)	D. J. Hagedorn	Comparison of races
F. tricinctum	W. F. Marasas (1969)	E. B. Smalley	Taxonomy
Fusarium spp.	C. C. Chi (1959)	E. Hanson	Etiology
Fusarium spp. producing mycotoxins	D. Cullen (1981)	E. B. Smalley	Genetics, descriptions

TABLE 2 *Continued*
Doctoral dissertations containing mycological contributions produced from 1912 through 1983, with fungi classified according to Ainsworth and Bisby's *Dictionary of the Fungi*, seventh edition, 1983.

Taxon	Thesis	Advisor	Mycological contribution
Fusarium spp.	A. A. Reyes (1961)	J. E. Mitchell	Population dynamics in rhizosphere
Helminthosporium			
—on barley	A. G. Johnson (1914)	L. R. Jones	Taxonomy, life history
—on rice	G. O. Ocfemia (1923)	J. G. Dickson	Taxonomy, life history
H. oryzae and *H. sativum*	C. Wang (1947)	J. G. Dickson	Nutrition in culture
H. sativum	R. D. Tinline (1954)	J. G. Dickson	Physiology, genetics
H. sativum	R. V. Clark (1956)	J. G. Dickson	Variation in pathogenicity
H. turcicum	P. S. Knox-Davies (1959)	J. G. Dickson	Cytology, genetics
H. carbonum and *Stemphylium sarcinaeforme*	G. M. Murray (1975)	D. P. Maxwell	Cytology of germinating conidia
Isariopsis griseola	C. Cardona-Alvarez (1956)	J. C. Walker	Life history
Kabatiella caulivora	J. P. Martin, Jr. (1959)	E. Hanson	Life history
K. zeae	F. J. Reifschneider (1979)	D. C. Arny	Life history
Agonomycetales			
Rhizoctonia solani	B. L. Richards (1920)	L. R. Jones	Temperature effect
R. solani	L. R. Roth (1940)	A. J. Riker	Environmental influences

CHAPTER 14

Phytobacteriology and the Making of the Department

Luis Sequeira

"Some people strengthen society just by being the kind of people they are."
—JOHN W. GARDNER

On the evening of April 22, 1985 in Washington, D.C., a brilliant young researcher, Steven E. Lindow, received the National Academy of Sciences Award for Initiatives in Research. The award was in recognition of Lindow's pioneering research demonstrating the role of epiphytic bacteria in ice nucleation and resultant frost damage in plants. As the tall, bearded figure of young Lindow slowly made its way to the podium to receive the award, I reflected on the reasons and circumstances that led to his being there. The reasons are clear enough—his work had been innovative and exciting, and had received a great deal of publicity, as will be discussed later in this account. The circumstances, however, are not as evident. Lindow's main contributions stemmed from work he carried out for his Ph.D. thesis in the Department of Plant Pathology at the University of Wisconsin. To understand how this work came about, one would have to know a great deal about the long history of strong ties between that department and the Agricultural Research Service of the U.S. Department of Agriculture (USDA). Above all, one would have to know about the tradition of excellence in the field of phytobacteriology at Wisconsin. How this tradition was established is the subject of this article.

It is important to note that phytobacteriology as a field of research had its inception at Wisconsin long before the Department of Plant Pathology was established. In fact, phytobacteriology provided the "raison d'être" for the establishment of the department. How this came about is both interesting and enlightening; circumstances and serendipity played as much a role as careful planning and a vision of the future.

THE RUSSELL LEGACY

When one attempts to chronicle the history of phytobacteriology at Wisconsin, all geneological lines intersect at one point: Harry L. Russell. Russell was one of the real leaders of agricultural science at Wisconsin and was best known for his ability to apply theoretical science to the needs of agriculture. Most would recognize Russell as the long-term (1907–30) dean of the University of Wisconsin College of Agricultural and Life Sciences. Very few would know, however, that Russell was one of the first trained plant bacteriologists in the world.

When young Russell was an undergraduate at the University of Wisconsin, the field of bacteriology had just come into its own as a result of the fundamental discoveries of Louis Pasteur and Robert Koch. By 1887, when Russell was a junior in college, the scientific world had just been given irrefutable proof that microbes caused animal disease. There was an air of excitement because new discoveries into the nature of disease were being made at a rapid pace. The new subject of bacteriology quickly captured the imagination of many young scientists, such as Russell. He enrolled in bacteriology and by the time he had completed his college work he had decided to pursue graduate work in this new science.

Russell travelled to Germany in 1891 to work in Koch's laboratory in Berlin, where so many other young scientists had flocked to work under the celebrated scientist. Finding that Koch was virtually unavailable to students, however, he returned to the United States after a year and enrolled at Johns Hopkins University. During that year abroad he had broadened his horizons well beyond the orientation into public health in Koch's laboratory and by now had decided to specialize in plant bacteriology. What prompted that decision is not entirely clear, but it is evident that he perceived that this was an uncrowded area of research where rapid progress and fundamental new discoveries, akin to those that Koch had made in the animal field, were possible. He was fortunate that his mentor at Johns Hopkins was W. H. Welch, a distinguished animal pathologist who had the good sense of allowing his students the widest possible freedom in the selection of research projects. Russell now felt free to pursue his interests in plant pathology and with Welch's full support, began investigations into the nature of plant immunity to bacteria.

It should be pointed out that Russell launched a career in a field that, in 1891, was virtually unknown and not regarded as very promising by many. After all, eminent scientists such as de Bary, Hartig, Migula, Sorauer, etc., had expressed skepticism about the importance of bacteria as plant pathogens. In the United States, only a few investigators, including T. Burrill at the University of Illinois, J. C. Arthur at the Geneva Agricultural Experiment Station in New York, and M. Waite at the USDA in Washington, D.C., were actively involved in research with bacterial plant pathogens. Their work, at the time Russell became active in the field, had not received much notoriety. He soon made contact with Waite, however, and a short while later found it convenient to shift his laboratory from Johns Hopkins to the USDA. There he found stimulation in being able to discuss his research findings not only with Waite but with Erwin F. Smith, who at that time was heavily involved in research on the nature of peach yellows. Smith did not resolve that problem, but later went on to study bacterial diseases of plants and became the leading scientist in this field. It is interesting to speculate that had destiny allowed Russell to develop a professional career in phytobacteriology, it is likely that he and not Smith would have become the leading figure. Russell had received more extensive training in bacteriology and had an earlier start in the field than Smith. Like Smith he was bright and aggressive; unlike Smith he was gregarious and outgoing, which surely would have provided him with considerable advantages in a scientific career. As it was, Smith was destined to have the entire field of phytobacteriology to his own for many years.

It is important to note that for his Ph.D. thesis Russell had selected a topic that is still one of the major unresolved problems in plant pathology. Specifically, he wanted to determine why ordinary bacteria are prevented from multiplying in the intact plant, but do so rapidly when plants are injured or debilitated in some way. Beardsley points out that Russell's dissertation "represented the first general treatment of the bacterial immunity of plants." Although the techniques available at the time did not allow Russell to explore the subject in other than a superficial way, his work impressed his mentor and contemporaries. In 1883, after a short sojourn at the University of Chicago, he was offered the position of assistant professor of bacteriology at the University of Wisconsin, his duties to be divided between the College of Agriculture and the College of Letters and Science.

It is a curious turn of fate that Russell accepted the position at Wisconsin even though Dean William Henry made it clear that the new assistant professor had to work on bacteriological problems affecting the dairy industry. This meant that Russell would have little time to work with

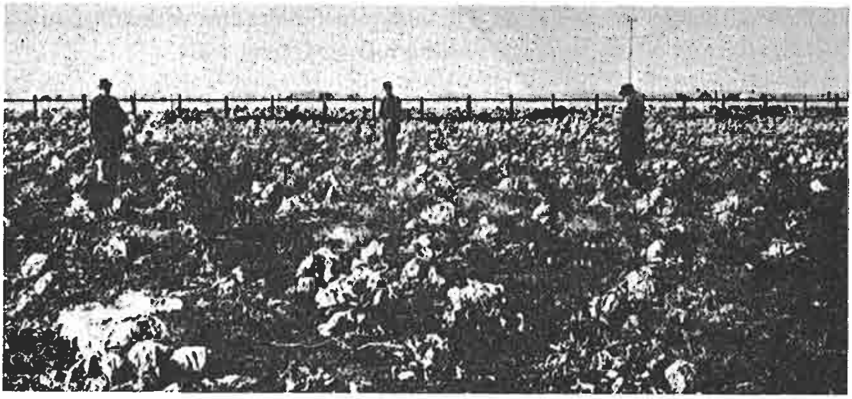


Figure 14.1 A devastating leaf rot, *Xanthomonas campestris,* of cabbage in the Racine area of Wisconsin, 1895.
L-R H. L. Russell, W. J. Hansche (farm), J. J. Davis, MD

bacterial plant pathogens, his main area of interest. He persisted with his interest in this field, but only in the early stages of his career at Wisconsin. While dedicating most of his efforts to the problem of tuberculosis in dairy cattle, he found time in 1895 to explore a devastating leaf rot disease of cabbage in the area of Racine, Wisconsin. He determined by inoculation with pure cultures that the problem was bacterial in nature and, in fact, suggested that the pathogen was *Bacillus campestris,* an organism previously described from rotted turnips and rutabagas. He wanted to discover how the bacterium penetrated the plants and suspected that the water pores (hydathodes) at the edges of the cabbage leaf were involved. He carried out inoculation experiments in the field in 1897 that proved conclusively that his ideas on bacterial penetration were correct. As he prepared his material for publication, he discovered that Smith had published a detailed account of the cabbage rot problem. Although Russell was aggravated and complained that Smith had full knowledge of the work going on at Wisconsin, there was little he could do. This experience, however, did not diminish his enthusiasm for plant bacteriology and only impressed on his mind the need to bring to Wisconsin additional strength in this area of science. He had the opportunity to bring these ideas to fruition when, as dean of the college, he convinced the administration to establish a Department of Plant Pathology and brought L. R. Jones from the University of Vermont as its first chairman.

OF DESTINY AND SERENDIPITY: ENTER "L. R."

Jones had impeccable credentials for the position at Wisconsin. Like Russell, he had strong roots in Wisconsin, having been born and raised in a farm near Brandon. Like Russell, he had shown an early interest in plant bacteriology when, as a senior at the University of Michigan, he had come in contact with Smith. At that time Smith was completing his Ph.D. thesis, based on the research on peach yellows that he had carried out at the USDA. Jones attended Smith's Ph.D. examination and was immediately struck by the great opportunities for research that existed in plant pathology. Encouraged by his counselor at Michigan, V. M. Spalding, Jones decided on a career in plant pathology. Upon receiving the bachelor's degree in 1889, he moved to the University of Vermont where, during the next twenty years, he developed one of the leading centers for research on plant pathology in the nation. He maintained close ties with colleagues at the University of Michigan, from which he received the Ph.D. degree in 1904.

Soon after his arrival at Vermont, Jones became interested in diseases of potato and other vegetables, particularly the bacterial soft rot problems. This research interest continued unabated for several years and culminated, in 1899, with a six-month visit to Smith's laboratory in Washington. There he had an opportunity not only to renew his acquaintance with Smith, but to pursue intensive investigations on the potato soft rot problem without the burdens of teaching and other duties at Vermont. More importantly, the central location of the laboratory in Washington necessarily brought Jones in contact with many of the leaders of agricultural research in the United States, contacts that would be extremely useful to him in the future.

An important product of Jones' research on bacterial soft rot was the publication, from 1901 on, of several papers that became classics and firmly established his reputation as an innovative scientist. In particular, two papers published in 1905 and 1909 were mainly responsible for establishing basic concepts on the mechanisms for tissue breakdown, a characteristic of the soft rot syndrome. He recognized that the bacterium *Bacillus carotovorus,* which he described (now known as *Erwinia carotovora),* produces enzymes that dissolve the middle lamella of the potato tuber cells, thus causing tissue maceration. He demonstrated that these enzymes catalyze the breakdown of the pectic substances that bind cells together. It was this research that brought Jones to the attention of Dean Russell, who at that time was involved in recruiting a chairman for the proposed Department of Plant Pathology at Wisconsin. Russell's own interest in promoting basic studies in plant bacteriology, and his earlier involvement in the solution of the cabbage rot problem in Racine, clearly coincided with Jones' interests and approach. That he offered the position to Jones is not at all surprising—they were kindred minds, brought together at the appropriate time by circumstance. This early relationship was to shape the destiny of the Department of Plant Pathology at Wisconsin for the next seventy-five years.

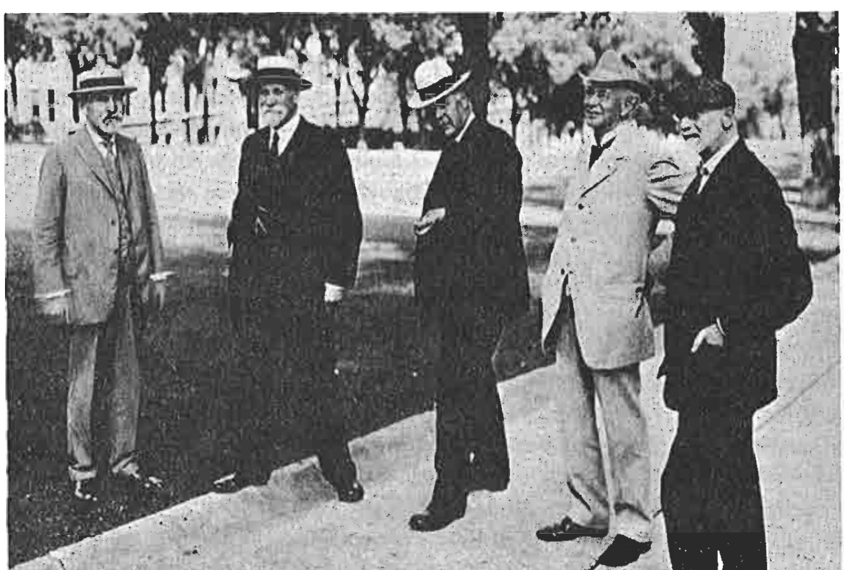


Figure 14.2 Leaders at the time of the founding of the Department of Plant Pathology.
L-R Pres. C. Van Hise, Pres. T. C. Chamberlain, Dean H. L. Russell, Dean W. A. Henry, Prof. S. M. Babcock

With Russell's support, Jones went on to build what was unquestionably the strongest department of plant pathology in the country for many years. He brought to Wisconsin the famous triumvirate—James G. Dickson, J. C. Walker, A. Joyce Riker—and others that, like George W. Keitt, were less flashy but equally effective leaders. Together they trained hundreds of young plant pathologists for several decades, and many of these students themselves became leaders in the field. Although it is apparent that Russell and Jones had a community of professional interests and shared a firm desire to achieve excellence for the institution, their personal interactions as dean and chairman frequently were strained. Affable outside of his office, once inside Russell was a strict disciplinarian, demanding in the extreme, and tight fisted. He requested a close account of every penny that had been doled out to the departments. Beardsley relates that, when asked by the chairman of the Department of Genetics, Leon Cole, how a particularly difficult meeting with the dean had gone, Jones replied: "Well, Leon, I'll tell you. I'm going to have to take the whole weekend off just to get my self-respect back."

It is interesting that, in spite of the absorbing administrative duties and deep involvement with professional societies, Jones continued to publish research dealing with diseases, many of them bacterial, of a wide variety of crops. For example, between 1916 and 1923 he published several articles (in collaboration with A. G. Johnson, C. S. Reddy, and other colleagues) on bacterial blights of barley and red clover. In a landmark paper on the influence of soil temperature on potato scab published in 1922, he established for the first time the close dependence between disease and environmental conditions. He trained a large number of students, many of whom went on to distinguished careers in plant pathology. In the field of phytobacteriology, special mention should be made of Charlotte Elliott, who obtained the Ph.D. in 1918 and soon thereafter joined the laboratory of Smith at the USDA in Washington. Although overshadowed by Smith's preeminence, she made substantial contributions, culminating with the publication of the *Manual of Bacterial Plant Pathogens* in 1930, three years after Smith's death. This manual, and its subsequent revision, remained the best taxonomic guide and source of information on specific bacterial pathogens for many years.

By 1920 the department had expanded far beyond the initial interest in plant pathogenic bacteria. The excellent staff that Jones had assembled covered a very wide range of disease problems caused by fungi and viruses. Interest now centered on the effect of environment on disease development, thus leading to the establishment of the famous Wisconsin tanks where soil temperatures could be controlled with some degree of precision.

Jones' major contribution was that he made research the focus of the activities of the department. He perceived that the practical needs of the farmer could only be resolved by excellent research on basic aspects of plant disease. He made research the most important component of instruction of graduate students. He selected staff members with care, he delineated their responsibilities, and then gave them not only complete freedom of activity but all the support he could muster. Among the earliest appointments he made to the department were those of Keitt, Walker, and Riker. He persuaded the USDA to assign Dickson and F. R. Jones to Madison, and he saw to it that their work was closely integrated with that of the department. These young staff members were destined to become leaders in many areas of plant pathology; phytobacteriology was one of the areas they emphasized. It is to their contributions in this area that we must now turn.

THE CABBAGE ROT CONNECTION: ENTER "J. C."

Like Russell and Jones before him, Walker had deep roots in Wisconsin. He had grown up in Racine, Wisconsin, the son of a dairy man. He was keenly aware of the disease problems faced by the vegetable growers in his area, and, as a freshman at the University of Wisconsin, he sought the advice of Jones. Jones guided the young investigator into the study of onion smut for an undergraduate thesis, which won all-university honors, then suggested that he go on to graduate school and, eventually, brought him to the department as a staff member in 1919. That Jones was a keen judge of character and ability is attested by the preeminence attained by Walker during the next forty years as a plant pathologist. He has been one of the dominant figures in plant pathology; during his professional life he probably contributed more to our knowledge of vegetable diseases than anyone before him or since. He developed to a fine art the approaches previously established by Russell and Jones: the use of basic research as a tool to solve applied problems. He was able to combine basic and applied aspects of the science of plant pathology in such a way that both advanced apace. Others will describe in this volume the significance of the many contributions of Walker and his students to the development of plant pathology in this country. For the purposes of this article, I must limit myself to his contributions to phytobacteriology, an extremely important component of his research activities.

Early in his career at Wisconsin, Walker turned his attention to cabbage black rot, the bacterial disease that had been Russell's preoccupation some twenty-five years earlier. In a paper published in 1920 (in collaboration with W. B. Tisdale) he showed that the pathogen was transmitted by contaminated seed. A short while later he showed how, by immersing the seed in hot water, this and other diseases of cabbage could be controlled simply and effectively. This was an early demonstration of Walker's overall approach: to carry out basic research to determine where in its life cycle the pathogen is most vulnerable to control procedures.

Walker's greatest contribution to the field of phytobacteriology, however, was the demonstration that the variability of the host could be used to advantage in developing control measures. The approach was disarmingly simple. He operated on the general principle that if one searched hard enough within wild and cultivated forms of a particular crop, resistance to any plant disease could be found, provided that a proper assay had been developed. Standard breeding techniques could then be used to transfer resistance to an appropriate commercial cultivar. At the same time, one could learn a great deal as to the number of genes that control resistance and their stability under different environmental pressures. Thus, general principles concerning the nature of disease resistance could be derived.

Walker and his students applied this general approach to a wide variety of bacterial plant diseases. These included black rot of cabbage, angular leaf spot of cucumber, common blight and halo blight of beans, and bacterial wilts of cucumber and bean. Space does not allow a detailed listing of the many contributions that deal with these particular diseases. Suffice it to say that a wide variety of resistant germplasm and many resistant varieties became available to plant breeders and the seed industry as a result of this work. Many of these same sources of resistance are being used today. Much of our present knowledge of the genetic control of disease resistance in these crops stems from this work. The breeding approach for the control of vegetable diseases has been continued to our day by many of his students and by many of their own students as well. At Wisconsin, Glenn S. Pound, Donald J. Hagedorn, and Paul H. Williams have been outstanding representatives of this lineage.

Walker's breeding work also provided the basic tools for studies on the nature of disease resistance: a wide range of susceptible and resistant plant genotypes. Many of Walker's students explored possible physiological properties associated with the resistant genotype in many different bacterial diseases, particularly halo blight of bean and angular leaf spot of cucumber. The names of S. Van Gundy, P. N. Patel, B. Deverall, and J. N. Chand figure prominently in this work. The physiology of bacterial plant pathogens received a great deal of attention, particularly with regard to virulence factors, as in the example of the production of pectolytic enzymes by soft-rot bacteria (E. Echandi and Van Gundy). The discovery that specific amino acid changes were associated with toxin production by halo blight bacteria in bean (Patel) provided the basis for work that, much later, pin-pointed a specific plant enzyme as the target for the toxin. Other students explored environmental effects on multiplication and spread of bacterial plant pathogens, specifically of *Pseudomonas lachrymans* (Van Gundy, A. G. Wiles), *Xanthomonas vesicatoria* (M. V. Nayudu), *Pseudomonas phaseolicola* (Patel), *Xanthomonas campestris* (A. A. Cook), and *Corynebacterium flaccumfaciens* (S. Rickard).

Walker helped the development of phytobacteriology at Wisconsin in many indirect ways. An example from my personal experience may suffice to illustrate the point. Walker had the reputation of being rather gruff and uncommunicative. Upon arriving at Wisconsin I found that, to the contrary, he was most cordial and helpful. He invited me to come along on several short trips, during which he introduced me to the problems of the vegetable industry in Wisconsin. His grasp of the agronomy of vegetable crops was as impressive as his recollection of every paper published on any particular disease of those same crops. He suggested various bacterial disease problems that could be tackled from a physiological standpoint. I indicated that having just arrived I did not have the funds to purchase the minimum equipment that I required to initiate this work. He said nothing at the time but, early the next day, he came into the laboratory and said, in a very casual way: "I have about $4,000 left over from a grant; why don't you buy something nice for your lab with the money. Just tell Audrey what it is that you want." He left before I could mutter a few words of gratitude. That and other expressions of encouragement I received from him during my early days at Wisconsin were extremely important to me in establishing a research program on bacterial physiology.

THE CROWN GALL CONNECTION

The appointment of Riker as an instructor of plant pathology in 1922 was, in my view, part of Jones' plan to strengthen phytobacteriology at Wisconsin. Walker was already there to carry on with the research that Jones had initiated on bacterial diseases of vegetables; Riker was selected to provide strength on bacterial diseases of orchard crops. Riker was one of the first students of Keitt and it was at Keitt's instigation that Riker was given a faculty appointment. Keitt's responsibilities included many difficult problems affecting the orchard fruit industry; among these were fireblight and crown gall, diseases that to this day have proven refractory to control. Before he came to Wisconsin as a student, Riker had worked as a bacteriologist at a hospital in Cincinnati during World War I. Thus, by the time he arrived in Wisconsin he was unusually well qualified for work in phytobacteriology and Keitt was happy to hand him the crown gall problem. Keitt, however, retained an active interest in the fireblight problem. Over the years many of Keitt's students (for example, P. W. Miller, S. S. Ivanoff, and L. Shaw) made substantial contributions to our knowledge of the epidemiology and control of fireblight.

Riker's Ph.D. thesis on crown gall initiation and morphology was technically superb. He continued this research once he joined the faculty at Wisconsin. It was this early work that established Riker's reputation as a scientist for it brought him to a classic confrontation with E. F. Smith, at that time the world's authority on bacterial diseases. Smith believed that crown gall was initiated after the bacterium multiplied inside the plant cells; Riker's anatomical studies indicated that the bacterium remained outside the cells throughout the entire process of tumor formation. Although it was obviously difficult for a young researcher to confront the more senior, established investigator with his data, he did so and was proven right. This episode provides a useful insight into Riker's character; a mild, rather unobtrusive person, he was nonetheless stubborn and determined. Much later in his professional life, he was involved in another classic confrontation, this time with G. McNew (who later became the head of the Boyce Thompson Institute) at an annual meeting of the American Phytopathological Society. McNew, a rather aggressive person, insisted that bacteria could be purified by the simple dilution plate procedure; Riker protested that only single cell isolation could accomplish purification. C. J. Nusbaum, now at North Carolina State University and one of Riker's first students, related to me that it was only during this argument that he had ever seen Riker become "livid with rage." In reality, there should have been no argument at all; Riker was right.

Riker's lifetime interest in the crown gall disease stemmed from his conviction that plant and animal cancers were fundamentally similar at the biochemical level. He was instrumental in convincing the National Institutes of Health and other medically oriented foundations of the value and convenience of studying plant cancer. With their support, he expanded his group and one of his graduate students, Albert C. Hildebrandt, became a staff member. In association with Riker, Hildebrandt guided a large number of students in the areas of crown gall and cell biology. The basic concept that crown gall was an extremely useful model system for the study of plant cell transformation was quickly embraced by laboratories throughout the world. The fact that crown gall is probably the best understood plant disease in the world today attests to the foresight and wisdom of Riker and his colleagues.

One of the early converts to the crown gall system was A. C. Braun. Although his mentor at Wisconsin was James Johnson, and his responsibilities centered on tobacco diseases, Braun realized the potential of the crown gall system. Soon after he joined the staff at the Rockefeller Institute (now Rockefeller University) in 1938, Braun initiated a program of research on the basic biology of plant transformation that provided, over the years, many of the basic concepts that guided research in this area. Noteworthy among his many contributions was the demonstration that callus tissues derived from crown galls grew in the absence of growth-regulating substances in the medium, whereas normal tissues could not. It is interesting that along with his work on crown gall, Braun went on to do pioneering work on tobacco wildfire toxin, which provided the basis for much of the research program of Richard D. Durbin at Wisconsin years later.

Interest in the crown gall system became almost universal in the plant sciences soon after Braun's seminal contributions; the search for the factor he called TIP (for "tumor-inducing principle") became the "Holy Grail" of plant pathology. TIP was the subject of numerous claims and counterclaims that clouded the issue and illustrated once more the futility of attempting to run before you learn to walk. Only after the techniques in molecular biology were in place was the answer to the TIP question possible. The question eventually was resolved in E. W. Nester's laboratory at the University of Washington, where it was shown that a portion of the bacterial genome was transferred and stably integrated in the plant. Part of the necessary proof, however, was obtained at Wisconsin. John Kemp and one of his graduate students, E. Hack, were the first to show that a bacterially coded enzyme, octopine synthetase, was expressed in crown gall tissues. Kemp and several collaborators at Wisconsin were the first to show that the bacterial transformation system could be used to transfer foreign genes (for example the gene for bean seed storage protein) from one plant to another. This work was partly responsible for the tremendous increase in interest and activity in the area of plant genetic engineering that we are witnessing today. After Kemp's departure, interest in crown gall at Wisconsin continued via the appointment of Jo Handelsman, first as research associate and, more recently (1985), as assistant professor. Handelsman's research interests involve the development of monoclonal antibodies to surface constituents of virulent and avirulent strains of *A. tumefaciens*. These studies are an essential step to determine precisely how DNA is transferred from the bacterium to the host cell.

It is clear that Riker's major contributions to science stemmed from his ability to promote phytobacteriology (as well as tissue culture, forest pathology, and epidemiology) at the university, state, and federal government levels. He had an uncanny ability to persuade people to provide funds for research or merely to collaborate with him. One of the long-lasting relationships he established was with O. N. Allen of the Department of Bacteriology. Allen was one of the leading experts in the field of root-nodulating bacteria (rhizobia) in the country. Both scientists perceived that *Agrobacterium* and *Rhizobium* were closely related organisms and that there were interesting parallels between their parasitic and symbiotic ways of life. Allen and Riker became good friends and over the years they shared responsibilities for guiding several graduate students. The close ties that Riker and Allen established between the Departments of Plant Pathology and Bacteriology initiated a tradition of collaboration that has remained to this day. This relationship has been of inestimable value in providing graduate students with an environment where they benefit from exposure to a wide range of research approaches and from expert help in specific areas. A direct result of this collaboration was the establishment at the University of Wisconsin in 1978 of a fund, in memory of Professor Allen, designed to promote work on plant-associated bacteria in the Department of Plant Pathology. This was the generous gift of Mrs. O. N. Allen. The fund has been used to support visits by distinguished scientists who have contributed to the instructional program of the department. A further example of Mrs. Allen's generosity was the establishment of the O. N. Allen Graduate Fellowships, which are being used to attract outstanding students in the field of phytobacteriology to enroll in the Department of Plant Pathology.

OF BLIGHTS AND WILTS AND MANY THINGS

Thus far in this account, as in so many other descriptions of the formative years of the department, there is a tendency to emphasize the contributions of staff members who achieved world-wide notoriety, while omitting important contributions of other members who, for one reason or another, did not achieve the same degree of recognition. In this section I intend to remedy this problem by highlighting the impact of these contributions to the field of bacteriology, although space does not allow me to do them full justice.

In the early 1920s tobacco wildfire appeared in Wisconsin and was so destructive that it threatened the entire tobacco industry in the state. It is fortunate that J. Johnson, then of the Department of Horticulture and a collaborator with the USDA, was on the scene. He began a long series of important investigations leading to control of the disease. Influenced by L. R. Jones, he sought basic information concerning the epidemiology, the process of infection, virulence factors, and potential sources of resistance. A critical contribution was the publication in 1937 of a paper that, for the first time, described the relationship between water-soaking of leaf tissues and bacterial invasion. In addition, in collaboration with H. F. Murwin, he demonstrated that the wildfire bacterium produced a toxin in culture that could reproduce some of the symptoms of the disease. This was one of the first demonstrations of the importance of toxins in pathogenesis and eventually led to the establishment of the wildfire toxin as a premier tool in physiological plant pathology. Control procedures were devised with the help of several graduate students, including Braun, W. B. Allington, and Murwin. Collaboration with Robert Fulton eventually led to the identification and utilization of sources of resistance, culminating with the release of resistant varieties that are widely used even today.

Alfalfa today is Wisconsin's most important agricultural crop and, to a large extent, owes its enormous popularity as forage for dairy cattle to the research efforts of soil scientists, plant breeders, soil microbiologists, and plant pathologists at the University of Wisconsin. Among the key contributions made by plant pathologists were those of F. R. Jones, a USDA scientist working in the Department of Plant Pathology, whose classic work on control of bacterial wilt is one of the major success stories in the history of plant pathology. About 1924, Jones noted a new soil-borne disease in southern Wisconsin and northern Illinois that caused substantial stand losses. Plants were lost due to wilting but, more importantly, losses due to winter injury were intensified; farmers had no choice but to plow up the alfalfa stands and plant again, but to no avail. Jones quickly identified the problem as bacterial wilt; he isolated and identified the causal agent (now known as *Corynebacterium insidiosum)* and soon afterward had developed a screening technique that could be used to select resistant plants. By 1926 he had initiated a breeding program in collaboration with R. A. Brink of the Department of Genetics and L. F. Graber of the Department of Agronomy.

The process of developing a resistant alfalfa proved to be extremely difficult; few plants were resistant and these exhibited no winter hardiness at all. Hybrid lines that combined both characteristics had to be synthesized and, by the mid 1940s, several promising clones had been selected. Only after several years of field evaluations in Wisconsin and elsewhere was certified seed of the a new variety, Vernal, available to growers. That was in 1954, after some thirty years of painstaking work. Vernal became immensely popular and by 1975 this variety had added an estimated one billion dollars to the value of the Wisconsin alfalfa crop.

Throughout this account I have pointed out how certain bacterial diseases traditionally have been studied at Wisconsin over several generations; thus, the history of the department can be traced merely by pointing to succeeding staff members who have tackled the same problem. Yet another example is potato scab. I have indicated that L. R. Jones did classical work on environmental factors that affect the disease. After that early work, substantial contributions to our knowledge of resistance to scab were made by Henry M. Darling in 1937, while, at the same time, Russell H. Larson emphasized the relationship between soil reaction and incidence of scab. Several graduate students, including R. W. Goss and W. J. Hooker, contributed greatly to our knowledge of the activities of the pathogen in the soil and in contact with host roots.

"MODERN TIMES"

This last section is euphemistically titled "Modern Times", for as in Charlie Chaplin's classic film, the world of phytobacteriology today seems to be overwhelmed by tools and techniques. Phytobacteriology today is dominated by molecular biology and is dependent on rapidly developing techniques that seem to dictate where the work will go. When laboratory techniques dominate thought, there is little opportunity to consider how whole organisms, or indeed entire populations, behave in the field. Walker wrote, not so long ago, that "specialty groups will lose plant pathology. There is a real danger of being cut off in space without a landing gear." Phytobacteriology at Wisconsin has not escaped this problem entirely, but, in my estimation, has managed to keep abreast of modern developments yet retain contact with the real world. Walker's admonition has had a strong influence in maintaining balance in research approaches in phytobacteriology within the department. Just prior to his retirement, the department brought Luis Sequeira and Durbin to work on the physiology of disease resistance to bacterial plant pathogens. A short while later, new staff appointments included Arthur Kelman and Christen D. Upper, who have since made important findings dealing with the ecology, epidemiology, and control of bacterial pathogens. More recent staff appointments (Kemp, Sally Leong, Handelsman) illustrate a preoccupation with maintaining leadership in molecular biology.

It is not my intention to provide a detailed account of the contributions of present staff members in the Department of Plant Pathology to the field of phytobacteriology. First, such an account would be self-serving. Second, one cannot determine now which recent contributions are really significant and will survive the test of time. I must, however, justify my view that balance has been maintained in this field of research. A few examples should suffice to illustrate the point; the first will allow me to return to my opening remarks concerning the recent award to Lindow.

The numerous recent articles about ice-nucleating bacteria in learned journals, and the extensive coverage in the press and television of the controversies regarding field testing of genetically modified epiphytic bacteria for frost prevention, all fail to point out that the origin of all this excitement can be found in observations made many years ago by Paul Hoppe, Deane C. Arny, and J. Martens at Wisconsin. They noted that corn seedlings infected with *Helminthosporium turcicum,* from inoculum consisting of ground-up leaf material, were more susceptible to frost damage in the field than healthy controls. They were right, but for the wrong reasons. In the early 1970s Upper, a member of the USDA's Plant Disease Resistance Laboratory at Wisconsin, decided to pursue these initial observations. In collaboration with Arny, he demonstrated that fungal infection was not involved in the phenomenon. Rather, some unknown substance or microbial contaminant appeared to be responsible. The young graduate student, Steven Lindow, established that a bacterial contaminant in the inoculum was responsible for increasing frost damage. Lindow went on to determine the nature of the bacterium and established that it served as a nucleus for ice nucleation. This was the beginning of Lindow's very extensive studies on ice-nucleating bacteria, on the use of certain non-ice-nucleating mutants for control of frost damage, and on the nature of the bacterial component responsible for ice nucleation. Most of this work was carried out at the University of California at Berkeley and was the basis for the award given to him by the National Academy of Sciences, as mentioned earlier.

While Lindow's interests shifted to the genetic control of the ice nucleation property of bacteria, Upper (in collaboration with Arny, Susan S. Hirano, Douglas I. Rouse, and several graduate students) focused on the ecology and epidemiology of epiphytic bacteria. The ice-nucleating activity of some of these bacteria was used as a tool for quantitatively determining their populations on leaves. From this work have emerged several important concepts relating to the epidemiology of bacterial diseases, particularly of those incited by pathovars of *Pseudomonas syringae.* For example, J. Lindemann established that in brown spot of snap beans the bacterium has to multiply extensively on the surface of the leaf before symptoms appear. The concept that plant pathogenic bacteria have an extensive resident phase on leaf surfaces before a certain infection threshold is reached has important consequences. It certainly implies that the principles of bacterial epidemiology must be very different from those of fungal plant pathogens. This view is supported by field data which indicate that multiplication of epiphytic bacteria is independent of disease development. Similarly, the concepts that epiphytic bacteria are lognormally distributed among single leaf ecosystems and have a finite probability of causing disease (dependent on population size, host, and environment) have important implications in terms of our approach to control of these diseases.

Yet another example of research on diseases that have become important traditions at Wisconsin is bacterial soft rot of potato. The work of Kelman is but the latest link in a long chain that includes Henry M. Darling, Larson, Walker, and L. R. Jones, which ties the present with the beginnings of the department. The disease has been a perennially important problem for the potato industry of Wisconsin and has been responsible for major losses of stored potatoes. Kelman and collaborators have pinpointed the relationship between soft rot and sources of inoculum, handling of potatoes during harvest and storage, and the environmental conditions during storage. The development of methods for determining the potential for soft rot of potatoes going into storage has been a major contribution. Also, the demonstration, in collaboration with R. McGuire, that there is a relationship between calcium content of the tuber and incidence of soft rot has had a significant impact on the fertilizing programs employed by potato growers in the central sands area of Wisconsin. At the same time, Kelman and collaborators have pursued basic research on the relationship between the physiology of wound healing and relative susceptibility of potato tubers to soft rot. This work has provided guidelines as to proper handling of potatoes prior to storage. Thus Kelman's important contributions provide an excellent example of the department's strong tradition of applying the products of basic research to the solution of major problems faced by the agricultural industry.

Another strong tradition at Wisconsin is that the boundaries of the university reach well beyond the borders of the state. Research on plant pathogens at Wisconsin illustrates well this long-held principle; disease problems in other states or other countries have always been considered within the province of the department. The work on *Pseudomonas solanacearum* illustrates the point. Although one of the most important plant pathogens worldwide, it is typical of tropical and warm temperate zones; it occurs only occasionally in Wisconsin when the bacterium is brought in on transplant seedlings from the South. As far back as 1949, the basic relationships between severity of bacterial wilt of tomatoes, plant nutrition, and environmental factors had been determined at Wisconsin by M. E. Gallegly and Walker. When I interviewed for a position at Wisconsin, I indicated to the chairman at that time, Glenn S. Pound, my strong interests in pursuing research on virulence factors of *P. solanacearum,* but wondered if research on a problem of such limited importance in the state would be acceptable to the department. Pointing to Walker's work with the same pathogen, he said: "There's your answer. Dr. Walker had the freedom to work on that problem then and you have the same freedom to work on that problem now". His broad view of the mission of the department was one of the reasons I moved to Wisconsin. After many years of enjoyable and fruitful collaboration with other staff members and many fine students, I know that I made the right decision. We do know a bit more now about this interesting, forever treacherous organism.

> "They had a dream. . . . The dream was to build a fort of strength in plant pathology at Wisconsin, a fountainhead of knowledge where students could drink, and the waters of which would wet the dry lands of the whole world."—GLENN S. POUND

CHAPTER 15

Nematology

Henry M. Darling

Nematology in Wisconsin began quite abruptly in 1953 with identification of the potato rot nematode by Henry M. Darling. Grower reaction was immediate, demanding, even hostile, as the extent of the infestations expanded. Seed growers were most alarmed, for their future was at stake. They realized that several rather heavily infested fields had been found and that the pest persisted in the soil and was tuber-borne. First steps in containing its spread involved emergency measures restricting movement of diseased tubers, their controlled disposal, and prohibiting the production of all potatoes on infested land. Working with the State of Wisconsin Department of Agriculture, and the nematology section and quarantine people from the U.S. Department of Agriculture (USDA), a state quarantine was developed that would adequately restrict the pest locally and nationally. After several departmental meetings, strategies for eradicating the pest from infested soil were explored. Gerald Thorne was consulted on the use of chemical soil fumigants and a thorough review of the literature also indicated such an approach. As a result, Darling selected a piece of heavily infested land in 1954 and applied four fumigants in a replicated plot. At the end of the first season, it was evident that a split plow sole application of ethylene dibromide (EDB) was superior to all other treatments. Not a single infested tuber was found in any of the EDB replicates. Without added treatment, the plots were replanted the following year. Again, no infested tubers. In the meantime, a twenty-six acre field known to be heavily infested was similarly treated with EDB. No diseased tubers were found at harvest nor were any subsequently found on three successive crops following the single recommended treatment procedures with EDB. Other infested land was treated by growers using the methods that were developed, with similar results.

At this point, grower concern began to subside somewhat, but not until the federal government approved a bromide residue level for potatoes grown on treated land. This took two years, thanks to the patient and persistent efforts by lawyers from Dow Chemical Company. From 1954 to date, over 700 infested acres have been treated with EDB as described above without finding a single infested tuber, representing about half of the land known to be infested. Soil fumigation and a quarantine were thus satisfying immediate early demands.

This was not satisfying other departmental interests and concerns, however. Early in the program, the department received sound council and advice from Thorne who had charge of the nematology laboratory of the USDA in Salt Lake City, Utah, and who first described and published at length on the potato rot nematode. Shortly after his first visit to Wisconsin he retired from the USDA and was appointed professor of nematology in the department (1956). Outlines were prepared of courses that were open to all graduate students. In 1960, Darling received a Senior Fellowship Award to study nematodes in Holland to better prepare his background in nematology. Besides his studies with Professors Oostenbrink and Seinhorst at Wageningen, Holland, visits were made to nematology laboratories in England, Denmark, Germany, Sweden, and Norway. Upon returning, source information gathered in Europe and in the United States was organized into formal courses for presentation to our graduate students.

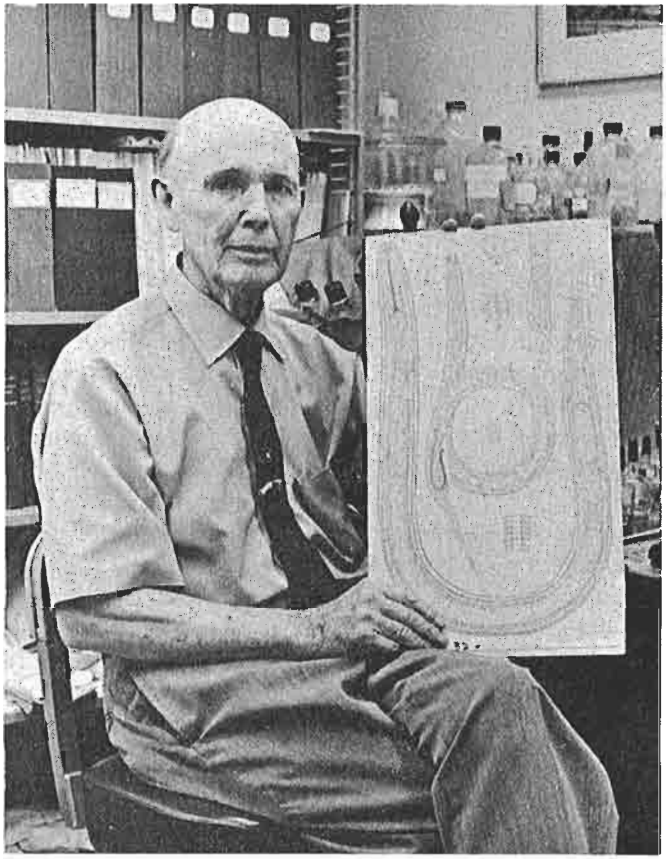


Figure 15.1 Gerald Thorne.

In addition, guidance in research in the diseases caused by nematodes, techniques to isolate and handle them, taxonomy, morphology, and much more were offered. Early research, however, related to *Ditylenchus destructor*. Lin Faulkner began studies on winter survival and hosts, population build-up, and other biological relationships under the Wisconsin environment. By 1959 he had developed techniques on rearing *D. destructor* on many species of soil fungi and on callus tissue in pure culture. After a period as head of nematology at Kansas he became director of the Irrigation Research Station at Prosser, Washington. Grover Smart published on the complex problem of host specificity and taxonomic variation between diverse collections from widely separated geographical locations and hosts. Smart currently heads nematology at the University of Florida, Gainesville. Roger Anderson did a fine thesis problem on the embryology and reproduction of *D. destructor* in 1967. He is currently in charge of the nematology laboratory for Agriculture Canada in Ottawa.

The first student in nematology was Vernon Perry, who had a part-time appointment in nematology with the USDA. His research involved the taxonomy and control of the spiral nematode on native bluegrass. Because of his previous experience with nematodes, he also provided council on nematode problems. He had Marie Standifer as a laboratory assistant during most of his stay, and shortly after receiving his degree in 1958 accepted the position of nematologist with the University of Florida, Gainesville, replacing the well-known nematologist J. R. Christie who was retiring. He is currently associate dean of agriculture in charge of research at Gainesville.

During this period, several other graduate students were working on problems involving nematodes other than *D. destructor.* Joe Dickerson studied population trends, overwintering, and pathogenicity of the lesion nematode on potatoes and corn. Dickerson did some excellent work with nematode problems in Kansas after receiving his degree and is currently head of plant pathology at Clemson University in South Carolina. Gerald Griffen also worked with a rather common nematode in Wisconsin, doing his research on ecological factors effecting the dagger nematode in an ornamental spruce nursery. He correlated winter injury to spruce with varying populations of this nematode. Since leaving Wisconsin, Griffen has been located in Logan, Utah, as regional nematologist with the USDA. Vernon White also worked on a problem that was common to Wisconsin. Three hosts were involved, apple, corn, and strawberry. He demonstrated that root damage caused by the dagger nematode incited early stages of decline in all three hosts. He is currently nematologist with the Great Lakes Chemical Company, and lives in West Lafayette, Indiana, specializing in the complicated legal problems associated with chemicals used for pest control. Although doing his major studies in entomology, Joe Saunders completed his thesis on nematode parasites associated with a wilt disease in Costa Rica in 1963.

Arthur J. Weber was one of the first students to work with Kenneth R. Barker, receiving a master's degree in 1964 for work on the canary grass root knot nematode. Johannes W. Klink studied the role of four nematode-trapping fungi on population trends of selected nematodes, and received his M.S. in 1965. Not all students coming to the department studied nematode problems peculiar to Wisconsin. Juan Heyns brought an extensive collection of both free-living and parasitic species collected from South Africa. Heyn did a thesis in 1961 on the taxonomy of his collection, describing twenty new species, four new genera, and a new subfamily from ninety species representing fifty genera. His superb camera lucida drawings are unsurpassed in quality. Heyn also had a fine musical talent and with his wife entertained group gatherings on several occasions. Returning to South Africa, he continued his interest in taxonomy and is currently professor in the Department of Zoology, Rand University, teaching and publishing regularly. Pedro Torrealba came to the department from Venezuela, also bringing a rather extensive collection of preserved specimens for study. Torrealba prepared keys to the species of two genera and the genera of one subfamily, and described four new species. His seventeen camera lucida illustrations rank with the finest ever prepared. Returning to Venezuela, he has worked as nematologist with the Shell Oil Company, Caracas. Armondo Campos came from Mexico, under the sponsorship of the Rockefeller Foundation. His research involved a cyst nematode from Mexico similar in morphology and apparently closely related to the destructive cyst nematode found on potatoes. Campos could not establish pathogenicity on potato, but did infect experimentally a wild *Solanum* sp. and tomato. In 1962, he completed an M.S. degree on overwintering of the root knot nematode in Wisconsin. He and his family returned to Mexico on completion of his Ph.D. studies in 1967, spent a few years in Pakistan and again returned to Mexico. Gaston P. Blair came to the department from Trinidad, West Indies, with material for studies on the destructive red ring disease of coconuts. It is one of the few nematode-incited diseases shown to be spread by an insect, the palm weevil. Blair returned to Trinidad to complete his studies with living material, came back to the department and completed his thesis in 1963, and again returned home to continue with the Ministry of Agriculture.

Several other activities were included in the overall nematology program. During the early years, several training schools were held mainly for agricultural commodity inspectors from states producing potatoes. Instruction concerned the detection and identification of *D. destructor.* They were also familiarized with details of the Wisconsin quarantine program to prevent possible imposition of reciprocal quarantines. Follow-up reports on the situation were sent to these people and to their departments at frequent intervals. No quarantines by other states developed, nor were any restrictions imposed on potatoes originating in Wisconsin. Almost from the beginning, several people from numerous states and a few foreign countries with interests in nematology, came for short periods to study, consult, and attend lectures.

As a laboratory assistant, Ella Mae Noffzinger prepared many of the permanent microscopic mounts from many diverse collections. At the same time, she became an accomplished taxonomist and often assisted others in identifying their collections. Mostly because of her work, the Thorne collection of permanent microscopic mounts totals about 2500 specimens and represents an excellent permanent reference source as well as a teaching aid. Included in the collection are major genera and many species of plant parasitic and free-living nematodes. Noffzinger left Wisconsin to assume a similar position in the Department of Nematology, Davis, California. A separate collection of Kodachrome slides was also assembled during this period from throughout the world and consists mainly of disease symptoms caused by nematodes on many hosts. Much of the research data recorded by photographs taken in the departmental photo lab are filed in this collection. A fine collection of books was purchased and given to the departmental library where it is cataloged. Many reprints have also been donated and are on file. All of the original camera lucida drawings Thorne prepared for his many publications are preserved in six special boxes and have become a part of the departmental archives. In 1961 Thorne published his book ***Principles of Nematology*** that has become a standard text throughout the world.

Budget restraints provided problems from the start. Modest amounts really stimulated ingenius arrangements for materials and equipment. Other than funding by the department and the dean's office, USDA-State North Central Regional project support provided needed laboratory microscopes, supplies, and some labor. Wisconsin Alumni Research Foundation also provided modest support. Private and industry sources originally provided limited gift funds as did the seed potato project. In total, all sources supported a lab assistant, student assistantships, materials and equipment, and some travel, and shared in staff salaries.

From about 1961 staff changes became rather frequent. For a short period before Thorne's book was published, he became restless and began to travel. He spent some months in Puerto Rico, took two winter trips to Arizona, and traveled down the Nile River in Egypt in what he described as a most memorable trip. In 1961, he officially retired. Barker then assumed all of the responsibilities for nematology and Darling returned to his potato projects with added interests in mint problems. Barker had been trained in nematology at North Carolina (Raleigh), but had just completed his studies in plant pathology here at Wisconsin. After three years, he returned to Raleigh as a staff member in nematology. This, again, necessitated the return of Darling, which was later followed by the temporary appointment of Dropkin in 1966. Blake from Australia came to nematology for a year of teaching in 1970. Bill Mai from Cornell University, Ithaca, New York, followed in 1976 and taught an accelerated two-week course. This was offered to all students in plant pathology. Then G. Bird from Michigan State, East Lansing, along with D. MacDonald (Minnesota), taught the two-week accelerated course in 1974. After a delay of a couple of years, Darling returned from retirement to teach the two-week course. During this period, the department decided that this temporary arrangement would at least offer some nematology to graduate students while pursuing their studies in plant pathology. On several occasions, the nematology position was voted number one priority by the staff and a search to fill the position intensified. It was felt that the two-week intensive course was too exhausting for student and lecturer alike, for each lecture session lasted an entire day. Finally in 1983, Ann MacGuidwin, who took her work first in Florida and then at Michigan State University, was hired as a full-time faculty member. She is presently organizing a teaching and research program.

Space seems to have always been a problem from the start as staff increased and more students arrived. Something had to be done. In 1958, all of the nematology group moved from the Horticulture Building to T-18, a temporary structure located about a block away. T-18 is now gone and the west end of Russell Labs covers its former location, but the move created problems. Although space was adequate, desks and microscope benches and other critical facilities were not in place, particularly benches for the microscopes. Work orders were delayed or ignored so long by the carpenters that necessary research studies declined, so staff and students alike got busy and built the benches and other furniture. This really got action, negative by the carpenters, but positive for everyone else. The situation resulted in a very viable rapport among faculty and students alike. Research thrived, enthusiasm for studies advanced, and a healthy spontaneity stimulated everyone. Students no longer complained about walking a short block to their lectures in the department, but this didn't last too long. The next move was made to the basement of a former garage near the corner of Walnut Strret and University Avenue, several blocks from the department and classes. Facilities were poor, even lacking, and spontaneity declined as did creativity and productivity. Contacts with other students and staff became fragmented. Better times arrived, however, and the move was made to Russell Labs in 1964.

Certain facts and events have coursed through the nematology program since it began. The high quality of its graduate students' research and subsequent accomplishments places a mark of excellence on each. Many other students in plant pathology learned about nematodes and the role they play in a pathologist's career. In more recent times frequent, but temporary, staff changes in nematology appeared to be fragmented, but it is now back on track. The legacy of excellence will continue. The service nematology has contributed to the welfare of the Wisconsin potato industry has also been of high quality. Research demonstrated for the first time that a chemical could be used to eradicate certain species of nematodes from infested soil by fumigation with EDB. However, this chemical has now been banned by the Environmental Protection Agency (1984). Cooperation through the years has been excellent with our state Department of Agriculture and a free exchange of ideas and data has made it a well coordinated and productive effort.

PART 3

Contributions and Perspectives

CHAPTER 16

Major Advances and Contributions by the Department

Arthur Kelman

During the past seventy-five years, dramatic advances have been made in the production of the diverse crops that are not only the mainstay of the animal industry of Wisconsin, but also provide food and fiber for the people of the state and nation. In 1984 Wisconsin ranked first in the United States in production of hay, corn for silage, cranberries (tied with Massachusetts), snap beans and green peas for processing, beets for canning, and cabbage for making sauerkraut. It also ranked among the top ten states in production of eleven other crops.

The improved quality and yield of crops in Wisconsin have resulted from the efforts of research and extension faculty in many departments in the College of Agricultural and Life Sciences. A major factor in this progress has been effective cooperation with the many U.S. Department of Agriculture (USDA) scientists who have been stationed at the University during this period. Additional strong support has come from faculty in the Departments of Bacteriology, Biochemistry, and Food Science in the College of Agricultural and Life Sciences, and the Department of Botany in the College of Letters and Science.

Plant pathologists have had a major role in these advances in crop production in Wisconsin and the nation and have also contributed significantly in advancing both the science and art of plant pathology. It is not possible to document completely within this article the specific major contributions made by faculty, staff, and students since this department was established. The references to specific research activities serve merely to illustrate the type and quality of the investigations in selected areas. More details are provided in the other chapters concerned with the various subject matter topics. Reference in most instances is made to the faculty member who served as the leader on a project to which other staff members and students may have contributed significantly. In general, examples selected are those that have had an impact on the direction of research in plant pathology or have a potential for future influence on specific areas of the field. The contributions cited have been organized under the following subject areas: etiology, epidemiology, disease physiology and nature of disease resistance, genetics of plant pathogens, and control, including breeding for disease resistance, chemical control, management practices, and biological control.

The importance of the contributions of our faculty and alumni not only to the field of plant pathology but to agriculture and science in general is reflected to some degree by the many honors that have been bestowed on them. Tables 1, 3A, and 3C summarize the major honors that faculty and alumni have received not only from their own peer groups, but also from national and international organizations. In addition to awards and honors, a large number of our faculty and alumni have been elected to leadership roles in many national and international organizations (Tables 2, 3B, and 3D).

ETIOLOGY

A large number of diseases have been discovered and described for the first time by faculty and students at the University of Wisconsin–Madison (Table 4). It is beyond the scope of this review to discuss each of these contributions in detail. The listing presented in Table 4 includes a broad range of different diseases caused by fungi, bacteria, viruses, and abiotic causal factors. For more detail on these discoveries reference should be made to other chapters in the text that describe specific research contributions.

In the late 1800s a very prosperous cabbage industry had developed in the Racine area. The first study on the diseases of the cabbage crop was made by Harry L. Russell, who was a new bacteriology faculty member. At that time black rot disease was beginning to cause severe losses periodically in the kraut cabbage crop in southeastern Wisconsin. In 1895 Russell identified the pathogen and proposed several good approaches for control. This was the first detailed study of a bacterial disease in Wisconsin. Erwin F. Smith was also working on the disease at this time and published a description of the bacterium, thus preempting Russell's studies on this pathogen.

One of the novel discoveries of the past decade arose from the 1964 experiment by Paul E. Hoppe (USDA-plant pathology) designed to evaluate resistance in corn lines to northern corn leaf blight. Test plants were inoculated by dusting them with a powder made by grinding blight-infected corn leaves. During the second night after this inoculation, a frost produced severe injury on all inoculated plants (resistant and susceptible to northern leaf blight); adjacent non-dusted plants were not injured. An investigation of this phenomenon by Steven E. Lindow, Deane C. Arny and Christen D. Upper led to the discovery that frost damage in corn and other frost-sensitive plants is mediated by the presence on leaves of certain bacteria that act as ice nuclei and trigger freezing of tissues at temperatures slightly below 0°C (−3 to −5°C). Plants without the bacteria supercool; they are able to withstand without damage temperatures that are several degrees below 0°C. One of these bacteria was discovered to be a strain of *Pseudomonas syringae,* a pathogen that causes leaf spots and cankers on many crops. The probability of injury at temperatures slightly below freezing is increased if ice nucleation-active bacteria are present. These findings indicated that frost damage can be minimized by reducing populations of ice-nucleating bacteria present on plants. Some practical progress has been made in reducing the hazard of frost injury by using the novel approach of reducing the populations of ice nucleation-active bacteria by direct or indirect methods.

A number of plant viruses, in particular those affecting deciduous woody plants such as species of *Prunus,* are highly unstable and extremely difficult to study. Many of these viruses produce similar and confusing symptoms on stone fruits. Leadership in development of methods for transmitting, separating, and purifying these viruses has been given by Robert W. Fulton and coworkers (1957–75). The elegant techniques that he refined are now in use around the world in laboratories that are engaged in studies on stone fruit viruses in particular. In addition, he was able to demonstrate the multicomponent nature of a number of viruses for the first time.

Specific antisera for the identification of a number of stone fruit viruses have been prepared by Fulton and his students. These antisera have become the standards in a large number of virus research laboratories around the world.

Improved serological techniques were developed by Steven A. Slack and coworkers (1978–82). These methods are currently used by many of the potato seed certification agencies in the United States. These studies initially involved the immunofluorescent staining procedures for the ring rot bacterium (with Arthur Kelman and Joy B. Perry, 1979) and were then followed by the use of the latex bead agglutination technique. The refinement of the latter technique for detection and diagnosis of the ring rot disease has served to stimulate research in other laboratories on methods to enhance detection of the ring rot bacterium, which still persists as one of the major threats to the seed potato industry of this country.

An intensive study of the early dying problem on potatoes in the central sands area was completed by Jack E. Mitchell, Douglas I. Rouse and coworkers (1978–83). The primary causal relationship of *Verticillium dahliae* and to a lesser degree the lesion nematodes to this problem were established. In the course of these studies Mohammad K. Rahimian and Mitchell (1982) provided the first clear evidence for a synergistic relationship between *Erwinia carotovora* and *Verticillium dahliae* in enhancing disease severity of the latter pathogen.

In the course of efforts to improve methods for detection and isolation of the soft rot *Erwinia,* Diane A. Cuppels and Kelman (1974) devised a semi-selective medium, crystal violet pectate, that has become accepted as one of the standard media in research with this group of bacteria because it allows easy detection and high recovery of pectolytic bacteria from soil or decayed plants.

EPIDEMIOLOGY

Studies on the epidemiology of the apple scab fungus by George W. Keitt, L. K. Jones (1926), and coworkers have served as a model for investigations that demonstrate dependence of effective chemical control on knowledge of the influence of environmental factors on spore production and dissemination. In the case of the apple scab fungus it was possible to demonstrate that a specific sequence of temperature and rainfall triggers the discharge of the ascospores. The clear delineation of the importance of ascospore infections in determination of the success or failure of apple spray programs has served as the basis for rational development of spray schedules in all apple-growing regions of the world. Detailed studies of the life cycle of the scab fungus yielded information on why early infections occur during rainy periods from the time of opening of the cluster buds of the apples until about two to three weeks after petal fall when the production of ascospores stops for the year.

A second major phase of this work was the discovery of the importance of the fallen leaves in the production of the perithecial stage that serves as the overwintering stage of the fungus and the primary source of inoculum in the spring (E. E. Wilson, 1928).

Similar studies of the influence of temperature and rainfall on the epidemiology of the cherry leaf spot fungus provided the basis for predictive models that served as the first studies of this type on cherry diseases (Keitt and coworkers, 1937). In cherry the period of susceptibility is the reverse of that in apple in relation to the apple scab disease. Primary infection by ascospores is sparse and serves chiefly to establish the fungus. Epidemic development of the fungus is dependent on the abundance of rain during the summer months.

One of the major conceptual developments on the role of environmental factors on disease development had as its starting point the interest of L. R. Jones (starting in 1916) in how soil temperature and mineral nutrition influence severity of soil-borne pathogens. In order to complete controlled experiments on soil temperature effects, a thermostatically controlled water bath unit was devised into which water-tight vessels containing plants growing in soil or other substrate could be inserted. This apparatus became known as the Wisconsin soil-temperature tank and various modifications of this system were constructed for studies of this type at research laboratories around the world (Jones and coworkers, 1926). A number of J. C. Walker's students completed research projects that explored the influence of macronutrients and soil temperature on the development of a large number of root and wilt pathogens. From the initial studies involving the

Fusarium wilt diseases of cabbage, flax, and tomato, a number of concepts, now generally accepted, were established: 1) soil temperature is a primary factor in determining rate and extent of development of root rots and vascular wilts while air temperature is of secondary importance, and 2) with a few exceptions the disease-temperature curve usually parallels the pathogen-temperature curve.

One of these exceptions is the classic investigation by James G. Dickson and coworkers (1923) on the influence of temperature on the incidence of seedling blight in corn and wheat (caused by *Gibberella saubinettii*). This was one of the first reports that provided clear evidence that one fungus can cause disease under very divergent temperature conditions on different crops mainly because of an effect of temperature on development of the host plant rather than an effect of temperature directly on growth of the fungus *per se.*

The study of Lewis F. Roth with A. Joyce Riker (1943) on the influence of pH and water status of the soil on root pathogens of pine seedlings remains as one of the classic studies of this type. This investigation clearly described the striking differences between organisms such as *Pythium,* which are dependent on a zoospore stage for primary infection, and organisms such as *Rhizoctonia,* that are in fact often inhibited under soil moisture conditions that are optimal for *Pythium.*

The most important disease of snap beans grown for processing in the Midwest is bacterial brown spot. Ecological studies in 1971–72 by G. L. Ercolani, a visiting scientist from Bari, Italy, with Donald J. Hagedorn and Robert Rand revealed for the first time that the causal bacterium overwinters on the surfaces of leaves of certain weed plants, particularly hairy vetch. Primary inoculum is disseminated in the spring from vetch plants that survive under snow cover during winter months. A novel aspect of these studies is the fact that these plants are not susceptible to the organism.

The various components of soil water potential were evaluated by Mitchell and coworkers to determine effects on differentiation of the asexual stage of *Aphanomyces euteiches.* This is one of the first reports indicating a major difference between physiological effects of osmotic water potential and matric water potential on this type of fungus. Furthermore, in the research on the ultrastructure of the somatic hyphae and zoospore formation of *A. euteiches,* it was found that mechanisms for zoospore formation in this fungus were uniquely different from those that had been described previously for phycomycetous fungi.

The ice nucleation temperatures of individual leaves were found to be related to the population sizes of ice nucleation bacteria and frost injury by Susan S. Hirano, L. S. Baker, and Upper (1985). In this study a novel technique was used which involves placement of individual leaves in buffer solutions in test tubes and holding them in constant temperature baths at −2.0°C to −4.0°C. With this assay a direct quantitative relationship was obtained between the temperatures at which ice nucleation occurred on individual oat leaves and the population sizes of ice nucleation-active bacteria present on these leaves. By means of this innovative approach it has been possible to predict the relative frost hazard to tomato plants.

As an outgrowth of epidemiological studies on ice-nucleating bacteria a model has been developed by Rouse, Erik V. Nordheim (Departments of Statistics and Forestry), Hirano, and Upper (1985) that relates the probability of foliar disease incidence to the population frequencies of bacterial plant pathogens. The lognormal distribution was used to describe the population size of pathogenic bacteria on individual leaves and the probit function was used to describe the probability of disease given the size of a bacterial population. When integrated with respect to bacterial population frequency, the product of the probability of disease, given a bacterial population size, for individual leaves and the frequency of pathogenic bacteria on individual leaves results in a cumulative normal frequency distribution. This distribution function describes the probability of disease incidence in a field. This is the first predictive model for bacterial disease incidence based on the conceptual approach delineated above and based on intensive and extensive quantitative analyses of the epidemiology of bacterial brown spot of beans.

Cultivars resistant to some bacterial diseases harbor smaller numbers of the ice-nucleating bacteria than susceptible ones; thus, the leaf-freezing technique also may become a tool in selection of frost-resistant plants.

Analyses by Jay W. Pscheidt and Walter R. Stevenson (1984) of the environmental factors governing spore production and dissemination of the potato early blight fungus have facilitated the development of one of the first programs in this region to forecast disease development patterns for the early blight disease. This program provides guidelines for growers to aid in decisions on timing of application of fungicidal sprays.

The basic ecological theory embodied in the concept of island archipelagos has been investigated by John H. Andrews and coworkers in studies on the diversity of microorganisms that exist as epiphytes on leaf surfaces (1980–85). These studies have been directed to identify the factors that influence prevalence and shifts of individual components including plant pathogens. This research is one of the first attempts to determine whether the MacArthur-Wilson equilibrium model of island biogeography can be applied to the dynamics of phylloplane communities.

Recent studies on the host-parasite relationships of the ring rot bacterium have revealed one of the major problems that affect the detection of the organism on the basis of field inspections (Andrew L. Bishop and Steven A. Slack, 1985). A large number of inoculated plants with high populations of the bacterium in the vascular system were found to show few if any symptoms of infection and thus could be completely overlooked in a normal field survey.

DISEASE PHYSIOLOGY AND NATURE OF DISEASE RESISTANCE

Early research on onion diseases by Walker and coworkers (1923–35) showed that bulb color was correlated with resistance to neck rot and onion smudge. High concentrations of toxic phenolics were present in the dead scale leaves of the yellow and red cultivars, but absent or at low concentrations in the white cultivars (Walker and K. P. Link, biochemistry, 1935). These fungicidal compounds prevented infection of the bulb by the spores of the neck rot and smudge fungi. These seminal studies were the first to demonstrate conclusively that resistance in a crop can be related to the presence of a specific chemical toxic to a pathogen. Furthermore, the genetic basis for the inheritance of this resistance was defined. This research on onion smudge is still cited as one of the classic studies on the nature of disease resistance in plants.

One of the common early approaches in studies on the nature of disease resistance was to determine whether compounds toxic to pathogens were present in resistant hosts but absent in susceptible plants. Thus, resistance in black mustard to the clubroot disease in cabbage was ascribed to the presence of allyl isothiocyanate, a compound that is highly toxic to the clubroot pathogen as well as other pathogens. Walker, M. A. Stahman (biochemistry) and coworkers (1955) were able in a series of conclusive tests to show that in fact the presence of this compound was unrelated to clubroot resistance. In one approach resistant and susceptible plants were grown in sand culture with nutrients devoid of sulfur. Isothiocyanates were not detectable in resistant or susceptible plants in the absence of sulfur. However, resistant plants lacking isothiocyanate were still resistant.

The investigation by C. Joe Nusbaum and Keitt (1938) on growth of the apple scab fungus in apple leaves led to the observation that the mycelium grows in a unique manner, initially in a subcuticular manner with little observable harmful effect on epidermal or palisade cells. Invasion of the leaf tissue only occurs after leaf fall.

Robert P. Scheffer and Walker (1953) found that the toxin theory for wilt induction in *Fusarium* wilt of tomatoes proposed by Gaumann and coworkers was not acceptable in view of their conclusive evidence that wilting resulted mainly from an interference with water movement. This study led to an intensive re-evaluation of the mechanisms of wilt induction by *Fusarium oxysporum* in tomato and other hosts.

The pioneering work of Riker and students (1904–60) in the field of cell and tissue culture evolved from his extensive studies on the crown gall disease and set the stage for further advances in this area. Techniques for culturing single plant cells were mastered. In 1965 A. C. Hildebrandt and coworkers were the first to demonstrate conclusively that an isolated, carefully nurtured, single tobacco plant cell can differentiate to form a plant that can grow to maturity and produce viable seed.

Research on the mechanisms of induced resistance in plants to bacterial wilt has been the focus of Luis Sequeira and coworkers for a number of years (1975–85). Lipopolysaccharide containing extracts from *Pseudomonas solanacearum* were shown to inhibit both susceptible and hypersensitive reactions to a number of pathogens in tobacco leaves. In the tobacco-*P. solanacearum* system, studies on the slime-producing, or fluidal, wild type and avirulent butyrous nonfluidal colony type strains have led to the following conclusions. Bacterial attachment may be mediated by the interaction of lipopolysaccharide (LPS) with hydroxyproline-rich glycoproteins (HPRG's) on plant cell walls. The binding between these two components *in vitro* appears to be the result of a charge-charge interaction. The introduction of extracellular polysaccharide inhibits the LPS-HPRG interaction *in vitro* but not in tobacco leaves. Apparently the avirulent strains attach rapidly to cell walls when infiltrated into leaves, and thus are prevented from multiplying; these strains have defective LPS molecules that interact strongly with the cell wall HPRG's. This research is the first conclusive demonstration that the chemical nature of the LPS determines the pattern of host reaction to invading plant pathogenic bacteria.

Serious questions had been raised as to whether tissue culture systems used in screening germplasm for disease resistance would express the same levels of resistance as the intact plants from which they were derived. John P. Helgeson and Upper (1975) were the first to demonstrate by genetic analyses that the factors for resistance to the black shank disease expressed in intact plants were expressed also in tissue cultures derived from the crosses of susceptible and resistant tobacco lines.

Advanced studies on fungal ultrastructure by Douglas P. Maxwell and coworkers (1970–80) have established the physiological role of fungal microbodies, in particular their involvement in lipid utilization during spore germination and oxalic acid biosynthesis. The lysosomal systems in a number of major plant pathogens were characterized in the course of these investigations.

The destructive stalk rot of corn caused by strains of *Erwinia chrysanthemi* provided a model system for an investigation of the possible role of DIMBOA (2, 4-dihydroxy-7-methoxy-2H-1, 4-benzoxazin-3(4H)-one) in resistance of corn to this disease as well as to other bacterial soft-rotting pathogens. Students and research associates of Helgeson, Upper, and Kelman (1975–79) found that strains of *E. carotovora* were very sensitive to DIMBOA and most of these strains were also weakly pathogenic on corn lines high in DIMBOA. In contrast, strains of *E. chrysanthemi* isolated in North America that were pathogenic on corn were very resistant to DIMBOA. However, expansion of the studies to include a large collection of isolates of *E. carotovora* and *E. chrysanthemi* led to the conclusion that the basis of resistance to *E. carotovora* in corn could not be ascribed to DIMBOA, since certain lines low in DIMBOA were also resistant to the soft rot bacteria. Nevertheless, it appears that those strains of *E. chrysanthemi* that have evolved in contact with high DIMBOA lines are able to resist the toxic effects of the chemical in the plants that they invade.

Investigations by Durbin and coworkers (1965–85) have led to major advances in our understanding of the chemical nature and mode of action of a number of bacterial plant pathogens that induce chlorotic symptoms in plants. This work has led to elucidation of the correct structure of the compound tabtoxin that induces chlorotic symptoms in the tobacco wildfire disease caused by *Pseudomonas syringae* pv. *tabaci*. Subsequently, Durbin and coworkers were able to determine a molecular mechanism of action involving glutamine synthetase, a critical enzyme in nitrogen metabolism. Surprisingly, it was found that tabtoxin *per se* has no biological activity until it is degraded by peptidases to tabtoxinine-β-lactam. Peptidases which hydrolyze tabtoxin are located in hosts and in the periplasm of the bacterium. This location of peptidase in the bacterium provides a degree of self-protection, since the β-lactam is not able to penetrate the inner bacterial membrane. This research is the first to define a role for the host in producing a biologically active toxin. Recently tagetitoxin, produced by *Pseudomonas tagetis*, a pathogen of marigolds, has been purified and its general biological and chemical characteristics elucidated (1979–84). The effects of tagetitoxin are restricted to the chloroplast and include an early, light-independent event in chloroplast development which indirectly involves RNA.

Durbin and colleagues' research (1973–81) on the structure and mode of action of tentoxin is especially noteworthy because it represents the first explanation for the action of a phytotoxin and host selectivity of a plant pathogen. Studies using purified tentoxin and plant receptors (chloroplast coupling factor 1) from resistant and susceptible plants clearly validate the hypothesis that a host-selective disease can result from a microbial toxin selectively binding to a host component and that the absence of this binding site in the plant confers resistance. Also, in studies on photosynthesis, tentoxin is useful because it is the only known compound that specifically inhibits certain chloroplast coupling factor 1 components.

The first demonstration of the effectiveness of labelled antibody studies on the interaction of non-persistent viruses with insect mouth parts was provided by Gustaaf de Zoeten and coworkers (1977) in his studies using the scanning electron microscope. De Zoeten and coworkers were the first to show that virus-specific dsRNA is a product of *in vitro* replicase activity in virus replication. The role of membranes in the replication of ss-(+)-RNA plant viruses has also been elucidated in his research. He provided evidence that these membranes are of host origin, and discovered that the membranes involved in replication can be transported via phloem from cell to cell and over long distances in plants (1983). The uncoating process of these viruses was examined and it was found that this process does not involve specificity of the virus for host plants.

Innovative techniques have been developed by Paul G. Ahlquist (1984) to engineer RNA plant viruses for genetic studies. In these elegant studies, several plant virus genomes have been mapped to facilitate determination of coding and regulatory functions.

Studies in the area of recombinant DNA research by John D. Kemp, Timothy C. Hall (horticulture) and coworkers (1983) led to the first report of the successful transfer of DNA from one plant species to another. To accomplish this the crown gall bacterium was used as a vector of the DNA from bean that codes for a specific protein, phaseolin. The transfer was made into sunflower resulting in formation of the so-called "sunbean" tissue culture. Subsequent studies (1985) resulted in the transfer of the phaseolin gene to tobacco and demonstration of expression of the gene by formation of phaseolin in tobacco seed. This seminal work opens the prospect for successful transfer of other beneficial genes, using this bacterium as well as other possible vectors.

The presence of extrachromosomal DNA elements has been discovered by Sally A. Leong and coworkers in *Fusarium solani* f. sp. *cucurbitae, F. oxysporum* f. sp. *conglutinans* and *F. sporotrichioides*. The 1.9 Kb linear element from a *F. oxysporum* f. sp. *conglutinans* race 2 isolate has been cloned. This plasmid-like DNA has been found in all strains of race 2 that have been examined. A similarly sized but unrelated DNA element has also been observed in race 1 strains of this pathogen. Extrachromosomal elements have also been observed in other strains of *Fusarium* under investigation. These observations have important implications in providing new powerful tools for differentiation of strains of fungi that are morphologically similar but which differ in virulence.

GENETICS OF PLANT PATHOGENS

Basic studies on the genetics of the apple scab fungus, *Venturia inaequalis,* were initiated under the leadership of Keitt (1952) and continued by Donald M. Boone (1955–75). These studies were the first to examine the genetic factors controlling virulence in the apple scab pathogen and resistance in the genus *Malus* to the scab pathogen. Genes at thirteen loci that controlled virulence in the apple scab fungus were described, and biochemical mutations were induced that were analyzed for their effects on virulence. Linkage maps for the chromosomes of *V. inaequalis* were described based on these and related studies.

These pioneering studies led to innovative attempts to control the apple scab disease by genetic manipulation of strains. The concept involved the use of mutant strains that would mate with virulent strains resulting in defective or sterile perithecia (Boone and Upper, 1970). Although practical application of this concept was not achieved, it was one of the first attempts on a field basis to interfere with the life cycle of a fungus of this type by means of a genetic approach.

DISEASE CONTROL—BREEDING FOR DISEASE RESISTANCE

Field Crops

The close cooperation among scientists from many differing disciplines that has contributed to a major advance in crop improvement is illustrated by the development of alfalfa as a major Wisconsin crop. The expansion of alfalfa acreage from less than 500 acres in 1889 to over 3 million acres in 1985, with an estimated annual value of nearly $700 million, is one of the spectacular success stories of modern agriculture. Plant pathologists played a major role in this achievement.

A destructive wilt disease appeared and began to take its toll of alfalfa in 1924, following widespread planting of a few cultivars without rotation. Because of wilting and premature decline, large acreages were plowed under. Fred R. Jones, a U.S. Department of Agriculture (USDA) scientist in the Department of Plant Pathology, identified the causal agent as a soil-borne bacterium (subsequently described as *Corynebacterium insidiosum*) and soon developed techniques for evaluating the resistance in alfalfa lines. Unfortunately, resistance levels were very low in the available commercial cultivars.

At this time a cooperative project was established involving R. A. Brink (genetics), Jones (plant pathology) and L. F. Graber (agronomy). A wilt-resistant cultivar possessing the desirable agronomic characteristics eluded the investigators until 1948, when a promising strain was obtained that combined winter hardiness and disease resistance. It took several years, however, to increase seed supply to meet the needs of farmers. The first large-scale plantings were made in 1954, almost thirty years after the research was initiated. This new variety, named Vernal, was so outstanding that it became the cultivar of choice, accepted not only in Wisconsin but also in other northern alfalfa-growing areas of this country and Canada. A responsible estimate of the increased value of Vernal alfalfa to Wisconsin agriculture is in the range of over $1 billion in the three decades since its release. By the mid 1970s various seed companies were breeding improved cultivars, often with Vernal as a parent, and the dominant role of Vernal has subsequently declined; however, it is still used as a standard in judging improved cultivars.

Phytophthora root rot disease, prevalent on poorly drained sites, is a continuing threat to alfalfa production in the state. The genetic basis for inheritance of resistance to this disease has now been determined by Maxwell, E. T. Bingham (agronomy), and coworkers (1983). A standardized progeny testing procedure has been developed and is being applied in selecting for increased levels of resistance.

In early years red clover was the primary forage legume. It was easy to establish, well-adapted, and tolerant of acid soils. Although the importance of this crop has declined, it is still grown on heavy soils. Agronomists and plant pathologists in a cooperative USDA program have succeeded in selecting lines of red clover with multiple disease resistance and increased stand survival. W. K. Smith (agronomy) and Earle W. Hanson (1957) released the cultivar Lakeland—the first cultivar to combine resistance to powdery mildew and anthracnose with winter-hardiness. Subsequently, cultivar Arlington was developed by R. R. Smith (USDA) and W. K. Smith in cooperation with Maxwell and Hanson. This cultivar incorporated and improved on the best features of Lakeland. Released in 1973, Arlington has been accepted widely throughout the northern United States and southern Canada.

In the early 1920s, a cooperative effort involving Brink (genetics), B. D. Leith (agronomy), and Dickson capitalized on the potential of hybrid vigor of crosses of inbred lines. From 1930 to 1950, corn hybrids clearly were superior in yield over open pollinated lines. New Wisconsin corn hybrids were developed that were adapted to the differing soils, environmental factors, and duration of growing season for eight maturity belts ranging from 85 to 120 days. N. P. Neal (agronomy) in Madison and A. M. Strommen (agronomy) at the Spooner Experimental Farm had key roles in this program. The release of new, early maturing hybrids, with maturities of 85 to 90 days, was a major advance for the farmers of northern Wisconsin. One of the corn inbreds (W64A) released in 1954 was the second most widely used inbred throughout the United States for almost two decades. Plant pathologists Hoppe and Arny collaborated in the evaluation of breeding stocks and developed several useful field and laboratory techniques to test lines for disease resistance.

The progress in the corn improvement program was not without some setbacks. In the late 1960s yellow leaf blight, a disease not previously observed in Wisconsin, caused severe damage on inbreds and hybrids that carried the Texas factor for male sterility. This was the first observation in the United States of the danger inherent in the use of the Texas cytoplasmic male sterility factor (TCMS) that had been incorporated in almost all of the commercial hybrids planted in the United States to increase the efficiency of hybrid seed corn production. The potential danger of continued use of the TCMS lines was brought to the attention of the seed trade on the basis of studies by Gayle L. Worf and Eugene B. Smalley (1968). By 1970 a shift to other genetic material was in progress. This was very timely because it barely preceded the outbreak of the southern corn leaf blight (SCLB) throughout the South and Midwest.

The SCLB epidemic in 1970 caused more economic loss on a single crop in one year than had ever occurred in the history of the United States. The corn seed companies shifted lines rapidly to normal cytoplasm with resistance to SCLB. The threat of SCLB was eliminated within a few years, although it was necessary to return to the costly procedure of detasseling for hybrid seed production. During the past twenty years, although corn production has doubled in Wisconsin, the state has shifted from the position of a corn-importing state to become one of the major corn-exporting areas in the Midwest. Wisconsin is now among the top corn-producing states in the United States, with average yields comparable with or superior to those of adjacent states.

In the early 1920s and 1930s crown rust and oat smut were constant threats to oat production in the Midwest. H. L. Shands (agronomy) gained prominence with the release of the cultivar Vicland in 1941; Vicland resisted both crown rust and a second damaging disease, oat smut. The phenomenal expansion of the acreage in this and related varieties has had few parallels in crop production history. In five years the acreage increased from 3,400 to 2.8 million acres; this represented 92 percent of the total acreage planted in oats in 1946.

Unfortunately Vicland was very susceptible to a previously unknown but devastating seedling blight caused by *Helminthosporium victoriae.* However, other sources of resistance to crown rust and smut, lacking susceptibility to the seedling blight disease, were soon identified, and many new cultivars were released in cooperative studies of Shands, with R. A. Forsberg and Arny. Thus, this outbreak proved to be only a temporary setback in the use of improved cultivars of oats. The challenge of the periodic appearance of new virulent races of crown rust and smut has been met since then by the development of a number of high-yielding disease-resistant cultivars.

Although not a major crop, tobacco has provided a significant source of income for Wisconsin growers for over ten decades. The industry was threatened by the black root rot disease in the early years until Johnson and coworkers in horticulture developed the resistant cultivar Havana 142.

The wildfire disease of tobacco has presented a problem for Wisconsin tobacco growers since the early 1920s. In 1960 a resistant variety, Havana 501, developed by W. B. Ogden (horticulture, USDA) was released to growers. Resistance was derived from an interspecific cross with *Nicotiana longiflora;* unfortunately this cultivar was not stable and breeding studies continued, culminating in the release of Havana 503 with stable resistance to the wildfire disease and resistance to black root rot and tobacco mosaic as well. As acreage in this cultivar increased, wildfire infections on it began to be observed. In 1969–70 a new virulent strain of the causal bacterium was identified to which Havana 501 and 503 had no resistance. In cooperation with the USDA, Fulton tested several breeding lines of tobacco and found that lines derived from an interspecific cross with *N. rustica* were resistant to both the old and the new strain of the bacterium. This resistance has now been incorporated, by crossing and backcrossing, into a Havana Seed type tobacco (Havana 615) that is resistant also to black root rot and mosaic; it matures early, and appears to be a good commercial type.

Vegetable Crops

At the turn of the century, a new disease called cabbage yellows began to cause severe losses; by 1910 some growers had lost entire fields. This was the year that L. R. Jones came from Vermont and founded the Department of Plant Pathology. As one of his first research projects Jones became interested in the problem and selected a few resistant plants from heavily infested fields; these served as the starting material for a very intensive breeding program. Wisconsin Hollander (released in 1916) was the first of a number of yellows-resistant cabbage cultivars. The cabbage disease research was taken over by Walker, a native of Racine, who became interested in this problem as an undergraduate in agriculture. He completed his advanced degrees in plant pathology and joined the faculty of the department in 1918.

In the next four decades, Walker released a number of other cabbage varieties with resistance not only to the yellows disease but also to a number of other damaging plant pathogens. The importance of obtaining pathogen-free seed for the cabbage industry was soon recognized, particularly in reducing infection from diseases such as black rot and blackleg. It was found that pathogen-free seed could be produced in the Puget Sound region in the western United States because of the lack of rainfall at the time seeds were maturing. This factor fostered the growth of the vegetable seed industry in the western states and also insured a stable source of high-quality seed for Wisconsin cabbage growers.

In 1940 Glenn S. Pound successfully combined resistance to mosaic with resistance to the yellows disease in kraut and market types of cabbage. With the recognition of the value of F_1 hybrids, there was a need to incorporate resistance to numerous diseases in breeding lines. In collaboration with Russell H. Larson, methods were improved for screening resistance to potential disease problems and introducing genes for resistance and quality into commercial cultivars.

Research on potato genetics in the Departments of Horticulture and Genetics by R. W. Hougas and S. J. Peloquin resulted in the elucidation of cytogenetic principles and discovery of procedures that permit the orderly transfer of genetic information from wild species to cultivated lines. The identification and utilization of haploids of the common potato made it possible to cross these haploid strains with diploids of the wild species of potato. Thus, many of the desirable traits, including disease resistance, can be introduced into lines with potential for commercial development.

The haploid technique was utilized in the joint project that involved P. R. Rowe (USDA-horticulture) and Sequeira (1965–70) in the production of lines with resistance to bacterial wilt caused by *Pseudomonas solanacearum,* which is one of the major diseases limiting the production of potatoes in the tropical and semi-tropical regions of the world. In cooperation with the International Potato Center in Lima, Peru, the first cultivars with high levels of resistance to bacterial wilt were developed. These cultivars have been planted in Central and South America, Africa, and southeast Asia. In addition genetic factors governing inheritance of resistance in potato to different pathogenic strains of the bacterium were analyzed for the first time.

Pink root of onions is caused by a soil-borne fungus, *Pyrenochaeta terrestris,* that can be controlled practically only with resistant varieties. Effective methods for screening for resistance to this disease were developed by Larson and coworkers (1948–50). His methods involving use of the Wisconsin soil-temperature tanks, and modifications of these procedures, have been adopted widely for this as well as other diseases of vegetable crops.

Improved techniques for effective screening of large populations of vegetable crops with a number of different pathogens have been devised by Paul H. Williams (1974–85), in cooperation with C. E. Peterson (USDA-horticulture), who supervises a program of breeding cucumbers, carrots, and onions for desirable characteristics and resistance to the major diseases.

Under the leadership of Williams the direction of the program in recent years has changed to facilitate the early release of resistant germplasm to the seed trade so that these desirable features may be incorporated into their individual programs. Since its inception, the cabbage program has received financial support from the National Kraut Packers Association. At present, over 50 percent of all the germplasm utilized in commercial cabbage breeding programs in this country is derived from the research at Wisconsin; furthermore, germplasm from Wisconsin is used by cabbage breeders throughout the world.

The release by Williams of inbred lines of cabbage with resistance to the black rot disease (1975) represents the most significant influx of new germplasm into the development of cabbage cultivars in the United States since the development of the *Fusarium* yellows-resistant cultivars in Wisconsin by Jones and Walker. This resistant germplasm has a very great potential value in reduction of losses from one of the major threats to cabbage production in this and other countries.

In the late 1940s a destructive fungus disease known as scab began to cause heavy damage to the cucumber crop in Wisconsin. A second disease, a mosaic, also caused periodic heavy damage. Losses from both diseases in some seasons were so great that many farmers became very discouraged and stopped growing cucumbers. In the early 1950s it became increasingly evident that the pickle industry of the state was threatened with extinction unless effective controls could be developed. Walker became concerned with this double threat to a vegetable crop that had become an important income producer for the state's vegetable growers. His intensive breeding program yielded several resistant lines with high production and fruit quality that remain unsurpassed. Since 1955 the entire cucumber acreage in Wisconsin and 70 percent of the national acreage devoted to pickle cucumbers have been planted to these cultivars or their derivatives. Production costs are lowered with these varieties because fungicides for control of scab are not needed. The cucumber crop in Wisconsin now adds approximately $6 million annually to the income of growers; the packaged product has an estimated value of over $25 million annually. This single contribution essentially saved one valuable crop and industry in this state and region.

Wisconsin has led the states in pea production for many decades and today produces one-third of the country's pea crop. As early as 1911, the Wisconsin Canner's Association made a grant to the university to support research on pea diseases—the first industrial grant made to the college. In 1982 the crop had a farm value of about $30 million. In the 1950s major advances in the genetic improvement of peas resulted in the release by Walker, E. J. Delwiche, and coworkers of pea cultivars with resistance to three of the major diseases of this crop—wilt, near wilt, and yellow bean mosaic. The release of these cultivars was essential in maintaining the economic production of this crop.

Resistance to corky root, a destructive disease of lettuce, was identified by Sequeira (1970) in wild lettuce lines from Turkey and Iran and in a loose-head cultivar. Resistance was found to be controlled by multiple recessive factors. Selections from crosses were backcrossed and inbred for several generations. From this material a new cultivar, Marquette, was obtained, with high tolerance to corky root rot and good horticultural characteristics. This was the first successful development of a commercial cultivar bearing resistance to a physiogenic disease that results from toxicity of decomposition products of crop residues.

A high level of resistance to brown spot on bean *(Pseudomonas syringae)* was identified by Hagedorn and coworkers and introduced into the cultivar Wisconsin 130, released in 1976. This cultivar carries resistance to six other diseases; since this release additional improved cultivars have been developed.

A unique set of genetic seed stocks of six economically important species in the genus *Brassica* has been developed by Williams and coworkers (1980–85). Normally these species require over six months to a year to complete their reproductive cycles from seed to seed; thus, improvement through breeding has been slow and genetic information on the brassicas has not been obtained as rapidly as on other economic species. Hundreds of brassicas from around the world have been examined for characteristics that favor rapid reproduction. Rapid-cycling populations have now been obtained for each of six species of interest. These populations complete six to ten generations in one year at densities of over 1000 plants per square meter.

Such rapid-cycling populations obviously have great potential not only in breeding for quality and disease resistance, but also in facilitating fundamental studies on basic genetics, physiology, and plant molecular biology. These unique lines also have a high potential in conjunction with experiments to aid in the teaching of basic genetics; procedures to make this material available for instruction at the high school level are being studied.

A major advance in prospects for enhancing resistance in potato to important diseases has been made by Helgeson and coworkers (1981–85) in their studies on somatic fusion techniques. Tetraploid somatic hybrids were produced by protoplast fusion between *Solanum brevidens,* a diploid non-tuber-bearing wild species, and a diploid tuber-bearing potato line derived from a *S. tuberosum* sp. Phurea-Stentotum population. *S. brevidens* is difficult to cross with cultivated potato, but it has high resistance to the potato leaf roll virus (PLRV) and also to frost injury. Hybrids with high resistance to PLRV were identified in the plants generated from protoplast fusions. These hybrids provide the means of incorporating beneficial traits, previously unavailable to breeders, into conventional breeding programs. In conjunction with this research, techniques were developed that make it possible to obtain thirty to fifty shoots from a single callus in a three-week period, and large numbers of plants can be made available for screening and field testing within a short period of time.

Forest Trees

White pine blister rust is one of the most destructive diseases of the white pine in North America. A project initiated by Riker and continued by Robert F. Patton (1955–70) has led to the identification of material with high levels of resistance to the blister rust fungus after many years of intensive effort. Stock originating from Wisconsin's program has been included in worldwide tests for evaluation of rust resistance. The field testing of the Wisconsin material is now under supervision of the U.S. Forest Service. This program, which is utilizing the selected stock and procedures developed by Patton, is approaching the point at which the interim seed orchard will be producing seed, with the prospect of much improved material being available for planting on high hazard sites by the year 2000.

A program to develop resistance to the Dutch elm disease was initiated in 1958 by Smalley. A number of resistant selections were soon identified, including American elms as well as other species and certain hybrids. One of the highly resistant selections, 'Sapporo Autumn Gold', was first released for public trial in 1973. Since that time this and related selections have been planted widely in the United States. More recently trees have been planted in England and a number of other European countries. The potential exists for the use of this selection for the replanting of many urban areas from which dead and dying elms have been removed. It is difficult to estimate the value of this resistant elm and related selections that are under development, but the potential economic benefits can be measured in terms of millions of dollars.

DISEASE CONTROL—CHEMICALS

One of the major early contributions of Keitt and coworkers was the detailed analysis of the sequence of environmental factors that determine when the spores of the apple scab and cherry leaf spot fungi are discharged in the spring. This pioneer study provided the logical basis for specifying the time for spraying fungicides to prevent the outbreak of an epidemic (see section on epidemiology).

In mid 1953, the potato rot nematode was discovered to pose a serious threat to the potato seed industry in northern Wisconsin. Henry M. Darling and Gerald Thorne determined the soil fumigation procedures and management practices that would be effective, and all infested fields were treated with a nematicide. A state quarantine was imposed and annual surveys were instituted. These efforts were highly effective and for all practical purposes the nematode was eradicated. This is one of the few examples of the successful large-scale elimination of a soil-borne plant pathogen by such methods in the United States. Without the speedy action of the college and the state department of agriculture personnel and the cooperative efforts of the growers, it is likely that movement of seed potatoes from Wisconsin to other states could have been prohibited. This would have resulted in the eventual demise of the seed-potato industry that currently generates an income to the growers of over $10–15 million annually.

One of the major problems that has confronted potato growers in the central sands region is the early dying complex. The use of Vapam for control was evaluated by Mitchell and coworkers (1980–83); the dosage and application methods were determined. The extensive use of this procedure by growers indicates the value of this contribution as one means of reducing losses from early dying.

The value of the cranberry crop in Wisconsin has risen markedly in recent years. The increase from 3,500 acres in 1950 to 8,000 acres in recent years has been exceeded by the even more rapid increase in production from 63 barrels per acre in the 1950s to 185 barrels per acre in 1982. Wisconsin is now one of the country's leading cranberry-producing states. This remarkable increase reflects successful cooperative efforts of faculty and coworkers in plant pathology (Boone) and horticulture (M. N. Dana), as well as good financial support from the cranberry industry. The successful marketing of products containing cranberry juice has also been important. Several fungicides were registered for use on cranberries for the first time and effective spray schedules were developed for their use by Boone and coworkers.

DISEASE CONTROL—MANAGEMENT PRACTICES

In the 1920s Wisconsin was a leading national supplier of potatoes, particularly for the midwestern and eastern markets. By 1930 over 300,000 acres were in production, with a total yield of about 18 million hundredweight and with the heaviest concentration in the central sands area of central Wisconsin. In the early 1930s potato production underwent a rapid decline due to periods of extreme drought, lack of high-quality seed, lowered soil fertility, the period of severe economic depression, and the prevalence of several diseases, particularly those caused by viruses for which there were no adequate controls at that time.

Wisconsin was the first state to establish a potato seed certification program in 1913 under the leadership of R. E. Vaughan and J. W. Brann. However, rigorous seed quality control was not possible until a program to produce disease-free seed potatoes was instituted and a foundation seed farm was purchased in 1940. This was the first farm of its type in North America. In 1941 Darling was employed to supervise the operation of the seed farm and the potato seed certification program. The program that he developed has served as a model for similar programs in several other states, in which responsibility rests with a faculty member in the College of Agricultural and Life Sciences rather than a staff employee of the state department of agriculture or a grower association. Another important factor in the success of this program was the leadership of Larson in a wide range of studies on potato diseases. In particular his work emphasized the value of the use of certified seed in the elimination of seed-borne pathogens.

Availability of high-quality disease-free seed potatoes contributed to the remarkable recovery of the potato industry in the four decades since the economic depression. By 1970 Wisconsin was once again supplying midwestern and eastern markets with a stable supply of potatoes.

In 1984 Wisconsin ranked among the top states in per acre yields, and the yield of potatoes produced on 50,000 acres was equal to the yield from the total acreage planted in 1930. This is evidence of the remarkable advances in the efficiency of production of this crop. Plant pathologists contributed significantly to this remarkable increase in productivity. In particular, improvements in seed quality resulted from research by Darling and Larson and information on control of major diseases developed by Earle K. Wade and more recently by Walter R. Stevenson. Because of high yields and low production costs, major processing companies such as American Potato and Ore-Ida have recently constructed extensive storage and processing facilities in central Wisconsin.

Under the direction of Slack (1976–85), seed production at the Elite Foundation Seed Potato Farm has been shifted to the increase of nuclear stocks of pathogen-tested tissue culture plantlets. After four decades of work at the Three Lakes Foundation Farm a new foundation seed farm was established in 1984 at a location east of Rhinelander (Chapter 11).

In potato tubers the severity of bacterial soft rot caused by *Erwinia carotovora* pv. *atroseptica* was found to be inversely related to content of calcium in tubers (Raymond G. McGuire and Kelman, 1984). As tuber calcium increased, the percent surface area that decayed under mist chamber conditions was reduced significantly. In low cation-exchange-capacity soils that are typical in the central sands area of Wisconsin, potato tubers were found to be very low in calcium content unless soils have had calcium fertilizer supplements. Field experiments in cooperation with K. E. Kelling of the Department of Soil Science confirmed results obtained in laboratory and greenhouse studies, indicating a significant correlation between high calcium content of tubers and increased resistance to bacterial soft rot under experimental conditions.

Improvement of poplar for enhanced growth potential has been the objective of a research project initiated by James E. Kuntz and continued under John G. Berbee's direction (1970–80). Hybrid poplar clones have been improved significantly by application of heat therapy and tissue culture methods. The rapid growth potential of these improved clones has been demonstrated dramatically in test plantings at a number of locations in the state. With the intensive application of improved agronomic practices, plantations of these hybrid clones could provide five to tenfold increases in fiber production over traditionally managed plantings of poplars or other hardwoods. The economic feasibility of high-yield forestry operations utilizing these materials can be considered to be of future economic potential when availability of other wood fiber sources declines in this region.

In Wisconsin, oak wilt has killed thousands of oaks in woodlands, residential areas, parks, and other recreational areas. Research initiated by Riker and continued for several decades by Kuntz (1955–75) has provided a number of approaches to reduce disease incidence and to prevent local and long-distance spread. One of the key elements in this study was the determination of the importance of root grafts and methods of breaking these underground conduits for spread of the fungus. Results of these and related studies on host pathogen reactions have direct application to the control of other vascular wilt diseases of forest and shade trees.

At present approximately half the acreage in Wisconsin, Illinois, and Minnesota is infested with the soil-borne fungus that causes *Aphanomyces* root rot, making it hazardous to grow peas on the infested fields. Since practical methods for direct control of *Aphanomyces* root rot are not available, it was essential to have a method to determine the root rot potential of specific fields.

R. T. Sherwood and Hagedorn (1958) developed a relatively simple but sensitive greenhouse bioassay of soil from prospective planting areas. This test gave growers a way to avoid the high costs of planting on high hazard sites. Savings from this procedure, now in wide use, can be measured in many thousands of dollars annually.

Under the leadership of J. Duain Moore (1945–68), sensitive indexing methods were devised to obtain virus-free nursery stocks for sour cherry and other fruit trees. Regional and inter-regional projects led to the establishment of the national program designated as IR–2 that made virus-free material available worldwide.

DISEASE CONTROL—BIOLOGICAL SYSTEMS

Antimycin is an antibiotic that was isolated in 1945 by Curt C. Leben and Keitt at a time when there was intense competition to discover new antibiotics that might have a potential for use in control of fungal diseases. In 1948 F. M. Strong and associates in the Department of Biochemistry were able to isolate the chemical in purified form, and the patent obtained was assigned to the Wisconsin Alumni Research Foundation (WARF). In experiments completed in Japan in which the compound was tested as a fungicide for the control of rice blast, it was noted that the fish growing in the treated rice paddy were rapidly killed. With this finding the research at WARF was directed to the development of this material as a fish poison. Antimycin has been highly effective in this unexpected usage since it is highly toxic to nearly all species of fish including carp, which are particularly resistant to other poisons. It also is rapidly degraded and thus it is possible to restock treated ponds in a short time without danger to the new population of desirable species.

In an investigation of biological control systems and an effort to reduce the amount of fungicides used to control of the apple scab disease, Christian Heye and Andrews (1981) found that a saprophytic fungus, *Athelia bombacina,* shows promise as a microbial control agent for the scab fungus. The primary effect of the fungus was to prevent the production of ascospores of the scab fungus at the critical time in the spring when initial infections occur. Antagonism was demonstrated on leaves both incubated in the laboratory and in nylon mesh bags in an apple orchard. Additional studies will be needed to determine whether direct applications of spore material to fallen leaves in the autumn under commercial orchard conditions will serve as a practical control method.

SUMMARY AND OUTLOOK

The remarkable progress that is reflected in the increased productivity of field, forage, fruit, and vegetable crops in the state was built upon a balanced combination of basic and applied research. Plant pathologists have had an integral role in these advancements. Although the major contributions were made in the area of breeding for disease resistance, major advances were made in other areas, such as influence of environment in disease development, disease physiology, and host-parasite relationships. Much of this progress resulted from innovative advances unique to Wisconsin, but obviously scientists here were alert in adapting research results from the USDA, other agricultural experiment stations and universities in the United States, and research groups in other countries. The variety of projects now under way indicate that the momentum of past research in plant pathology will be maintained in the future.

Although the full yield potential of most crops has not been reached, it is likely that major increases in productivity will depend on application of the new powerful tools of molecular biology.

Additional sources of variability will be generated by these new approaches in genetic engineering. Cell and tissue culture work have already indicated the rewards of new sources of genetic variation that may be useful to plant breeders. In addition to traits related to yield potential and resistance to disease and insects, new cultivars will have improved ability to cope with environmental stresses such as mineral nutrient deficiencies or lack of oxygen in flooded soils, enhanced nutritional characteristics such as higher protein levels, increased photosynthetic capacity, and improved ability in legumes to fix nitrogen symbiotically.

The availability of computers with properly designed software will make it possible to complete the complex analyses of biological and environmental factors that influence plant growth and development. The knowledge gained from these studies will enable us to maximize utilization of nutrients and water and also to minimize application of pest control chemicals.

The innovative research projects already in progress offer strong evidence that the propsects for future advances are very bright. One may be confident that the next seventy-five years of research in plant pathology will be as productive as the first seventy-five.

TABLE 1

Major awards of the American Phytopathological Society to faculty and alumni

The Award of Distinction of the American Phytopathological Society

J. C. Walker 1969
A. Kelman 1983

The Fellow Award of the American Phytopathological Society

1965	A. C. Braun, M. W. Gardner, J. H. Jensen, G. F. Weber, G. W. Keitt, I. E. Melhus, G. S. Pound, C. E. Yarwood, A. J. Riker, G. Thorne, J. C. Walker, R. W. Goss
1966	C. W. Bennett, C. Drechsler, E. E. Wilson, A. E. Dimond, W. C. Snyder, W. J. Zaumeyer
1967	R. M. Caldwell, H. H. McKinney
1968	A. F. Ross
1969	R. G. Grogan, A. Kelman
1970	R. W. Fulton, L. J. Alexander, E. E. Clayton
1971	M. E. Gallegly, Jr., L. Sequeira
1973	R. J. Shepherd, A. J. Ullstrup
1974	G. W. Bruehl, A. L. Hooker, F. L. Wellman
1976	D. J. Hagedorn, C. J. Nusbaum
1977	E. C. Calavan, E. B. Cowling, J. L. Lockwood
1978	A. H. Ellingboe, J. E. Mitchell, S. H. Ou, S. Van Gundy
1979	R. P. Scheffer, P. H. Williams
1980	L. F. Roth, K. R. Barker, W. J. Hooker, T. P. Pirone
1981	J. B. Bancroft, C. Leben, A. O. Paulus
1982	J. E. Duffus
1984	R. D. Durbin, G. E. Templeton
1985	R. D. Berger

Ruth Allen Award: W. C. Synder 1969, J. B. Bancroft 1970, R. J. Shepherd 1981

AAAS—Campbell Award: M. E. Gallegly 1960, D. J. Hagedorn 1961, R. T. Sherwood 1961, R. G. Grogan, 1962, R. D. Berger 1974, B. J. Jacobsen, 1980

CIBA Geigy Award: D. J. Hagedorn 1975, W. W. Hare 1976, J. M. Duniway 1983, S. E. Lindow 1985

TABLE 2

Major offices held by faculty and alumni in the American Phytopathological Society

President	Editors or Editors-in-Chief of Phytopathology
L. R. Jones 1909	L. R. Jones 1911–14
I. E. Melhus 1926	N. J. Giddings 1923–24
M. W. Gardner 1931	A. J. Riker 1929–30
G. W. Keitt 1937	E. Carsner 1932–37
J. C. Walker 1943	A. J. Riker 1944–45
A. J. Riker 1947	J. H. Jensen 1948–50
J. G. Dickson 1953	M. W. Gardner 1950–51
G. W. Weber 1954	A. F. Ross 1955–57
J. H. Jensen 1955	E. E. Wilson 1958–60
G. S. Pound 1959	R. W. Fulton 1961–63
W. C. Snyder 1960	G. W. Bruehl 1968–69
A. E. Dimond 1964	L. Sequeira 1979–81
W. J. Zaumeyer 1965	
A. Kelman 1967	
G. W. Bruehl 1977	
J. F. Schafer 1979	
J. L. Lockwood 1985	
L. Sequeira 1986	

Treasurer	Secretary
R. M. Caldwell 1944–46	G. S. Pound 1953–55
A. E. Dimond 1950–53	J. R. Shay 1964–66
E. L. Kendrick 1977–82	D. A. Slack 1977–80
H. R. Cameron 1983–85	

Councilors or Councilors-At-Large (After 1960)

N. J. Giddings 1921	R. M. Caldwell 1965–66
I. E. Melhus 1922–23	J. E. Mitchell 1966–67
I. E. Melhus 1927	G. A. Gries 1967–68
G. W. Keitt 1930–32	J. B. Kendrick, Jr. 1968–69
M. W. Gardner 1932	G. W. Bruehl 1972–73
J. C. Walker 1935–36	J. F. Schafer 1973–76
G. W. Keitt 1938	J. L. Lockwood 1978–81
A. J. Riker 1948	D. A. Slack 1980–83
A. Kelman 1961, 1962–63	B. Jacobsen 1983–86
J. H. Owen 1963–64	

TABLE 3

Major awards, honors, positions, and other recognition accorded faculty and alumni

A. Faculty and alumni recipients of major national and international awards and honors

National Academy of Sciences (U.S.): L. R. Jones 1920, J. C. Walker 1945, A. J. Riker 1951, A. C. Braun 1960, E. B. Cowling 1973, A. Kelman 1976, L. Sequeira 1980

International Wolf Foundation Award for Excellence in Research in Agriculture: J. C. Walker 1978

American Academy of the Arts and Sciences: A. C. Braun 1966, A. Kelman 1978

National Academy of Sciences (U.S.) Award for Initiatives in Research (Applied Biology): S. E. Lindow 1985

American Association for the Advancement of Science, Fellow: W. M. Bever, A. C. Braun, R. G. Grogan, J. E. Halpin, D. G. Hamilton, A. L. Hooker, G. W. Keitt, A. Kelman, J. S. McFarlane, V. G. Perry, J. F. Schafer, J. C. Walker

American Association for the Advancement of Science, Newcomb Cleveland Award: A. C. Braun 1949

USDA Superior Service Award: J. E. Duffus 1983, R. D. Durbin 1983, E. L. Kendrick 1982, T. H. Nicholls 1976, W. R. Phelps 1975, K. R. Shea 1975, C. H. Walkinshaw, Jr. 1972, R. W. Webb 1970, 1982

USDA Scientist of the Year: R. D. Durbin 1982

Gamma Sigma Delta, Award for International Service to Agriculture: G. S. Pound 1975

Charles Leopold Mayer Prize of the French Academy of Sciences: A. C. Braun 1982

The National Forty-Niner Service Award: J. C. Walker 1955, D. J. Hagedorn 1983

National Academy of Sciences (India) Fellow: W. M. G. Nair 1981

O. A. Vogel Award for Plant Improvement: G. W. Bruehl 1970

National Science Foundation Presidential Young Investigator Award: P. G. Ahlquist 1985

National Institutes of Health Career Development Award: G. A. de Zoeten 1969–1974

Agricultural Institute of Canada, Fellow Award: D. G. Hamilton 1967, C. B. Willis 1985

Royal Swedish Academy of Science, Jacob Eriksson Gold Medal: P. H. Williams 1981.

Royal Society of Canada, Fellow: J. B. Bancroft 1979

Officer of the British Empire (OBE): H. R. Angell

South African Academy of Arts and Sciences Havenga Medal for Agricultural Research: J. Heyns 1984

B. Positions held in National and International Societies

American Association for Advancement of Science: L. R. Jones, Vice-president 1924–25

Botanical Society of America: L. R. Jones, President 1913

Mycological Society of America: J. D. Rogers, President 1978

American Institute of Biological Sciences: J. C. Walker, Vice-president 1953, J. G. Dickson, President 1959, G. A. Gries, President 1977–78

Crop Science Society of America: J. F. Carter, President 1972

Council for Agricultural Science and Technology: J. F. Carter, President 1978–79.

Potato Association of America: H. M. Darling, President 1965–66; E. D. Jones, President 1983–84

Society of Nematologists: V. G. Perry, President 1966–67; K. R. Barker, President; G. D. Griffin, President 1984–85; S. D. Van Gundy, President 1973–74

Canadian Phytopathological Society: R. J. Copeman, Secretary-Treasurer 1976–80; W. P. Skoporad, President 1968–69; C. B. Willis, President; J. W. Mertens, President 1986

International Society for Plant Pathology: A. Kelman, Vice-president 1968–1973, President 1973–1978; Executive Committee 1978–83

TABLE 3 *Continued*
Major awards, honors, positions, and other recognition accorded faculty and alumni

Canadian Society of Agronomy: M. N. Grant, President 1954–55

American Society of Agronomy, Fellow Award: L. M. Josephson 1971, C. W. Schaller 1983, A. L. Hooker 1978, H. L. Shands 1956

Canadian Phytopathological Society Fellow Award: R. D. Tinline 1983

Society of Nematologists, Fellow Award: I. J. Thomason, G. Thorne, V. G. Perry, S. D. Van Gundy

Agricultural Science Society of Thailand, Award of Honor: S. Wasuwat 1978

South African Society for Plant Pathology and Microbiology: P. Knox-Davies, President 1968–69, 1976–79

Nigerian Society for Plant Protection: P. O. Oyekan, Secretary 1982–84, J. N. C. Maduesi, President 1976–76

C. *Other special recognition*

Honorary Degrees:

L. R. Jones: University of Vermont, University of Cambridge, University of Wisconsin, and University of Michigan
J. C. Walker: University of Göttingen
D. J. Hagedorn: University of Idaho
A. Kelman: University of Rhode Island
G. W. Keitt: Clemson University
S. Wasuwat: Kasetsart University, Thailand

Virology—Editor: R. Fulton 1964–1970

Distinguished Professorships:
A. Kelman, L. R. Jones and Wisconsin Alumni Research Foundation Senior Research Professor
L. Sequeira, J. C. Walker Professor of Plant Pathology, University of Wisconsin–Madison
C. J. Nusbaum, Reynolds Professor of Plant Pathology, North Carolina State University
G. L. Worf, Vaughan-Bascom Professor, University of Wisconsin–Madison

D. *Major administrative positions in the United States and in other countries*
J. B. Bancroft, Dean of Science, University of Western Ontario, 1973–present
H. W. Browning, Dean of A & S, University of Rhode Island, 1942–58; Vice-president 1942–62
L. R. Faulkner, Superintendent, Irrigated Agriculture Research and Extension Center, Washington State University, Prosser, Washington
R. Goss, Dean, Graduate School, University of Nebraska
G. Gries, Dean, Letters and Science, Oklahoma State University
R. K. Grover, Dean, College of Agriculture, Haryana Agricultural University, Hisar, India
J. E. Haloin, Director, Baruch Research Institute, Director at Large, State Agricultural Experiment Station (Southern Region)
A. Hooker, Bioscience Director, DeKalb-Pfizer Genetics
J. H. Jensen, Provost, Iowa State University, 1953–1961; President, Oregon State University, 1961–1969; Vice-rector, Kasetsart University, Thailand, 1969–1973
L. R. Jones, Chairman, Division of Biology and Agriculture, National Research Council
A. Kelman, Chairman, Division of Biological Sciences, Assembly of Life Sciences, National Research Council and Chairman, Board on Basic Biology, Commission on Life Sciences, National Research Council; Chairman, Section of Applied Biology and Agricultural Sciences, National Academy of Sciences
E. L. Kendrick, Administrator, Office of Grants and Program Systems, Science and Education, USDA
J. B. Kendrick, Jr., Vice-president, Agriculture and Natural Resources, University of California
M. Lortie, Regional Director General, Canada Department of the Environment
J. C. Maduewesi, Member, National Universities Commission Nigeria

TABLE 3 *Continued*

Major awards, honors, positions, and other recognition accorded faculty and alumni

G. S. Pound, Dean, University of Wisconsin, College of Agricultural and Life Sciences; Acting Chancellor, University of Wisconsin–Madison
C. J. Rodrigues, Jr., Director, Coffee Rust Research Center, Lisbon, Portugal
K. R. Shea, USDA Science and Education Administration, Assistant Director, 1978–80; Forest Service, Director of Forest Insect and Disease Research, 1972–74, 1977–78
T. Staub, Head, Biological Research, Agriculture Division CIBA-GEIGY, Basel, Switzerland
R. B. Stevens, Executive Director, Division of Biology and Agriculture, and Division of Biological Sciences, Assembly of Life Sciences, National Research Council
E. C. Stevenson, Assoc. Dean, Agriculture, Director of Resident Instruction, Oregon State University
R. Syamananda, Deputy Director General, Dept. of Agriculture Bangkok, Thailand
L. Weathers, Assoc. Dean, College of Natural and Agricultural Sciences, University of California, Riverside
N. N. Winstead, Provost and Vice-chancellor, N.C. State University, 1974 to present; Acting Chancellor, 1981–82

TABLE 4

Parasitic and abiotic diseases identified and described in Wisconsin as initial reports for a given host in the United States

Host	Common Name	Causal Agent	Identified or Described by
Alfalfa	*Verticillium* wilt	*Verticillium albo-atrum* (alfalfa strain)	Delwiche, Arny, and Grau, 1980
	Bacterial wilt	*Corynebacterium (Aplanobacter) insidiosum*	F. R. Jones and L. McCullock, 1925
Apple	Hairy root	*Agrobacterium rhizogenes*	Riker *et al.*, 1923
	Bacterial brown rot	*Pseudomonas melophthora*	Allen and Riker, 1932
Bean	Root and hypocotyl rot	*Aphanomyces euteiches* f. sp. *phaseoli*	Pfender and Hagedorn, 1982
Birch	Line pattern	Apple mosaic virus	Gottlieb and Berbee, 1973
Bluegrass	Necrotic ringspot	*Leptosphaeria korrae*	Worf, 1982 (fungus identified by Smiley)
Butternut	Canker	*Sirococcus clavigigenti-juglandacearum*	Kostichka, Nair, and Kuntz, 1978
Cherry, sour	Sour cherry yellows	Virus	Keitt and Clayton, 1940
	Recurrent necrotic ringspot	Virus	Moore, 1945
	Bar splitting disease	Virus	Moore, 1955
Clerodendron	*Clerodendrum* ring spot on *Clerodendron thomsoniae*	Tobacco ringspot virus	Khan and Maxwell, 1975

TABLE 4 *Continued*
Parasitic and abiotic diseases identified and described in Wisconsin
as initial reports for a given host in the United States

Host	Common Name	Causal Agent	Identified or Described by
Corn	White line mosaic	Virus	de Zoeten and Arny, 1980
	Yellow leaf spot	*Phyllosticta maydis*	Worf and Arny, 1967–68; Arny and Nelson, 1971
	Eyespot	*Kabatiella zeae*	Worf and Smalley, 1968
Cranberry	Blotch rot	*Physalospora albovaccinii*	Brown and Boone, 1982
	Black rot	*Strasseria oxycocci*	Schwarz and Boone, 1980
	Berry speckle and fruit rot	*Phyllosticta elongata*	Weidemann and Boone, 1980
	Red leaf spot	*Exobasidium vaccinii*	Tontyaporn and Boone, 1974
Dandelion	Apical chlorosis and leaf spot	*Pseudomonas syringae* pv. *tagetis*	Rhodehamel and Durbin, 1984
Douglas-fir	Swiss needle cast	*Phaeocryptopus gaumannii*	Morton and Patton, 1970
Larch	Needle cast	*Mycosphaerella laricina*	Patton and Spear, 1981
Lettuce	Vascular wilt and leaf blight	*Pythium tracheiphilum*	Tortolero and Sequeira, 1978
	Corky root	Phytotoxic decomposition products of lettuce	Amin and Sequeira, 1966
Maple	Blight	Defoliation by insects followed by frost damage and ultimately *Armillaria* root rot	Houston, Kuntz, and Riker, 1958
Maple, sugar	Collar rot	*Phytophthora citricola*	Drilias, Kuntz, and Worf, 1982
Oak	Wilt	*Chalara quercina*	Henry and Riker, 1944
Onion	Mycelial neck rot	*Botrytis byssoidea*	Walker, 1925
	Small sclerotial neck rot	*Botrytis squamossa*	Walker, 1925
Pea	Seed-borne mosaic	Virus	Stevenson and Hagedorn, 1968
	Aphanomyces root rot	*Aphanomyces euteiches*	Drechsler and F. R. Jones, 1925
Pine, jack and red	Decline	Root damage in association with the root weevil, *Hylobius rhizophagus*	Krebill, 1962

TABLE 4 *Continued*
Parasitic and abiotic diseases identified and described in Wisconsin as initial reports for a given host in the United States

Host	Common Name	Causal Agent	Identified or Described by
	Burn blight	Association of *Chilonectria cucurbitula* with spittle bug	Gruenhhagen and Riker, 1947
Pine, red	*Polyporus* root rot	*Polyporus tomentosus*	Myren and Patton, 1970, 1971
	Needle droop of pine	Abiotic factors (high temperatures and water stress)	Patton, 1952
Poinsettia	Mosaic	Virus	R. W. Fulton and J. L. Fulton, 1982
Poplar	Decline	Poplar potyvirus	Martin, Berbee, and Omuemu, 1982
Ragweed	Apical chlorosis and leaf spot	*Pseudomonas syringae* pv. *tagetis*	Styer and Durbin, 1982
Rose	Mosaic	Virus	Fulton, 1980
Smilacina stellata	*Stemphyllium* leaf spot	*Stemphylium arnyi*	Reifschneider, 1979
Stone fruits	Line pattern disease	Virus	Moore, 1955
Tobacco	*Fusarium* wilt	*Fusarium oxysporum* f. sp. *nicotianae*	Johnson, 1921
	Wisconsin bacterial leaf spot	*Pseudomonas mellea (Bacterium melleum)*	Johnson, 1923
Walnut	Decline	Disease complex; branch and stem cankers caused by *Phomopsis* sp., *Fusiococcus* sp., and *Sirococcus clavigigenti-juglandacearum*	Kuntz, 1983
	Seed rot	Freezing and thawing during winter months followed by bacterial soft rot	Radke and Kuntz, 1984
	Stem canker	*Fusarium sporotrichioides*	Kuntz, 1983
	Root rot of seedlings	Low temperature damage during winter months in seed beds and "healing in" of beds	Tisserat and Kuntz, 1981

CHAPTER 17

The Academic Experience

John H. Andrews and Melissa Marosy

THE ORIGIN

Shortly after the inception of our department, a high school principal wrote the following evaluation of an applicant to the university, which was intended to ". . . be used by the chairman of freshman advisers in adjusting new students to work for which they are best fitted and in assisting them to meet the larger responsibilities of their university life":

> This boy is very bright but has no habits of study. He is an excellent worker in the restaurant but a very poor one in school. He is not strong physically but ambitious. Has the big head and is very intolerant in his views. His father has been dead for many years—his mother is a great worker and a great talker—not an excellent manager for her boys.

We cannot say whether this candidate fared poorly, or whether he became enthused by the undergraduate courses in plant pathology and went on to become a pillar of our discipline. The question is, what kind of department would the prospective student have found? How has the curriculum evolved over the seventy-five years since its beginning, during which time 874 students at all levels have graduated and another 61 undergraduates and graduates are currently enrolled?

It is interesting that the roots of plant pathology at Madison reside not with us, but in the Department of Botany. Starting in 1901, R. A. Harper taught Botany 25, initially a laboratory course on plant diseases which emphasized fungal pathogens. C. E. Allen was responsible for Botany 27, which comprised lectures and laboratory work on tree diseases and timber decay. The "Department" of Plant Pathology, consisting solely of a "Professor Jones", first appeared in the 1909–10 edition of the university catalogue. Thus, L. R. Jones launched the curriculum, which in the second semester of that year comprised four courses: Plant Pathology 2—Plant Pathology (undergraduate), PP 19—Thesis (undergraduate), PP 20—Seminar, and PP—21 Research. Shortly thereafter, PP 115a—Diseases of Field Crops, PP 115b—Diseases of Timber and Forest Protection, and PP 122—Fungicides in Relation to Host and Parasite were added. By 1915 the foundation was laid. Most of the courses had been renumbered to reflect graduate credit (numbers $\geq$ 100), in line with Jones' philosophy that plant pathology was primarily a graduate endeavor.

Concurrent with the establishment of courses in the new Department of Plant Pathology, all botany department offerings in plant pathology were dropped from the catalogue. Although Harper and Allen may have been disappointed to lose their courses, Jones was offered the position at Wisconsin with the understanding that he would assume responsibility for teaching pathology. Botany had concurred with his appointment. So, despite the friction that developed as to whether the College of Agriculture or Letters and Science would acquire the new department, on a personal level there was apparently good cooperation. Harper and Jones seemed to genuinely respect each other; in fact since our college had no facilities for teaching these courses, Harper agreed to let Jones temporarily use his laboratories and equipment in Science Hall, where botany was then situated.

Figure 17.1 Plant pathology laboratory, 3rd floor of Horticulture Building, 1915.
L-R C. W. Hungerford, J. Brann, O. Reinking

EXPANSION AND SHIFTING EMPHASIS

The Crop Orientation and Mycological Emphasis

Jones was selected in large measure because he had ". . . been exceptionally strong as a teacher", according to Dean Harry L. Russell who proposed him for the position in a letter to President Van Hise on July 24, 1909. Jones moved quickly to hire faculty and develop the pivotal courses from which the curriculum would evolve.

By 1920, one decade after the inception of the department, the basic curriculum which was to remain intact for the next forty years was in place. In addition to the undergraduate introductory class and introductory thesis, this core curriculum included graduate-level courses addressing six subject areas, as described below.

An introductory class intended primarily for graduate students was first taught in 1914 as PP 101. It was, as its successor remains today, the central course of the curriculum in terms of precedence, breadth, enrollment, and continuity. This course was overseen by Jones, assisted by others, until 1929, when J. C. Walker assumed major responsibility for the course.

Jones had also established PP 102—Methods in Plant Pathology, which still survives (PP 611) as one of the stalwarts of the curriculum. It was designed to provide "practical work in the laboratory and greenhouse with parasitic diseases of plants, isolation of parasites, technique of culture methods, spore germination, and inoculation". Jones was the lead instructor for several years, after which it fell largely to George W. Keitt and then, in 1930, to A. Joyce Riker who assumed control for almost three decades. Among his other contributions to the course, Riker collaborated with his wife, Regina, in writing *Introduction to Research on Plant Diseases.* Pub-

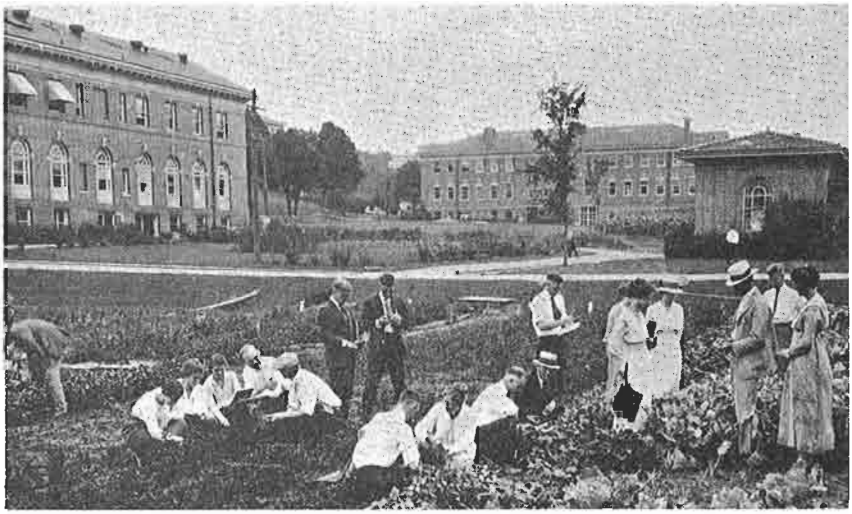


Figure 17.2 Class in the disease garden with R. E. Vaughan, 1919.

lished in 1936, the book contained a great breadth of information on working with microbes and plants under controlled conditions, and included a prefatory chapter on the scientific method.

Plant Pathology 115—Diseases of Special Crops was a complex of courses which included: 115a—Diseases of Field Crops; 115b—Diseases of Orchard Fruits; 115c—Diseases of Timber and Forest Protection (handled by staff of the U.S. Forest Products Laboratory); and 115d—Diseases of Garden Crops. These were destined to be the forerunners of the current PP 559—Diseases of Economic Plants and PP 510—Forest Pathology.

In addition, Jones had overseen the origin of PP 122—Fungicides in Relation to Host and Parasite, for which Keitt assumed primary control, until it was dropped in 1942. The subject of disease control was then relegated entirely to the general undergraduate-level courses.

The weekly seminars have always played an important role in the curriculum of the department. L. R. Jones initiated the series (PP 20, now PP 923) and assumed the leadership for it until he retired, when the responsibility passed to Keitt. Originally, the fall semester offering consisted of four themes (history, variability, pathogenesis, or chemical control) while in the spring, research reports were presented. The fall theme-oriented seminars are vividly remembered by students. H. E. Waterworth recalls:

> I can still hear Dr. Pound's exciting lectures in virology and Dr. Walker's contemplative delivery on diseases of fruit and vegetable crops. Dr. Keitt was in charge of a seminar one semester on the history of plant pathology. It was one of the more interesting seminars because Dr. Keitt was part of the history and was able to add numerous anecdotes.

Beginning in the fall of 1965, various other topics were covered, many of which evolved into full-fledged courses. The introductory seminar, presented to a small group of peers, was introduced at this time. In the spring of 1968 the thematic seminars were replaced by three formal seminars, required of each Ph.D. candidate: a research proposition seminar, originally an exercise in logic but currently a prospectus of the student's research program; a literature review; and a final seminar when the thesis research is being completed.

Research (PP 125) remained, as it still does, an integral part of the curriculum.

In the early years of the plant pathology department's existence, most plant pathology graduate students took minors in botany, and their curriculum had a strong mycological flavor. This mycological orientation undoubtedly reflected the importance in botany of classical fungal taxonomy, and in pathology of the emphasis on description, particularly of fungal pathogens and host-parasite interaction.

Botany 120—Mycology, taught by Gilbert, Harper, and others, was available to plant pathology majors as early as 1912. In 1920, three mycology courses were cross-listed as plant pathology offerings. PP 104—Morphology of Fungi was taught by Gilbert until 1945; it was then taken over by M. P. Backus and later by W. Whittingham, and was renamed PP 332 in 1963. Plant Pathology 220—Advanced Mycology, a year-long course, was taught for twenty-five years by Gilbert and for almost twenty by Backus. Backus was one of the outstanding mycologists of the era and an instructor universally acclaimed for excellence. In addition to the mycology courses, he also participated in introductory plant pathology. Graduates recall him with affection and admiration for the time and effort he put into teaching, and the high expectations he had of his students. For example, in the introductory course, the class was required to write detailed reports on about twenty-five diseases. Backus read each of these and meticulously criticized, corrected, and commented upon each. He demanded details and completeness. Curt C. Leben remembers Backus as the toughest teacher he ever had, but also one of the best. The course provided a real challenge and shake-up for entering students who had never been pushed so far. R. G. Grogan recalls that in his mycology course, Backus would bring in armfuls of old herbals that had been carried up several flights of stairs. Because he looked so tired and bedraggled, the students felt especially obliged to study them! In 1964, PP 220 was split into PP 731 and PP 732, and is now taught primarily by Harold H. Burdsall and Michael J. Larsen of the U.S. Forest Products Laboratory.

Plant Pathology 221—Classification of Parasitic Fungi was offered by J. J. Davis through 1936–37, then by Backus and H. C. Greene until 1945–46 when the course was discontinued. In 1921, PP 252—Cytology of Fungi was added. The course was taught by Gilbert until it was dropped in 1943. A course on fungal physiology was added in 1940, taught first by B. M. Duggar and then by P. H. Allen. The course was renowned for its breadth, depth and rigorous attention to analysis of research by the "scientific method". Students remember Duggar because he apparently had a photographic memory. Grogan, who took Duggar's course, recalls that when queried about an article Duggar could recite journal, year, and pagination as well as contents! His office resembled a narrow hallway and along one side was a twenty-foot long table piled with reprints, seemingly in disarray. Nevertheless, he could somehow always locate the particular article needed.

Thus, by 1920 the fundamentals of an academic program which reflected the major concerns of the era were in place. The curriculum was crop-oriented and the courses were largely descriptive and pragmatic. Courses in mycology and fungal taxonomy supplemented the plant pathology offerings. All graduates of the department left with a common, broad knowledge of plant disease and its many facets.

The Demise of the Crops Courses

In the 1963–64 academic year, elimination of the crops courses marked a major change within the departmental curriculum. These changes had been coordinated by a standing curriculum committee, which was established on July 1, 1955 under the chairmanship of Donald J. Hagedorn and continues to oversee all curriculum changes within the department. Indications of the change were evident a few years earlier, when the early focus on fungi as a pathogen group established a precedent for the development of two new "organismal" courses. Plant Pathology 106—Plant Viruses and Virus Diseases (later PP 206 and then PP 706) was first taught in the spring of 1958, by Glenn S. Pound and Robert W. Fulton, in response to the rapid growth of virological work appearing in the current literature. Plant Pathology 107—Plant Nematology was first offered in 1961, by Henry M. Darling and Gerald Thorne, but did not attract sufficient enrollment to continue on a regular basis. It was not until Ann MacGuidwin joined the faculty in 1984 that plant nematology received renewed interest. The last of the organismal courses, PP 518—Biology of Plant Pathogenic Bacteria, was added in 1978, taught by Arthur Kelman and Luis Sequeira.

A trend toward the basic science of plant pathology and an instructional approach emphasizing principles and synthesis of material was also taking place in the early 1960s, as evidenced by the incorporation of combined principles into the methods course (PP 102) to form PP 205a,b—Principles and Methods in Plant Pathology. For a short time the sequence continued as PP 701/702. The theoretical portion of the course was split away to become the now familiar two-semester PP 601/602 sequence which is taught in a lecture format and involves many staff members. Plant Pathology 601 emphasizes abiotic diseases, plant pathogens and pathogenesis, disease physiology, and disease resistance. Sequeira played a leading role in PP 601 for much of the 1970s and 1980s. He is remembered for his organized, polished lectures and astute evaluation of the literature. One graduate comments as follows:

> No one could forget Dr. Sequeira's lectures in PP 601—Physiology of Pathogenesis. He would stroll into the classroom just before the bell rang and compose himself beside the lectern, elegantly attired. As the class settled into an expectant silence, Dr. Sequeira's face would assume a distant, though benevolent, expression. He would cross his feet, lace his long graceful fingers over his midriff, and begin to speak. There were rarely any notes, but his lectures were masterpieces of logical organization, interesting detail, relevant examples (always with complete citations given from memory), and immaculate syntax. From time to time Dr. Sequeira would find it necessary to discuss a piece of work that was incomplete, had been disproved, or that made use of poor methods. A pained expression would cross his usually serene countenance and he would make a very mild suggestion that perhaps these researchers would proceed differently if they were given the opportunity to repeat their work. As I publish results now, no reviewer's criticisms pain me so much as the thought that Dr. Sequeira might in future lectures have to single out a paper of mine for one of his gentle rebukes.

Jack E. Mitchell and Paul H. Williams spearheaded PP 602—Ecology, Epidemiology and Control of Plant Diseases, which supplements PP 601 with detailed treatment of environmental factors in the development and spread of diseases, pathogen variability, genetics of disease resistance, and principles of disease control. Douglas I. Rouse, an epidemiologist, assumed responsibility for the course when he joined the faculty in 1979.

The abandonment of the crops courses and the elimination of the methods aspect of PP 205 meant that the curriculum, as of 1963, included no graduate-level laboratory couse. This void was filled in 1969 when Eugene B. Smalley first taught PP 611—Plant Parasitic Fungi and Bacteria, largely a methods course dealing with techniques for isolation, culture, and identification of plant pathogenic fungi and bacteria. John H. Andrews assumed responsibility for the course in 1981. Andrews added aspects of the scientific method, light microscopy theory, histo- and cytochemistry, laboratory protocol and plant propagation to the course content.

As a replacement for the crops courses a single semester course, PP 659—Diseases of Economic Plants (later PP 559), was initiated in the summer of 1965. Intially, Earle Hanson was the instructor; later John G. Berbee was involved for four years, and eventually Deane Arny, who assumed responsibility from 1972 through 1985. Arny rapidly became identified with the course and beloved by the students for his perceptive observations, kind and relaxed disposition, and fairness. Both he and his wife, Edith, who joined the class occasionally on field trips—invariably with a supply of cookies and refreshments—were skilled naturalists, and successive classes learned to appreciate aspects of plant biology other than pathology. The large white bus that Arny navigated along rural roads throughout the state became a symbol of the course. An affectionate and amusing recollection of the course is presented in Chapter 26.

The Integrated Pest Management (IPM) Program

On September 23, 1976, details of a prospective M.S. program in IPM were presented to the curriculum committee. The program was approved by the faculty shortly thereafter. The curriculum was broad, applied in emphasis, and involved a summer internship in lieu of a thesis. It was designed to prepare graduates who would become "general practitioners" of plant health (rather than specialists trained in research) with a strong base in pathology, weed science, entomology, and the related natural sciences. Eventually, after much debate and countless hours of discussion among the departments concerned, the modified program was elevated to an interdisciplinary committee degree status (M.S. in integrated pest management) when the Board of Regents formally approved the new curriculum on March 9, 1984.

The stage was being set for these events as early as the 1960s with the growing importance of IPM nationally. The IPM philosophy, with its roots in applied ecology, addresses the pest complex of a particular agroecosystem, rather than a specific organism, and emphasizes diversified, coordinated controls coupled with the use of economic thresholds. Initial contacts with the agronomy, entomology, horticulture, and soils departments were made by the Department of Plant Pathology in the late 1960s. Such efforts to develop a program at Wisconsin in response to the new IPM approach were met with strong opposition, due largely to problems of funding and the lack of personnel needed to teach the courses to be included in such a program. After initial efforts by Kelman and Mitchell, the development of the program lay dormant for many years. In recognition of the need to pursue these endeavors, the department in 1976 hired Andrews; he was given the responsibility of developing teaching and research programs in IPM.

This endeavor revealed the need for three new courses consistent with the nature of the existing curriculum. All were interdisciplinary in scope and were cross-listed among several departments. PP 346—The Use of Chemicals in Agricultural Pest Control was developed under the leadership of Mitchell and taught first in 1978. Concurrently, Andrews developed PP 560—Principles of Integrated Crop Pest Management, which was first offered in 1978 as a special topics course; in 1980 it became a regular offering, with faculty from agronomy and entomology also participating in the instruction. Finally, a course in environmental law was deemed advisable to inform students of the legal implications of pest control and to provide a prospective for situations they might face as consultants or practitioners (for example courtroom testimony, preparation of environmental impact statements). Although the Law School was not willing to undertake the course, it supported the concept. The situation was resolved when the Public Intervenor and Assistant Attorney General Tom Dawson agreed to teach the course one evening a week, every other spring, on an *ad hoc* basis. It became a most popular offering, with an enrollment typically exceeding 100 graduate, undergraduate, and part-time students from numerous disciplines. The IPM program has gained widespread approval and recognition of its importance within the university.

The Current Situation—a State of Flux

There is no such elusive creature as the ideal curriculum. Curricula, by their nature, reflect compromises among many different viewpoints, abilities, needs, and the reality of what can actually be done with the resources at hand. The questions are endless. They have occupied the time of generations of curriculum committees and will do so for generations more.

One interesting question is the degree to which curricula reflect what *should* be taught as opposed to what *can* be taught by the faculty at hand. At large research universities such as Madison, research needs take precedence. What, then, does the distinguished molecular enzymologist contribute, other than a course in his specialty? It seems that curricula evolve primarily around the abilities and interests of the teaching faculty rather than from a systematic, preconceived strategy of what a balanced curriculum should include. One case in point is the spotty coverage of nematology prior to 1984 in our department.

It is evident from Figure 17.3 that the number of courses offered has increased about sixfold over our seventy-five year history. Are we turning out better plant pathologists in 1984 than we did in 1914? Can they think better; can they do better science? Certainly they are more broadly trained. How important is this? How important is breadth vs. depth? If our current graduates are indeed "better" than their predecessors, to what extent is the curriculum responsible?

It is easy and appealing to focus on growth, on new courses, and on new programs. But what about the converse situation, when, for example, courses are dropped. Why does this happen? Usually it reflects declining student interest or departure of the faculty member responsible for the course. There are several examples of this in our curriculum. For instance, it is noteworthy that Keitt's course (PP 122) on fungicides appeared consistently in the university catalogue for thirty years (from 1912 to 1942). According to the timetable records, however, it was only offered for fourteen of those years, and for five of these, including the last two, the actual student enrollment was zero. It is also interesting that courses or subject matter once dropped are often revived at a later date. The current offering PP 520—Plant Pathogenic Fungi is essentially PP 221—Classification of Parasitic Fungi which appeared in the catalogue from 1919 to 1946. The modern day PP 310—Plant Disease Control is a continuation of the lineage of PP 5—Crop Dis-

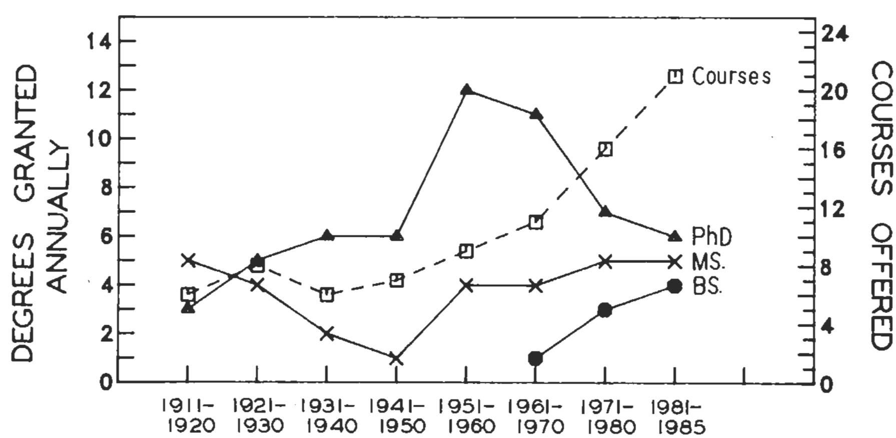


Figure 17.3 Average number of degrees awarded and courses offered in the department annually, by decades.

eases and their Control offered by Jones, R. E. Vaughan, and staff from 1917 to 1934. The curriculum in the department has yet to return to the stable position it held between 1920 and 1963. The department's curriculum committee is considering faculty and student concerns and proposing changes accordingly. A modification of prerequisites, a reduction in the amount of repetition among classes, and an increased emphasis on molecular biology are in the offing. The "evolution" of all courses offered in the department since its inception in 1910 is presented in Table 1.

THE GRADUATE PROGRAM

The Role of Research

The hallmark of the Ph.D. degree is research. It is the central element of the curriculum, as well it should be, because the instructional value of the thesis far exceeds that of any course or body of courses. When properly executed, the thesis work exposes the candidate to the art of scientific investigation: he or she must run, largely alone, the full scientific gauntlet from conception of hypotheses to publishing a paper. Meanwhile, the major professor looks on as an interested and concerned coach, much as a parent watches his offspring ride a bicycle for the first time.

Thus, it is little wonder that from the time the candidate enters graduate school, the thesis looming before him will become the dominating influence in his professional and personal life. It has been said, and is largely true, that psychological obstacles, not intellectual deficiencies, are the largest single problem to be mastered.

Requirements and Examinations

The Graduate School and the department itself have a number of requirements which students must fulfill in completion of the graduate program, including coursework, examinations, and preparation of the thesis. Aside from five basic required classes, the course of study for the M.S. degree is planned by each student in consultation with his or her major professor. Additional requirements include a thesis or "well-executed research report" and a final oral defense of the thesis or report. Candidates for the Ph.D. degree must: (1) have the proposed course of study, including a minor area, "certified" by the Evaluation and Admissions Committee, as recommended by an ad hoc Certification Committee; (2) pass a comprehensive preliminary examination covering the major and minor subject areas and the proposed thesis research, (3) prepare a dissertation which represents original research; and (4) pass a final oral examination covering the thesis research and related subject matter.

An additional requirement, prior to November 1974, was that of foreign language proficiency. Soon after their arrival in the department, students were expected to pass an exam on reading comprehension in two foreign languages, as part of the certification process then administered by the Biological Division of the Graduate School. These exams presented a major hurdle to most students early in their graduate career, and are "fondly" remembered by many. For others, failure to pass the language exam meant termination of their studies in the department. In 1973–74 the responsibility for certification was passed from the Biological Division to the department, at which time a formal foreign language requirement was dropped.

A more recent policy change regarding requirements relates to the format of the preliminary examination. For students who started their programs prior to the 1979 summer session, the exam was given in the conventional oral format. Students beginning after that time have been required to take a two-part preliminary examination. The first, taken soon after completion of the required courses, is a written component covering general subject matter in plant pathology. This format was adopted by the faculty with the hope of making the examination process more standardized, balanced, and thorough. The second component is an oral exam covering only the student's proposed thesis research and subject matter directly related to it.

As might be expected, this new approach has sparked some controversy over the philosophy behind the exam, standards to be expected, the time a student should actually take it, and so forth. In principle, the idea is sound. In practice, the consensus of both faculty and students is that the process has worked generally well and is improving as adjustments are made.

Teaching Students How to Teach

It is ironic that in preparing so many graduates for careers in academia so little attention is given to the art of teaching. One graduate refers to the information transfer systems that do exist as a "cascade of ignorance", whereby mistakes in the professor's notes are dutifully copied by attentive classes to be passed on in turn to subsequent generations of students. Some sort of teaching experience has been required of all Ph.D. candidates in plant pathology. In 1982, under the leadership of Williams as teaching coordinator, the department embarked on a more ambitious and formal plan (PP 799—Practicum in Plant Pathology Teaching) to convey the rudimentary skills. The components include an instructional orientation to teaching, direct supervised teaching experience, preparation and grading of exams, and analysis of teaching performance. This has provided a much more balanced, thorough, and meaningful experience for the students involved.

THE UNDERGRADUATE PROGRAM

Prior to 1965, students could obtain a plant science major, and the department had offered undergraduate courses for students since its inception. In 1960 the faculty approved an undergraduate major exclusively in plant pathology, which became operational by the mid 1960s. The program as currently structured comprises two options, "natural science" and "agricultural production and technology". The former, which is designed for graduate-track students, provides a strong background in the basic sciences, botany, and mathematics. The latter, for students who plan to terminate with the bachelor's degree, is more applied, and provides a broad education useful for individuals seeking careers in plant health or agribusiness. Plant Pathology 300 is the key comprehensive senior-level undergraduate course.

Annual enrollment in the undergraduate curriculum has varied from a half dozen students in the 1960s and early 1970s to about three times that number over the past few years. Students can extend their standard classroom experience by participating in such activities as an undergraduate club, research under the supervision of a professor, a year of study abroad, or a summer internship which provides both a salaried job experience and course credit.

WHERE DO WE GO FROM HERE?

Whatever its strengths or shortcomings, our curriculum has played a significant, if not the key role in shaping the thoughts of several generations of students for over seventy-five years. That so many Wisconsin alumni have gone on to influential positions as scientists and administrators says something about graduate education here. Will this distinguished record continue? What must be done to ensure that it does?

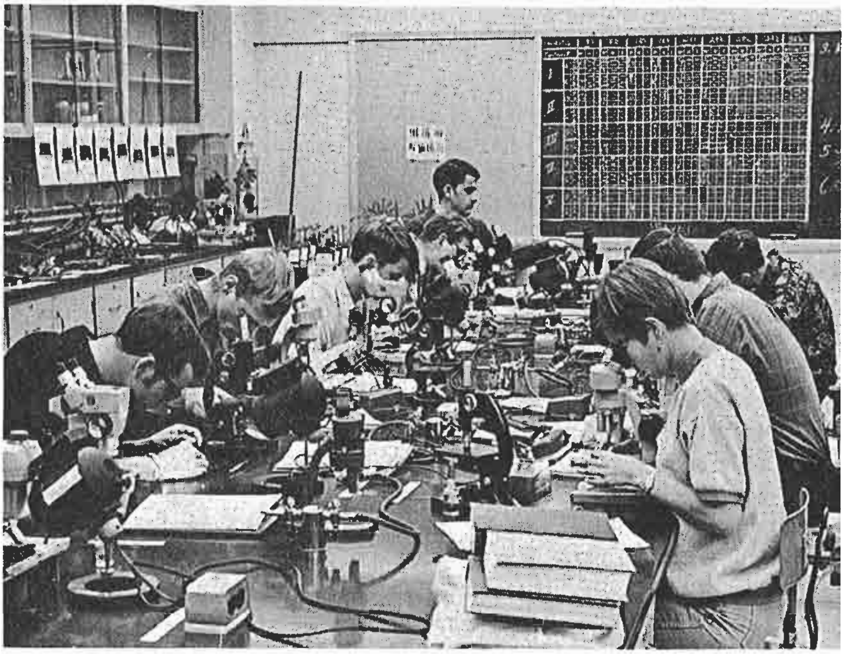


Figure 17.4 Plant Pathology 300 laboratory, 183 Russell, 1979.

It is interesting to reflect on the evolution of plant pathology as a discipline, from descriptive beginnings with a strong botanical and mycological flavor, through the physiology and biochemistry period, to the present era dominated by computers, mathematical models, and molecular genetics. This chapter has documented that as each stage unfolded, the curriculum was modified accordingly, almost in gene-for-gene fashion. Do we continue to expand course offerings, course contents, and curriculum options to meet these and other perceived needs, and yet still others to follow, *ad infinitum?* To cope with the information explosion in the sciences there are basically three alternatives: to demand increasingly more of our students, which seems unrealistic, to become increasingly specialized, which seems undesirable; or to make some difficult decisions about what really constitutes the essentials of an outstanding curriculum.

We suggest more emphasis should be given to fostering scientific individualism, rather than broad competency per se. The ability to develop a logical, clear argument, to think critically and independently, to analyze and synthesize, and to use one's imagination, are priceless and timeless skills. They do not change the way that facts change, and do not come into and out of vogue the way that theories do. Thus, the best way to prepare our students for every contingency is *not* to expand the curriculum or reward encyclopedic knowledge, but rather to instill a capacity to think and to be able to analyze any situation that presents itself. This does not mean to say that students do not now have the opportunity to develop what might be called the "rigorous scientific attitude" (presumably this is the major role of the thesis research), but its importance tends to be lost in the headlong rush to acquire information. For those fortunate souls who emerge with the philosophy, it seems to come to them almost incidentally, rather than having been conveyed forcefully as the central objective of graduate study.

A curriculum less demanding than the current version in number of formal courses would provide an atmosphere more conducive to developing analytic and synthetic skills. Equally important, it would send a signal to all comers that the emphasis would be on acquiring the correct *approach,* rather than on breadth and mastery of detail. For example, Hanna Holborn Gray, president of the University of Chicago, felt that the pivotal objective in education was to expose students to the writings of great authors. Who are the great thinkers in plant pathology and, more generally, in the biological sciences? What can we learn from them, *not* in terms of their factual accomplishments, but in posing the right questions and in cultivating the scientific method?

Courses could be modified with relatively little effort by faculty to reflect this new emphasis. For instance, a refreshing change from the conventional lecture format would be the Socratic method of addressing an issue by a series of questions. The use of case histories, where appropriate, would not only impart information but, more importantly, the manner (serendipity? incisive logic? tenacity?) in which it was obtained. Seminars would be a synthesis of ideas rather than a review of the literature. Exams would require the candidate to expound, rather than to check off a box or scribble a few short phrases. A premium would be placed on the ability to synthesize disparate pieces of data into a cogent, logical, and grammatically correct *essay.* It is insufficient to relegate this essential teaching technique to the preliminary exam, and even there it receives little emphasis.

One alumnus, when asked to comment on his student days, probably reflected the views of many when he wrote, "I think the thing one learned at Wisconsin was to keep the lights burning eighteen hours a day and to seek the truth no matter what the odds might seem." Future curriculum committees will undoubtedly spend many long hours trying to decide what is best for the department, just as their predecessors have done for decades. Whatever changes occur, the curriculum must first of all stand for fostering excellence and commitment.

TABLE 1

List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
GENERAL					
Undergraduate Plant Pathology					
2 Plant Pathology	3–5	1910	?	?	L. R. Jones (1)
1 Diseases of Plants	3	1911–14	2/4	103	L. R. Jones (2) A. G. Johnson (1)
5 Crop Diseases & their Control	1–2	1917–34	5/16	82	L. R. Jones (1) Vaughan (4)
7 Elem. Plant Pathology	3–4	1939–60	15/22	523	Riker (10) Dickson (10) Arny (12)

TABLE 1 *Continued*
List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
Introductory Plant Pathology					
101 Diseases of Plants	3	1914–60	11/11	1,017	L. R. Jones (12) Gilbert (14) A. G. Johnson (4) Miller (1) Baird (2) Street (1) Walker (34) Backus (10) Pound (11) Hagedorn (7)
103 Intro. to Pl. Pathology	4	1961–62	1/1	45	Kuntz (2) Boone (1)
300 Intro. to Pl. Pathology	4	1963–	22/22	1,608	Kuntz (3) Kelman (9) Maxwell (6) Slack (9) Andrews (5)
Methods					
2 Methods in Pl. Pathology	3	1911	?	?	L. R. Jones (1)
102 Methods in Pl. Pathology	3	1913–60	47/49	707	L. R. Jones (7) Keitt (11) Riker (22) Hildebrandt (4)
611 Pl. Path. Fungi & Bact.	1–2	1969–	16/16	56	Smalley (12) Andrews (4)
Principles					
613 Cyto. Aspects of Pl. Path.	1	1969–77	6/6	49	Williams (6) Plaut (2)
205a Prin. & Meth. in Pl. Path.	3	1961–62	2/2	64	Walker (1) Hildebrandt (2) Smalley (2) Pound (1)
701 Prin. & Meth. in Pl. Path.	3	1963–68	6/6	81	Pound (1) Smalley (6) Sequeira (5)
601 Pl. Pathogens & Pathogenesis	3	1969–	15/15	205	Sequeira (13) Williams (1) de Zoeten (4) Helgeson (4) Maxwell (4) Kelman (5) Ahlquist (1) Durbin (5) staff
205b Prin. & Meth. in Pl. Path.	3	1962–63	2/2	43	Mitchell (2) Sequeira (2)
702 Prin. & Meth. in Pl. Path.	4	1964–68	5/5	85	Sequeira (1) Mitchell (5) Moore (3) Barker (2) Dropkin (1)
602 Ecol., Epid. & Cont. of Pl. Dis.	3	1969–	15/15	222	Mitchell (8) Williams (7) Rouse (6)

TABLE 1 *Continued*

List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
708 Adv. Pl. Disease Physiology	3	1966–69	2/3	16	Sequeira (2) Williams (2) Maxwell (1)
708 Plant Disease Physiology	3	1972–79	0/3	0	
CROPS COURSES					
Diseases of Field Crops					
115a Diseases of Field Crops	1–2	1913–16	1/4	26	L. R. Jones (1) A. G. Johnson (1)
116 Diseases of Field Crops	2	1918–57	24/28	475	A. G. Johnson (1) Dickson (23)
114 Dis. of Cereals & Sel. Field Crops	2	1958–62	3/3	49	Arny (3)
115 Diseases of Forage Crops	2	1959–63	3/3	36	Hanson (3)
614 Dis. of Cereals & Sel. Field Crops	2	1964	0/1	0	
Diseases of Orchard Fruits					
115b Diseases of Orchard Fruits	2	1914–16	0/3	0	
117 Diseases of Orchard Crops	2	1917–63	21/23	353	Keitt (18) Moore (3)
617 Diseases of Orchard Fruits	2	1964	0/1	0	
Diseases of Trees					
115b Dis. of Timber & Forest Prot.	1	1913	1/1	6	Humphrey (1)
115c Dis. of Timber & Forest Prot.	1	1914–16	0/3	0	
119 Dis. of Timber & Forest Prot.	1–2	1918–34	6/11	26	Humphrey (3) Colley (3)
119 Fungus Deterior. of For. Prod.	2	1935–63	3/22	14	Richards (2) Sheffer (2)
619 Fungus Deterior. of For. Prod.	2	1964–67	2/2	9	Patton (2)
113 Diseases of Forest & Shade Trees	2	1961	1/1	3	Patton (1)
613 Diseases of Forest & Shade Trees	2	1963–66	2/3	9	Patton (2)

TABLE 1 *Continued*
List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
613 Forest Pathology	2	1968	0/1		
510 Forest Pathology	2	1969–	4/11	28	Patton (4)
500 Insects & Dis. in For. Res. Mgmt.	4	1970–	15/15	401	Berbee (14) Benjamin (13) Morgan (1) Giese (1)
Diseases of Garden Crops					
120 Diseases of Garden Crops	2	1917–27	4/5	74	L. R. Jones (4) Walker (3)
120 Diseases of Veg. Crops	2	1929–63	19/20	425	L. R. Jones (1) Walker (18) Hagedorn (1) Williams (1)
Diseases of Small Fruits					
118 Diseases of Small Fruits	1	1918	0/1		
118 Diseases of Truck Crops	2	1919	0/1		
118 Diseases of Small Fruits	2	1921–25	3/3	27	Keitt (1) L. K. Jones (2)
Diseases of Economic Plants					
659 Diseases of Economic Plants	2	1965–69	5/5	73	Hanson (3) Berbee (2)
559 Diseases of Economic Plants	2	1970–	16/16	234	Berbee (2) Arny (13)
CONTROL					
General Control					
122 Fungicides in Rel. to Host & Parasite	1–2	1913–41	9/14	99	Keitt (8) Vaughan (1) L. K. Jones (2)
310 Plant Disease Control	2	1977–83	7/7	223	Kuntz (7)
Biological Control					
714 Ecology of Soil-Borne Path.	1	1969	1/1	9	Mitchell (1)
614 Ecol. of Soil-Borne Plant Path.	1	1970–	7/9	56	Mitchell (6) Parke (1)
Breeding and Genetics					
617 Plant Disease Resistance	1	1969–	1/1	6	Arny (1) Hagedorn (1)

TABLE 1 *Continued*
List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
517 Plant Disease Resistance	2–3	1974–	6/7	119	Arny (1) Hagedorn (1) Haley (1) Williams (5)
709 Path. Var. & Host Resistance	3	1965–67	2/2	28	Arny (1) Boone (2) Hagedorn (2)
618 Var. of Plant Pathogens	1	1971–80	4/5	41	Boone (4) Leonard (1)
957 Seminar in Pl. Breeding	1	1980–	2/15	41	Williams (2)
Integrated Pest Management					
422 Insects in Rel. to Plant Disease	3–4	1971–	4/7	16	Chapman (5) Norris (5)
346 Use of Chem. in Ag. Pest Con.	2	1978–	8/8	144	Mitchell (6) Lichtenstein (3) Harvey (7) Beck (3) Hsia (5) Worf (1)
375 Special Topics	2	1977–80	5/5	114	Andrews (3) Dawson (2)
368 Env. Law, Toxic Sub. & Cons.	2	1981–	3/3	129	Dawson (3) Andrews (3)
399 Coordinative Internship	var.	1976–	15/15	34	variable
375 Comp. Appl. Pl. Pest Mgt.	1	1982–	1/1	3	Stevenson (1)
560 Prin. of Int. Crop Pest Mgt.	4	1980–	3/3	50	Andrews (3)
ORGANISMAL COURSES					
Mycology					
104 Morphology of Fungi	3	1920–44	24/24	?	Gilbert (25)
104 Fungi	3	1945–62	18/18	?	Gilbert (1) Backus (26) Whittingham (6)
332 Fungi	4	1963–	22/22	?	Backus (9) Whittingham (22)
220 Advanced Mycology	2–3	1920–63	?	?	Gilbert, Backus
731 Advanced Mycology	2	1964–	3/12	6	Whittingham (1) Burdsall (3)
732 Advanced Mycology	2	1964–	4/11	10	Backus (1) Whittingham (2) Burdsall (2) Larsen (3)

TABLE 1 *Continued*

List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
221 Class. of Parasitic Fungi	1	1920–46	?	?	Davis, Backus, Green
520 Plant Pathogenic Fungi	3	1982–	2/2	13	Smalley (2)
252 Cytology of Fungi	2	1921–43	?	?	Gilbert
249 Sp. Phys. of Path. Fungi	2–4	1940–47	?	?	Duggar, Allen
177 Physiology of the Fungi	4	1951–57	?	?	Allen, Backus
277 Physiology of the Fungi	4	1958–62	?	?	Allen
855 Physiology of the Fungi	2	1963–74	?	?	Allen
Virology					
106 Plant Viruses & Virus Dis.	1–3	1958–60	2/2	83	Pound (2) Fulton (2)
206 Plant Virology	3	1962	1/1	26	Pound (1) Fulton (1)
706 Plant Virology	3	1964–	10/11	190	Pound (1) Fulton (9) de Zoeten (8)
Nematology					
107 Plant Nematology	3	1961	1/1	21	Darling (1) Thorne (1)
207 Plant Nematology	3	1963	1/1	25	Darling (1) Barker (1)
707 Plant Nematology	3	1965–72	1/5	5	Darling (1) Barker (1)
616 Plant Nematology Techniques	1–3	1974–	5/5	49	Darling (2) Dropkin (1) MacGuidwin (2) Bird (2) MacDonald (2) Mai (1)
Bacteriology					
518 Biology of Pl. Path. Bacteria	3	1978–	3/3	33	Kelman (3) Sequeira (3)
MISCELLANEOUS					
201 Communications	1	1962	1/1	7	Hildebrandt (1)
703 Communications	1	1964–68	3/3	33	Hildebrandt (3)

TABLE 1 *Continued*
List of all courses offered in the Department of Plant Pathology, summarized from university catalogues (prior to 1915), university timetables (1915 on), and departmental records, through summer semester, 1985[a]

Number and Course Title	Credits	Years Offered	# Semesters Taught/ Offered	Total # Students	Instructors (# Semesters)
620 Pl. Path. Reports & Illustrations	1	1971–76	1/4	4	Hildebrandt (1) Vicen (1)
180 Special Topics	var.	1942–51	10/27	19	variable
180 Special Problems	var.	1952–62	20/33	73	variable
699 Special Problems	var.	1963–69	13/21	61	variable
699 Special Problems & Topics	var.	1970–	45/47	415	variable
606 Coll. in Env. Tox.	1	1970–	30/30	3,218	Smalley (23) Harkin (8)
299 Independent Study	1–3	1973–	24/31	59	variable
799 Pract. in Plant Path. Teaching	1–3	1981–	8/13	32	Williams (7)
875 Special Topics	1	1976–	9/16	101	variable
SEMINAR					
20 Seminar	1	1910	?	?	L. R. Jones (1)
23 Seminar	1	1910–11	?	?	L. R. Jones (1)
123 Seminary	1	1911–16	10/10	162	L. R. Jones (10)
223 Seminary	1	1916–46	59/59	1,395	L. R. Jones (38) Keitt (21)
223 Seminar	1	1947–63	29/29	1,359	Keitt (19) Fulton (1) Hagedorn (1) Thorne (1)
923 Seminar	1	1963–	21/21	911	Upper, Maxwell, de Zoeten, Durbin, Mitchell, Helgeson, staff
RESEARCH					
Senior Thesis					
19	2	1910–15	4/6	14	Jones (4)
100	2	1916–19	4/7	13	Jones (4)
Research					
21	var.	1910	?		
25	var.	1910–11	?		
125	var.	1911–16	8/8		
225	var.	1916–29	24/24		
200	var.	1929–63	62/62		
990	var.	1963–	42/42		

[a]A more complete year-by-year summary has been placed in the University Archives.

CHAPTER 18

Contributions of Professional Staff

Darlene Gakovich and Gary Gaard

When we talk about the professional staff, to whom are we referring? The professional staff operates under the direction of the faculty; consequently, we view our contributions mainly as support for whatever the various program or research goals of the faculty require. We can only write about ourselves in general terms, for there is a problem of documentation and information about us. In the early years and well into the fifties, it was the faculty, together with assistance from their graduate students and a few state-classified civil service employees, mainly farm laborers and gardeners, who did all the research. Not until the late 1950s and early sixties did the professional staff begin to emerge in any significant numbers. Since the mid 1970s, the size of the professional staff has experienced a mushrooming growth which can be attributed to several factors that will be discussed later.

What were the historical, political, and technological events that caused this dramatic increase in our numbers? What are the factors that shape the current status of the professional staff? Are there changes on the horizon that might affect our status and working conditions in the future?

THE PROFESSIONAL STAFF

The plant pathology professional staff is a heterogeneous group of individuals, most of whom belong to a group of university employees known as academic staff specialists. Prior to 1967–68, research specialists appeared in the budget book as project or program assistants. In the 1960s, it is interesting to note that academic staff members in general were referred to as "subprofessionals who are not students, faculty, or classified personnel". Many academic staff members resented what they perceived to be a demeaning definition, and though this ungenerous differentiation was abandoned later, the use of the term "subprofessional" still crops up from time to time. Recently, Governor Anthony Earl's policy advisor, Harold Bergan, used the term in reference to the academic staff, and he incurred the wrath of some Madison Academic Staff Association members, many of whom hold Ph.D. and M.S. degrees. A delegation was sent to the governor's office to set the advisor straight!

In 1985, most academic staff members are referred to as "specialists" of one sort or another. In plant pathology there are twenty-nine professional staff members classified as Specialists—Life Science Research. This broad title does not tell what a person really does. Gary Gaard has that title, although he works with the electron microscope. Steven Vicen is our departmental photographer and draftsman, which is hard to tell from his title of Specialist—Humanities/Communication. Department Administrator, Assistant Director, Assistant Scientist, and Project Associate are other academic staff titles. We also have three U.S. Department of Agriculture (USDA) employees who work in research.

Figure 18.1 Technical support staff, 1985.
Bottom row, L to R: L. Barlow, M. Palmer, L. Covert, B. Stanger, S. Adams, K. Ritchie, D. Galuska, F. Berbee, M. Taga
Middle row, L to R: A. Budde, A. Poplawski, C. Hill, D. Gakovich, T. Uchytil, A. Joy, R. Rand, J. Pscheidt, W. Russin, W. Robertson, D. Holden, J. Vignali, B. Livingston
Back row, L to R: G. Gaard, R. Gilbertson, S. Vicen, J. Stewart, M. Peterson, M. Klopmeyer, R. Spear, J. Gerik, E. Farmer, P. Moore

The wide range of titles reflects a wide range of responsibilities. The duties of the professional staff are varied, but one element is characteristic of all: to provide support for the varied needs of the department, faculty, and individual programs. The support can be administrative, instructional, scientific, or technical in nature. Duties are not strictly defined or limited. A research specialist may become a "right hand" to the supervising faculty by assisting with the writing of grant proposals, reviewing of manuscripts, and interviewing of prospective graduate students and job applicants. It is not unusual for a faculty member to invite a research specialist with particular expertise to give a lecture or a demonstration of an experiment or technique being discussed in class. Graduate students, in particular, often turn to professional staff for help. If they need assistance with enzyme-linked immunosorbant assay (ELISA), lyophilization techniques, protein-A antiserum purification, or various tissue culture techniques, they often turn to the technical staff. If they need to use a specialized instrument such as the electron microscope, they turn to the professional staff. We are there to assist students or give advice.

Our experience with experimental procedures can often save the student time. Frequently, we discover that the finer points of a published protocol are left out, and that may well make the difference between success and failure. Through repeated experiments, and trial and error, we are in the best position to evaluate a method and determine whether the language of a protocol needs refinement or clarification. In the "Sensitized Latex Agglutination" protocol, for instance, the last step calls for filtering the suspension. The inexperienced student is naturally inclined to use a glass funnel and a folded filter paper, and having done so, discovers that the test will not work. What has happened? The narrow end of the funnel caused sensitized latex particles to clump together at the bottom, preventing them from passing through the filter paper. No particles, no agglutination. Two days work lost, not to mention the cost of reagents. A knowledgeable specialist would have advised the student to use a small Büchner funnel and vacuum instead. Often, an actual demonstration is necessary to master a technique. The best way to learn the lyophilization technique, for example, is to have a "hands-on" practice session under the supervision of Elizabeth Barlow. For many students this has spared burned fingers and lost samples!

Specialists who frequently spend much time in tedious, repetitious, time-consuming tasks often find ways of saving time. Sometimes an idea comes up to help speed things along. Jeanette Fulton, for example, used to help Robert Fulton graft heat-treated poinsettia cuttings, a time-consuming task. She suggested rooting the cuttings instead of grafting them. Professor Fulton did not think it would work, but it did, saving many hours.

HISTORICAL PERSPECTIVES

Prior to 1960, plant pathology employed just a few people as part of its professional staff. These positions were associated more with departmental and instructional needs than with research. The faculty did most of the research, which was field-oriented and required intensive manual labor. They depended on their graduate students to do the work. Traditionally, a student would be chosen by a professor and offered a research assistantship. In reality, it was a graduate training stipend.

These research assistantships were funded by various sources. Some came from federal grants (USDA and Hatch), some from state funds, others from private sources. A bill would be sponsored by one or more legislators to fund a particular program that would benefit the state, and once the bill was passed, the funds would be included in the university budget and become automatic every year. This is how the pea and cabbage improvement programs were started. In 1935, the Wisconsin Alumni Research Foundation began providing money to the Graduate School, which in turn would distribute funds to various professors to support research assistantships. After WWII, the federal government, through the National Science Foundation (NSF) and the National Institutes of Health (NIH), supported research projects that were awarded to individuals on a competitive basis.

Postwar advances in analytical technology stimulated biochemistry and genetics toward the discovery of DNA as the central determinant of heredity. In the late 1950s, the shift from predominantly field-oriented research to primarily laboratory research began. Fueled by the Soviets' first Sputnik in 1958, the U.S. Congress appropriated huge sums of money for research.

The eminence of the University of Wisconsin resulted in it becoming a major recipient of NIH and NSF funding. With federal grants becoming more available, more research projects were undertaken, with the result that it became advantageous to hire non-student help.

In the words of Frank Kooistra, associate dean of the College of Agricultural and Life Sciences (CALS): "Essentially, there was the diminishing of graduate student labor. The federal research grant funds required a set of research objectives, a clear course of achievement toward some research goals, and the professorial staff simply did not have the time to do all of this on their own. Essentially, this brought about an academic staff group that was absolutely necessary in order for the University of Wisconsin to maintain its eminence as one of the outstanding research institutions, and certainly from the standpoint of a collaborative research group, I believe this academic staff title was a desirable thing. It created jobs, it expanded the work force, it increased productivity, and led to the continuing outstanding reputation of the University of Wisconsin."

One other factor could also have contributed to the diminishing reliance on graduate assistants to do research. To quote Dean Kooistra again, "the IRS started to investigate the scholarship activities associated with research assistants. Essentially, the IRS ruled that if there were duties and responsibilities consistent with employer-employee relationships, research assistants would lose their tax-exempt status."

Thus came the turning point. More and more academic staff personnel were hired to do research. They were usually new graduates starting their first professional jobs with limited or no lab experience. Most had to be trained on the job, due to the highly specialized nature of the research. Robert Fulton reflects, "It took a while to learn that you couldn't hire a technician. You hired a person and you had to train him or her." There was no screening of applicants as is the case in the civil service system, so there were always plenty of candidates to pick from. The wages then, as they are now, were quite low, but people were willing to work. For some, it was a job while the spouse was in graduate school; for others, it was a chance to gain experience before moving on to a better-paying job, or an opportunity to save money for graduate studies. For others in plant pathology, more than any other department in the College of Agricultural and Life Sciences, it was a career. Some of the first specialists hired in the department were from Poland. They were part of an exchange program sponsored by the United Brethren Church. Most had M.S. and some even Ph.D. degrees, and all were willing to work for whatever the faculty could pay them in exchange for a chance to improve their English. Fulton hired a young Polish woman who turned out to be "not a very good worker but very much an anti-capitalist". However, at the end of her one-year stay, she did not want to go back!

In addition to the increase in positions generated by granting agencies, other factors contributed to the increase in size of the professional staff in plant pathology. The move to Russell Labs in 1964 afforded more space for program expansions. The Disease Physiology Research Laboratory was established, funded by the USDA. More state-funded positions were created. In addition to continued financing of the photo media center, positions were established for the growth chambers and general services (Frank Vojtik), the electron microscope joint with entomology (Gary Gaard), the vegetable program (Robert Rand), and the Elite Foundation Seed Potato Farm (Robert Slattery). Many of these positions were established under the chairmanship of Arthur Kelman.

The growth of the Plant Pathology professional staff positions is illustrated in the figure below.

ACADEMIC STAFF CLASSIFICATION

As the professional staff grew, classification of the group became necessary in order to distinguish it from the tenure track faculty. How and why did we become academic staff and not a part of the already existing state-classified civil service system? The answer lies in the nature and source of funding, and the need for budgetary and program flexibility.

The majority of the professional staff positions in plant pathology are supported by extramural funds which are short term (two to three years) and do not allow principal investigators (PIs) to bring in permanent research staff. Thus, the appointments are intended to be temporary, not lasting beyond one or two grant periods unless new sources of funding are secured.

The principal investigators have more latitude in hiring academic staff than they would for civil service employees. Essentially, they may hire and keep any qualified person they want for the length of the grant, and when the funds run out, the person may be terminated without having to

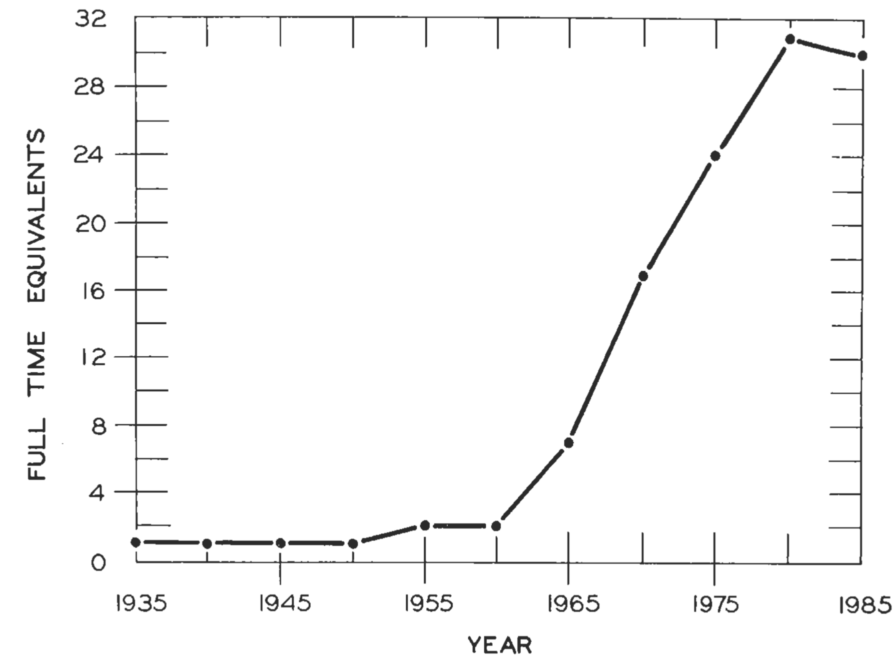


Figure 18.2 Growth of plant pathology staff positions.

show cause. With the state-classified system, the PI is required to hire from a list of pre-screened applicants offered by the State Personnel Division. Once hired, the person becomes a long-term employee with job security and seniority rights that translate into higher salary with each pay-step reclassification. To quote Dean Pound, ". . . at the outset of a classified position there is reduced control." With this type of personnel constraint, it would be difficult for the department to retain budgetary flexibility or to terminate a program. Flexibility is especially evident in funding. As noted earlier, professional staff positions are funded from various sources. Payroll records show some people being paid from six sources in a fiscal year. This may be repeated for several years.

Another major constraint in hiring classified personnel is their rigid job descriptions that do not allow for sustained input and increased responsibilities without reclassification and commensurate pay increases. The need for sustained input is best illustrated in the case of Eugene Herrling, whom we consider to be the prototype specialist. Gene served the department for fifty years, mostly in the capacity of a support person, but through the years his titles included: student hourly, 1919–35; assistant, 1935–46; instructor, 1946–64; and in 1964, when the university tightened up its tenure rules and regulations, program assistant, in order to reflect that he was not in a tenure track position. From 1967 until he retired in 1969, Gene was a specialist (Chapter 3).

Though the department and its research programs have benefited greatly from the flexible personnel policies afforded by academic staff hiring, these policies have presented a major problem for the professional staff. The specialists' only gain has been job experience, while the salaries have generally remained low. Little or no opportunity has existed for professional growth, job security, or career advancement. Where academic staff has succeeded in growing substantially professionally, it has largely been on the initiative of the individual's immediate supervisor or principal investigator. Thus, for example, Frank Vojtik's title has changed from program assistant to specialist, to administrative assistant, and presently, to department administrator. At this time, only two specialists, Gary Gaard and Robert Rand, have indefinite appointments.

CONTRIBUTIONS AND ACCOMPLISHMENTS OF PROFESSIONAL STAFF

As mentioned, the contributions of the professional staff are mainly as support services to the department and the faculty. In the words of Dean Pound, "If we think of research as a wheel, who is to say that the hub or spokes contributed most?"

It would be difficult to list all of the staff members and their contributions to the numerous programs of the individual faculty members of the department. Listed in Table I are the professional staff members of the department. Suffice it to say, their contributions have been legion. Many have been recorded in the publications from the department and perhaps just as many have gone unrecorded or unacknowledged. Instead, we will briefly focus on those specialists whose contributions have benefited everyone in plant pathology.

Eugene Herrling was the department's first employee, with the longest service. He started as a dishwasher while still at Wisconsin High School. He was always interested in photography. Professors Fred R. Jones, J. C. Walker, and Herbert R. Angell were also interested in photography, and they taught Herrling what they knew about the subject. After getting a degree in business administration, Herrling was employed in plant pathology in the capacity of general support. His photography expertise became more and more valuable to the department, and especially his drawing skills, for photography was still in its early stages and charts, graphs, etc., were hand done, including the tinting of all the color. He can recall the old glass negatives with emulsions made in each lab. As photography developed, so did Herrling, and he became the plant pathology professional photographer. He helped in other ways. Before he began his regular job, he spent several summers with James Johnson working on tobacco fire blight. He will never forget Johnson's struggle with filterable viruses, and how he would call to Johnson: "Just wait a bit, Jim, a new microscope is just in the offing that will make your work so much easier!"

Susan Daugherty began her long association with the department in the mid 1950s. She retired in 1984, and upon the suggestion of Jeanette Fulton, the department requested that she be given emeritus status for her long service in fruit disease research and instructional support. The request was granted. This was the first time in the University of Wisconsin history that emeritus status was conferred on an academic staff research specialist.

Frank Vojtik has served in various capacities since 1964. His duties have ranged from teaching and instructional support to administrative responsibilities. Gary Gaard started his job in 1965 as project assistant to Robert Fulton. He gained experience working with the electron microscope, and now his expertise serves the research of many. Steve Vicen is another example of one person who serves the needs of the entire department. Vicen apprenticed under Herrling for a period of time prior to Herrling's retirement and has served as the departmental photographer, draftsman, and instructor of microscopy since 1969. Flora Berbee, while still playing a key role in John Andrews' program, is now the lab assistant responsible for PP 611.

As a group, the plant pathology professional staff has been very active. In 1979 the plant pathology specialists were instrumental in forming the Technical Staff Organization (TSO), the first active departmental-level technical staff group on the University of Wisconsin–Madison campus. The TSO sponsors various activities to ensure that its stated purpose, "to provide intradepartmental communication and . . . to share job-related information and skills", is carried out. Contributions have been in improvement of education, technical information, communications, safety, productivity, and general working conditions within the department. Among the accomplishments of the TSO have been the updating and distribution to all personnel of 1) a Departmental General Information Guide; 2) a directory of technical staff expertise; and 3) a comprehensive list of laboratory research equipment to serve as a resource/reference guide. In addition, the TSO has organized and sponsored a Fire Safety Seminar and fire extinguisher demonstrations. A successful and well-attended (over 200 people) seminar entitled "Insect Control in the Greenhouse" was sponsored and resulted in the placement, in both greenhouse complexes, of permanent displays for identifying key plant pests and choosing insecticides. Together with the displays and seminar, insect/insecticide reference charts including a section on safety and toxicity were printed and distributed. The safety program was funded by the College of Agricultural and Life Sciences and was the first initiated by a non-faculty group.

The TSO has also devised a specialist job evaluation form to promote and facilitate communications between the academic staff and faculty advisors through annual job performance reviews.

ACADEMIC STAFF IN TRANSITION

The year 1985 finds the University of Wisconsin academic staff, and thus the professional plant pathology staff members, in transition. A major continuing concern is that of low salaries. Disaggregation of current titles and classification of new titles with steps and pay ranges within each would help recognize years of experience and increase in responsibilities. Some Wisconsin legislators are aware of the contributions of academic staff and are proposing a university-wide study of all University of Wisconsin System academic staff positions. According to Dean Kooistra, ". . . there are many other external elements . . . that probably bear more impact than anything else. When one thinks of comparable worth, when one thinks of a job classification system and the times of salary catch-ups, obviously all of these things will impact on academic staff positions. The whole issue of collective bargaining looms on the horizon, and this, probably more than anything else, will change academic staff and the academic staff employee group in the future."

We do not know what lies ahead. But one thing we do know: No matter what changes occur in the future, in plant pathology "the hub and the spokes" will continue to work together for many years to come.

TABLE 1

Plant pathology professional staff—past and present[a]

Aist, Sheila 1969–72	Kenerley, Charles 1976–79
Ahrens, Robert 1966–70	Kitzinger, Carol 1985–
Allan, Elizabeth 1973–77	Kostichka, Charles 1981–
Baker, Lawrence Stuart 1977–82	Kreunen, Julie 1984–
Barlow, Elizabeth A. 1975–	Maki, Arvid 1985–
Bellas, Christine 1980–83	McKee, Brownlee 1969–71
Berbee, Flora 1979–	McNabola, Sharon 1965–68
Bradshaw-Rouse, Judith 1979–85	Maher, Eileen 1977–84
Budde, Allen 1974–	Mai, Shing Huey 1977–80
Caine, Donald 1976–84	Maxwell, Martha 1971–77
Callis, Judy 1977–79	Murray, Pat Schneider 1973–75
Cannon, Sandra J. 1984–	Nesbit, Dorothy 1974–84
Carlson, Eric J. 1985–	Opgenorth, Dan 1971–75
Conrad, Janice 1979–82	Palmer, Mary 1976–
Cuppels, Diane 1971–73	Perry, Joy 1979–83
Daugherty, Susan 1972–84	Peterson, Marie 1981–85
Diez, Fernando 1954–81	Peterson, Michael 1984–
Dobberpuhl, June M. 1984–	Pohlman, John D. 1984–
Donald, Patricia 1973–77	Radke, Vicki 1977–85
Elliott, Candice 1980–84	Rand, Robert 1965–
Elmendorf, Eleanor G. 1968–76	Ritchie, Kathy 1983–
Fulton, Jeanette 1966–69, 1975–84	Robertson, Wendy 1984–
Gaard, Gary 1965–	Sanderson, Peter G. 1984–
Gakovich, Darlene 1981–	Sanford, Helen 1978–80
Galuska, Deborah 1984–	Schmidt, Carl 1969–79
Graves, Lynn 1975–85	Slattery, Robert 1974–81
Gullings-Handley, Josephine 1971–77	Smejkal, Catherine 1975–84
Haberlach, Geraldine 1967–	Spear, Russell 1974–
Heimann, Mary Francis, O.S.F. 1975–	Stewart, Jana 1981–
Herrling, Eugene H. 1919–69	Sutton, Dennis 1968–81
Hill, Curtis B. 1980–	Thomson, Norman F. 1983–
Howman-Combs, Beth A. 1984–	Toole, Lawrence J. 1982–85
Hruschka, Judith 1968–71	Uchytil, Tom 1964–
Hughes, William 1970–74	Vicen, Steven A. 1966–
Hunt, Gregory J. 1985–	Vojtik, Frank 1964–
Joy, Ann Ellen 1985–	Warfield, William 1978–83
Kazmierczak, Pam 1981–84	Wyman, Douglas 1962–68

[a]The list of names of past specialists is limited to those who have worked for three years or longer. The current staff is identified with (–).

CHAPTER 19

Civil Service Employees

Robert W. Fulton, Marleen S. Lippert, and Audrey Dunlap

GREENHOUSE FACILITIES AND EQUIPMENT MAINTENANCE—Robert F. Fulton

Any history of the Department of Plant Pathology would be incomplete without recording the contributions of the permanent civil service employees. They are the ones who took care of so many necessary duties, often tedious, that kept the department functioning. There will no doubt be omissions in this brief account; records were not always detailed, and memories fail. Many good deeds and much devoted service will probably go unrecorded. However, some of the anonymity may be for the best. It is not possible, for example, to record names of the Works Project Administration (WPA) workers (during the Great Depression) who, late one Friday afternoon, hacksawed through a pipe leading to a refrigerant tank in the greenhouse basement. The refrigerant was sulfur dioxide; the workers beat a hasty retreat. Unfortunately plants in the nearby greenhouse were all dead the next morning.

One of the first persons in charge of greenhouse operations was Chester Barlow. He was nominally attached to James G. Dickson's group and had a considerable facility for devising tem-

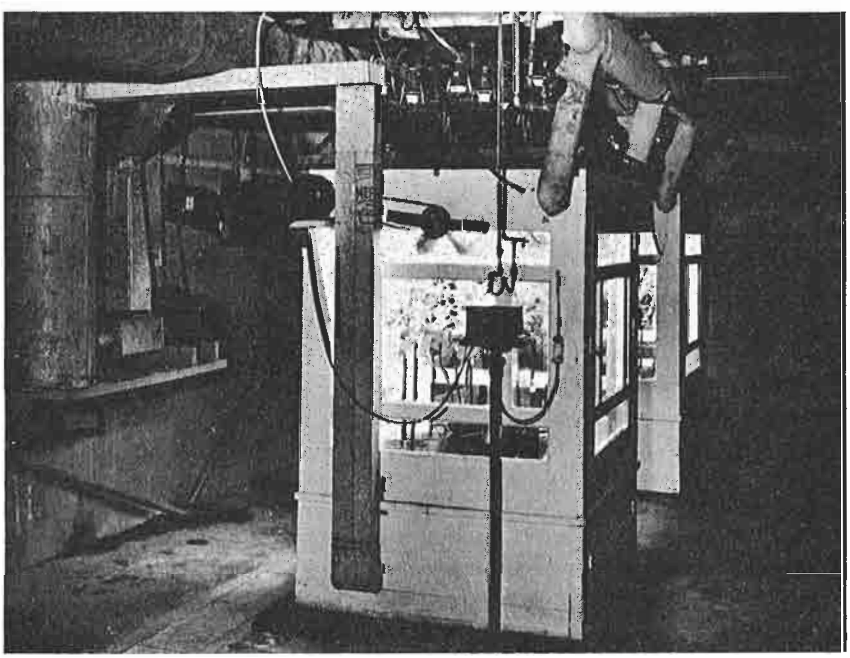


Figure 19.1 The first plant growth chambers, handiwork of Chester Barlow, 1932.

perature control equipment. He built an aluminum and glass chamber, double walled, for James Johnson. Over the years this served for experiments on tobacco curing as well as for experiments on the relation of temperature and light to disease occurrence. Unfortunately, the designers did not consider the degree to which the heavy aluminum conducted heat, so that temperature control was difficult. The last known location of the chamber was the Sturgeon Bay station.

When Barlow died, his duties were taken over by Albert H. Steinmetz, older brother of Alma Steinmetz. Alma was the department's only secretary for many years. Al was an important fixture in the department for forty years, beginning in 1921. He spent a good deal of his time with the cabbage breeding project, and he was one of those individuals who did not become sensitized to cabbage pollen. He maintained order in the greenhouse and always seemed to be able to organize space to accommodate everyone. He taught many generations of graduate students the fundamentals of plant culture without which the details of the more intricate aspects of plant pathology could not have been investigated.

In my own days as a graduate student, the word was, when you needed something "ask Al". I particularly appreciated his careful good-humored responses to such questions, because I was a member of another department (horticulture) at this time. Later on, Steinmetz was an extremely important cog in the functioning of the plant virology course. On top of his other duties, he managed to have thousands of plants ready at their appointed times throughout the semester. Steinmetz not only liked plants but he liked people. He always had a smile to spare even though his corncob pipe might have seemed to interfere. He was a diplomat on the one hand and a teacher on the other. On each and every graduate student who passed by, he left his impression. He knew that if one treats plants well, they will grow well. He knew that this philosophy applied to people as well.

When the calendar forced Steinmetz to retire, his friends in the department and the alumni staged a gala party in his honor. On a beautiful June day in 1961, under the towering oaks of Olin Park, the department had one of its finest hours. In addition to some personal gifts, the honorary

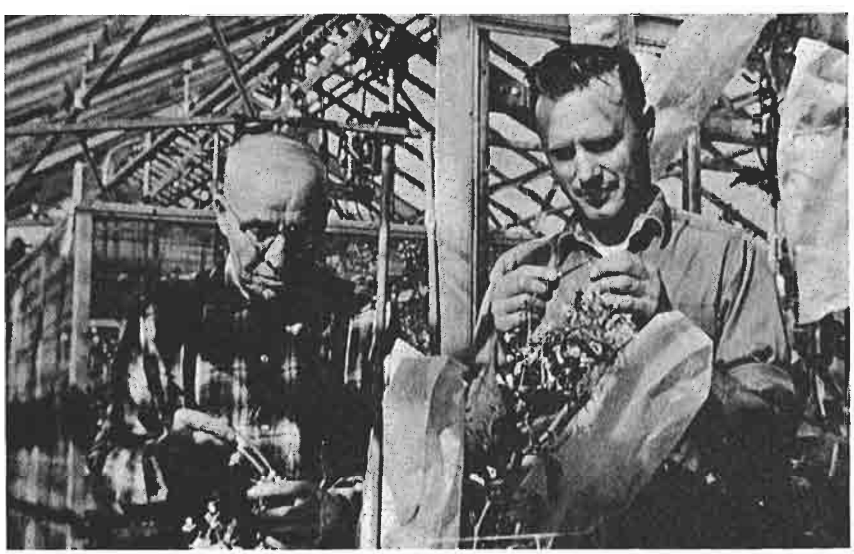


Figure 19.2 Leonard Squire getting a lesson in cabbage pollination from Al Steinmetz, 1961.

degree of Doctor of the Green Thumb was bestowed upon Steinmetz in a full cap and gown ceremony. This certificate was signed by the dean of the College of Agriculture and the president of the university.

Others of the civil service crew were George Farr and Louis Groneng, who may have handled more field than greenhouse work. Louis worked until he was seventy.

When Al Steinmetz retired in 1961, his duties were efficiently taken over by Wallace Reiner. Reiner also put in nearly forty years of service to the department before his retirement in 1976. He continued the greenhouse supervision and plant production that made the greenhouse staff so helpful. Another talent that made Reiner very useful to the department was his woodworking ability. Almost every laboratory and office in Russell Laboratories has shelves, benches, and cupboards that he fabricated to fit particular uses and niches.

Others of the greenhouse regulars were Ray Gasser and Leonard Squire. Gasser resigned in 1974 and Squire assumed responsibility for the vegetable operations at the Walnut Street greenhouses before his retirement in 1983.

A familiar face for many years around the greenhouse was Dale Frame, who began as a helper for Earle Hanson. Always eager to be helpful, he also could be counted on for the latest information on how the trout were biting. In 1968 he was assigned to assist Douglas P. Maxwell with his forage research and when David Cavanaugh was assigned tasks in Russell Labs, Frame willingly assumed major supervision of the Linden Street greenhouses in 1980 until his retirement in 1984.

Gil Dahman, whose service to the department began in 1974, was the person to see if you needed greenhouse space, a vehicle, or field help. He always said, "I'll see what I can do". Usually he was able to help. Gil has helped his son with farm work so he was always available for information on what was happening to the farmers in this area. If asked how things were going, he would usually reply, "In circles".

John Vignali was hired in 1981 to assist with the maintenance of the growth chambers. He quickly developed a flair for electronics and in no time had developed electronic switching controls for high and low temperature switches for the growth rooms. This led to his construction of specialized equipment for research projects. In 1984 a computer was purchased to monitor the growth chambers, and John wrote the appropriate programs to provide, at his finger tips, the requisite information on available space in each of the chambers.

SECRETARIAL HELP—Marleen S. Lippert

No department can operate at peak performance without an efficient secretarial staff. The department has had four head secretaries. Alma Steinmetz Doolittle was the only secretary for many years and was followed by Clara Sleicher from 1923 to 1948. Audrey Dunlap ruled the office from 1948 to 1975. She picked and trained Marleen Steinmetz Lippert, Al Steinmetz's daughter, as her successor. Marleen began working in the department when she was seventeen years old, at ninety-two cents per hour, as a typist. She diligently worked her way to office supervisor, financial clerk, and secretary to the chairman—a big task.

There were many excellent secretaries who stayed with the department over long periods of time and capably carried on the high secretarial standards set by Alma Steinmetz, Clara Sleicher, and Audrey Dunlap (Table 1).

Ada Connolly served as secretary to James G. Dickson and his staff from 1928 to 1953.

Colette Dwyer, with her bouncy pony tail, served as secretary to the extension staff and the Seed Potato Certification Program under the direction of Henry M. Darling from 1952 to 1964. She was always meticulous in her work and very business-like in her approach to her responsibilities.

Gladys Smith, a former dean's secretary, returned to the secretarial field after a sixteen-year absence to raise her family. She came to the department in 1959 to work for only a short period and then stayed on until 1984. She was an extremely capable and highly efficient secretary and she was able to assume responsibility for any task that was deemed essential.

Veronica King came to the department in 1964 at the time of the move to the "new building". She first worked in the general secretarial pool, but now serves as secretary to the Seed Potato Certification Program under the direction initially of Darling and now Steven A. Slack.

Henrietta Markham served the department from 1966–73 working with our extension staff and the graduate student evaluation committee under the direction of Robert F. Patton.

Margaret Johnson joined the department in 1968 and worked until her retirement in 1974. She was always pleasant, and diligent in her work.

The head secretary is the person responsible for the day-to-day management of the departmental office, and from 1948 until her retirement in 1974 Audrey Dunlap filled that position (Chapter 4). She was in the unique position of hearing all, knowing all, and serving all within the department. In the piece below she has provided some memorable insights into students and faculty.

A TIME TO REMEMBER—Audrey Dunlap

I came to the department as administrative secretary in 1948. I was then thirty-nine years old. The requirements for the position were: first, to be a mature person, and second, to pass a difficult examination on office procedures and secretarial skills. Professor George W. Keitt, then the departmental chairman, selected me out of the applicants. He said, "We have a nice department, and that's the way we're going to keep it". It is, indeed, a nice department. To bear this out, during the period from 1910 to 1948, there had been only two head secretaries: Miss Alma Steinmetz served through 1922 and Miss Clara Sleicher from 1923 to 1948. I began my term during the reign of the "Big Four"—Professors Dickson, George W. Keitt, A. Joyce Riker, and J. C. Walker. A time to be remembered!

Visitors came from all over the world to meet and consult with these highly esteemed agricultural scientists. I recall, especially, a woman professor from a foreign land who approached me and requested in heavily accented English that I arrange appointments for her with Professors Dickson, Keitt, Riker, and Walker. This was accomplished with ease, except with Professor Walker, who said he didn't have time. When I told her Professor Walker wouldn't be able to see her, she was very upset and said she could not go home to her department and tell them that she had not seen the great Professor Walker. If she could come in and sit in the corner of my office and see him as he went by, then she could at least tell the members of her department what he looked like. I repeated this to Professor Walker, and I asked him to walk through slowly so she could get a good look at him. He said, "All right, Audrey, bring her in." He was most gracious and treated her with the greatest of courtesy. This was the highlight of her visit to the Madison campus, and she thanked me over and over.

While we are reminiscing about Professor Walker, I like to think of the holiday season when he received at least a bushel or more of California walnuts from one of his former students. He gave me a large bag full, "for your Christmas baking", he said, and said that the balance he would put in a legal size file drawer. I should help myself, as needed. He added that if he took them home he would never see a one of them, that Mrs. Walker had him on a diet. After lunch I could hear the sounds of cracking and crunching from his office. When he married the second time, Marian said she had about the same luck putting him on a diet. When she had her day as a volunteer at the Verona Home for the Elderly, she left him a can of Metracal for his lunch. On inquiring how he liked it, he said, "Fine. I had a peanut butter and jelly sandwich with it and some cookies."

I have been asked to give some amusing anecdotes about the students, as I remember them, and let others deal with the historical events. I enjoyed the students, and it is a pleasure for me to think of them. Certain students were known as Miss Dunlap's boys. My students lounged in the chair by my desk, bringing me up to date on the departmental gossip, such as who had been chewed out by J. C. W., or what two students fought behind the Fieldhouse and who gave whom a boxing lesson. I was somewhat of a Dear Abby or Ann Landers. I was the advisor on a variety of problems, such as financing cars, furnishing apartments, getting married, or the best time to see Professor Walker—what his mood was for the day.

For a time we had a number of older married students getting degrees (Ed Kendrick, Neil Fulton, Charley Pierson, Lew Weathers, and so on). When I distributed paychecks, they usually voted me "the one they'd like to be alone with on a tropical island." I recall going to the third floor lab in Moore Hall where the glass cupboard doors were embellished with pin-ups of beauties attired in black lace undies and scanty bathing suits. One day the decorations were gone. "Where are the girls?" I asked. "Gone!" was the reply. "Dr. Riker made us take them down." "What for?" I queried. "A blonde in black lace undies would be good for him." Lew Weathers, sliding low in his seat, said, "Me too."

When I recall all the prelims and finals, I think of one of Professor Walker's students, all neatly turned out, standing in front of my desk worrying the button of his jacket until he twisted it off. I quickly sewed it back on. I kept a sewing kit in my desk for such emergencies, also a supply of aspirin and Bromo-Selzer.

I remember a prelim for a very brash German student, who was not shy about stepping on important toes or rubbing professorial fur the wrong way. Usually, during a prelim, I could hear laughter when one of the examining committee told a joke to break the tension. All was quiet during this period. The student came out, wet with perspiration, sank down in my visitor's chair, and said, "The sons of bitches are going to flunk me!" Shortly, his major professor, Russell H. (Fussy Russy) Larson, came out, shook his hand and congratulated him. Later, I asked, "Did you give him a rough time?" The reply was, "We showed him he wasn't as smart as he thought he was."

As I think over the past, I would like to tell you that my happiest and most rewarding working days were spent in the Department of Plant Pathology, and I thank you all—staff and students.

TABLE 1
Civil Service Employees of the Department of Plant Pathology[a]

Office	Field and Greenhouse
Albert, Catherine M. 1955–57	Barlow, Chester
Alsmo, Marlene G. 1956–58	Cavanaugh, David L. 1967–present
Anderson, Geraldine O. 1957–60	Dahman, Gilbert J. 1974–present
Becker, Cathie S. 1978–79	Farr, George H. 1930–54
Connolly, Ada L. 1930–53	Frame, Dale J. 1956–84
Davis, ValRae 1961–63	Frame, John C. 1981–85
Dwyer, Colette M. 1952–64	Gasser, Raymond A. 1954–74
Dunlap, Audrey 1948–75	Groneng, Louis 1942–54
Elphick, Elinor M. 1956–60	Haakenson, Leo C. 1963–75
Gosse, Judy 1984–present	Junion, William L. 1956–84
Haas, Connie L. 1973–76	Reiner, Wallace J. 1937–76
Hartling, Dora M. 1960–63	Showers, Raymond G. 1977–1985
Johnson, Margaret D. 1968–74	Squire, Leonard G. 1961–83
Kennedy, Mary V. 1952–55	Stedl, Lawrence W. 1977–79
King, Veronica A. 1964–present	Steinmetz, Albert H. 1921–61
Klagos, Norma 1980–83	Thornton, James B. 1959–present
Lippert, Marleen S. 1957–present	Troemner, Allan C. 1950–81
Malbon, Helene J. 1953–55	Vignali, John C. 1981–present
Markham, Henrietta S. 1966–73	**Other Services**
McCoy, Bonnie L. 1964–66	Bongiovani, Carmen 1978–84
Meerdink, Edith J. 1949–50	Covert, Lenice 1984–present
Parker, Lynn E. 1966–67	Dahlke, Helen 1981–84
Pfeiffer, Lynn K. 1979–present	Flood, Minnie L. 1951–65
Ramthun, Lois B. 1949–51	Laumer, Martin A. 1948–50
Saltz, Patricia M. 1978–80	Hauser, Genevieve D. 1960–81
Schultz, Kathleen J. 1976–79	Rafferty, Josephine T. 1965–78
Sleicher, Clara M. 1923–48	Stewart, Laurie 1984–present
Smith, Gladys C. 1959–76	**Potato Certification**
Schneeberger, Melodie 1979–present	Biesik, Nicholas J. 1982–present
Steinmetz, Alma 1910–1923	Bula, Kevin P. 1979–present
Stuntebeck, Marcella A. 1974–79	Guyant, Wayne A. 1953–78
Wollangk, Carol E. 1963–64	Hafner, Richard 1980–present
	Junion, William L. 1984–present
	Rydzewski, Edwin W. 1945–1982
	Schroepfer, Stanley W. 1966–84
	Sorenson, Leonard A. 1949–81

[a]Only those working more than one year are listed.

CHAPTER 20
Library

Deane C. Arny

When L. R. Jones came to Madison in 1910 he brought his extensive private library with him. When he and his students were established on the second floor of the new Horticulture Building in 1912 he had shelves built in the seminar room. This room was just east of the stairway and beyond it to the east, and connected by a door, was the graduate student room. He was insistent that his graduate students study the literature and thus he wanted the material nearby. His library consisted of quite a few books, the abstract journal *Experiment Station Record,* several journals (soon to include the fledgling *Phytopathology*), and many reprints.

During 1911–12 the following books were purchased (although no prices were given): Saccardo-*Sylloge Fungorum* (first installment), Clinton-*Smuts,* Anthur-*Rusts,* Engler and Prantl-*Die naturlichen Pflanzenfamilien,* Plowright-*Uredinales and Ustilaginales,* Massee-*British Fungus Flora,* de Bary-*Comparative Morphology of Fungi* (English translation), and Cook-*Handbook of British Fungi.* Also purchased were a library table ($12) and thirty-six book shelves ($216). In the next year a second installment was made on Saccardo—$400, with $100 on other books. In 1914–15 Saccardo was completed—$200, with $50 on dictionaries and lab manuals. In subsequent years the budget item for books ranged from $50 to $250—surprisingly large amounts considering that Professor Jones' salary was $3000 to $4000 for the academic year for this period.

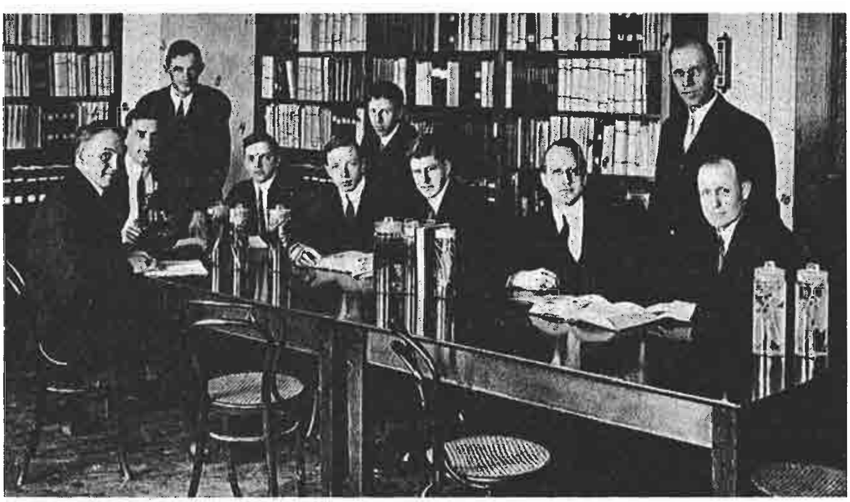


Figure 20.1 The plant pathology library, 1913.
L-R I. C. Jagger, H. G. MacMillan, R. E. Vaughan, J. C. Gilman, R. B. Wilcox, L. P. Byars, A. S. Orcutt, H. A. Edson, A. G. Johnson, M. P. Henderson

During the summer of 1913 Florence M. Coerper was hired for two months at $40 a month and part time for the following collegiate year at $15 a month. She had received a B.A. in English and helped Jones with the editing of *Phytopathology*. She eventually received an M.S. in plant pathology and also assisted him in his work on bacterial diseases of peas and clover. In addition, as "lab assistant", she was responsible for the literature material in the seminar room and had a desk in the room next to the door into the graduate room. For 1914–15 her salary was increased to $400 a year on account of proportionate (sic) increase in time to be given work.

Coerper began cooperative work with the office of Erwin F. Smith on grain bacterial blight investigations, and in July of 1917 part of her duties were taken over by Maude Miller who had done graduate work with a major in botany and a minor in plant pathology (M.S. 1917). Her duties involved the library as well as assisting with orchard and grain disease investigations and the handling of specimens and cultures. In a note on the organization of the department for 1919–20 the care of the library and the herbarium was assigned to Miller, as a full-time instructor, who, with an unnamed understudy, was under the guidance of George W. Keitt. At the same time, Ruth Bitterman was indicated as a half-time assistant, vice Coerper. Bitterman probably was not involved with the library, but did work on a translation of de Bary's 1853 book at the instigation of Keitt. She also was listed as an assistant in 1921–22. In June of 1922 Frances Wocasek took Bitterman's place and was indicated as a full time "general assistant in laboratory, library and editorial work of general application to departmental projects". In the next year she became the wife of Rupert B. Streets who was then a graduate assistant involved with *Fusarium* diseases of cereals. In 1925, Florence Markin is listed as taking over F. Street's duties at half time. In 1926 Bertha J. Miller, sister of M. Miller, replaced Markin on university and USDA funds. The budget for books was still at $100 although Professor Jones' academic year salary had risen up to $6500.

In 1930 the agronomy wing, or Moore Hall, was completed and additional space became available. The library was moved to the third floor of Moore Hall, just across the hall from one of the graduate offices. Elizabeth Larson replaced B. J. Miller in 1931. Her duties were: "To assist in the care of the departmental library, in ordering, care, and distribution of supplies, and to assist with typing editorial and statistical work". She had no biological background.

Larson's successor in late 1935 was Alva T. Amble, who had a major in English and a minor in biology and had been teaching English and Latin in high school for several years. She had partially completed the course in library training. She was a full-time assistant and was "to assume the responsibilities hitherto covered by Elizabeth Larson as described in the letter of appointment. This position covers a variety of duties, including ordering and dispensing supplies, care of departmental collection of books, separates, and class reference material; bibliographical service, routine assistance in the preparation and copying of manuscripts, routine technical preparation of class materials, and supervision of graduate laboratory assignments of equipment."

At about this time a Works Project Administration (WPA) Project (No. 648) was set up with a list of some fourteen items of work that were being done for the library by a librarian, Paula Binner, and two helpers, Minnie Navarro and Eleanor Cords. This was in addition to the duties of Amble. It is uncertain how long this project continued.

Marcia Strewler succeeded Amble as full-time assistant in 1941–42. She was shortly replaced by Irene Bull (later Irene B. Hodgson). In 1947 Geraldine Krawczak served for a short time until replaced in 1948 by Peggy E. Barry, whose duties were described as: "To collect, catalogue, and look after reprints and other publications in the plant pathology classrooms and reading room and to assist the staff in work with literature citations and manuscripts". Thus, concern with supplies and equipment was no longer a part of the librarian's duties.

In 1949 Kathleen Deighton was named vice Barry and she carried on for some ten years in charge of the library in addition to working part time for Albert C. Hildebrandt. Mary Buck was appointed in 1959, Alice Kingsbury in 1960, Cleo Loftsgarden in 1963, and Ruth Schwebke in 1964 when the library was moved to Russell Laboratory. Schwebke was an English major who was working part time toward a library degree. During her tenure all manuscripts of the department were supposed to be channelled through her for assistance in editing, etc. She also participated in the development of the de Bary *Phytopathological Classic* with J. Duain Moore and Deane C. Arny.

In the late 1960s the assistant position was eliminated and the duties of the part-time person were reduced to ordering and cataloging of books, binding of serials, and general upkeep of the library. Eleanor Elmendorf served until Helen Kuntz assumed this post. She continued until 1984 and presently Pat Herrling has this responsibility. Each of these persons had library training.

For a number of years Professor Jones maintained personal funds in Europe for the purchase of books. Former students, such as Dimitri Atanasoff in Bulgaria, were asked to search out valuable books for purchase. Some very old books were included in these purchases, and are presently in our old book collection.

Although the library, or more properly reading room, was never a part of the university library system, for many years books from the Agriculture Library were permanently assigned to the plant pathology library. In the early 1970s an agreement was reached with the then director of Steenbock Memorial Library, that some of those books should be returned to Steenbock and others allowed to remain. Thus the tenuous connection between our library and the agriculture library was severed.

As indicated, a book item was contained in the budget allocations for a number of years. It is uncertain just when this came to an end. For a number of years A. Joyce Riker contributed several hundred dollars per year toward the purchase of books, and other memorial funds have been used as they built up. Jones left $10,000. Other memorial funds have been established for the following:

> James G. Dickson, Isme Hoggan, James Johnson, Fred R. Jones, Keitt, Reubush G. Shands, Al Steinmetz, Russell H. Larson, A. J. Riker, Regina S. Riker, Gerald Thorne, J. C. Walker, Alan T. Brown, Tom N. Theis, Edith S. Jones, and Mathilde Bensuade.

Over a long period of years journals have been donated by various members of the faculty, with binding costs coming from the memorial funds.

Three *Phytopathological Classics* have been produced by members of the department over the years. The first was a translation of Prevost's *Memoir on the immediate cause of smut etc.* from French by Keitt, the second was by James Johnson of several early German works in the virus area—Meyer, Ivanowski, Beijerinck, and Baur. Moore and Arny, with the help of retired German professor Merrill Hefner, translated de Barry's 1853 *Investigations on the Brand fungi* from the German.

In the early days the assistants involved with the library were responsible for assisting with research work as well as for supplies, for the library itself and for editing and/or bibliographic assistance. Gradually over the years the research component was dropped, as was the supplies aspect. As the time of employment per week has declined, also the editing and bibliographic duties have been eliminated. The backgrounds of the persons have changed from those earlier with either

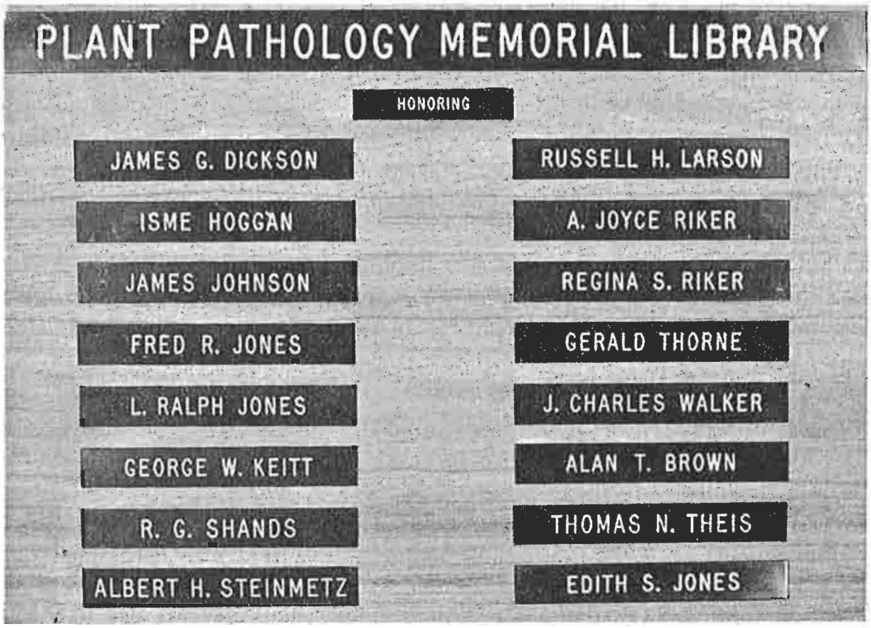


Figure 20.2 The Plant Pathology Memorial Library, Russell Laboratories.

botanical or plant pathology training or interest, but essentially no library experience, to those with only library training. Originally, they were carried as assistants named in the budget allocations, now they are on other kinds of funds.

Reprints, or separates, for a long period were collected by the library assistant, and at first these were assembled in bound volumes. Later they were simply assembled by number on the shelves. In either case they were catalogued by author. This collection has been discontinued for some time because of the cost of cataloging. Individuals of the faculty—L. R. Jones, Keitt, Dickson, F. R. Jones—also collected reprints and at or near the end of their careers placed them in the library. The card files of all of these have been integrated, but their present utility is very questionable—partly because they are not up-to-date, but mainly because photocopying is now so readily available. They are, however, of some historic value. The virus reprint collection started by J. Johnson and Hoggan—called the Hoggan Collection—has been kept up by Robert W. Fulton and Gary Gaard. These are filed by author and also are catalogued by author in a card file.

L. R. Jones was convinced of the importance of a knowledge of the literature in plant pathology, especially for graduate students. Although the support for the library and the duties of the librarians have changed over the years, the library has continued to serve as the nearby essential source of information from the literature for both staff and students. As such, it has made a continuing contribution to the development of the department and to its standing and reputation among similar departments.

CHAPTER 21

Contributions of the United States Department of Agriculture

Richard D. Durbin

The association between the department and the United States Department of Agriculture (USDA) has been a long and mutually fruitful one. As Professor J. C. Walker recently remarked, "We couldn't have built up the department to its present-day eminence without federal aid". However, the role that the USDA has played in the department's development, especially during its early years, has been largely overlooked and obscured in dusty financial files, obituaries and annual reports. In recounting this partnership—for this is what it really is—I have not dwelt on people's accomplishments that are covered in other chapters.

Early on, L. R. Jones realized that extramural help would be needed if he was to be successful in building up the staff and programs in the way he envisaged. One of his stratagems was to reach out to the Agricultural Research Service (ARS) of the USDA, especially in the person of W. A. Orton, a former student of his from Vermont. Orton had been especially successful in developing breeding for disease resistance as a major method of disease control; furthermore, he was head of the Office of Cotton, Truck and Forage Crop Diseases. Jones also established a close relationship with the Office of Cereal Crop Diseases.

Jones' strategy was simple, yet effective: he matched strength with strength. The ARS had strong programs in both vegetables and cereals. These were major crops in Wisconsin at the time and research areas where Jones had already begun to build strength. Thus, out of Jones' liaisons came long-term salary and program support for J. C. Walker and J. G. Dickson.

Ordinarily, the USDA support was used to partially support staff salaries; however, in other cases, they provided full salary and assigned the person to Madison. The university furnished the physical facilities, students, some support staff, and most importantly, a group of like-minded scientists. In most cases the USDA personnel were given academic appointments with all rights and privileges thereof. This arrangement provided "leverage" for the department as well as ARS, and was a scientifically successful bargain for both.

An additional bonus for the department was the establishment of the USDA, Forest Service, Forest Products Laboratory (FPL) at Madison in June of 1910. It soon occupied what is now the Metallurgical and Mineral Engineering Building on the south side of University Avenue across from the greenhouses; in 1937 it moved to its present quarters. From the very beginning, the FPL and the department have had cooperative programs in forest and timber diseases, together with joint staffing. Members of FPL who had or currently have lecturer or adjunct appointments in the department are: C. J. Humphrey, Eloise Gerry, C. Audrey Richards, Ralph Lindgren, Ted Scheffer, Kent Kirk, Harold Burdsall and Michael Larsen. In addition, close collaboration between J. E. Kuntz and Irv Sachs of FPL on ultrastructural aspects of tree diseases has gone on for at least twenty-five years.

Beginning in 1915, James Johnson established a cooperative relationship with the USDA. Although based in horticulture, he was a plant pathologist. He had come to the university in 1909 to study the culture and diseases of tobacco. Stimulated by Jones, who arrived a year later, he expanded his plant pathological interests and eventually took his doctorate under Jones in 1918. Johnson remained in horticulture, moving up to professorial rank in 1922. His title was finally changed in 1944 to Professor of Horticulture and Plant Pathology. The USDA provided program support for Johnson's work on tobacco throughout his career. When R. W. Fulton took over Johnson's place in 1946, they began to supply partial salary support too. This continued until 1955 when Fulton switched from horticulture to plant pathology and became a full-time state employee.

Aaron G. Johnson, who joined the staff after receiving his degree with L. R. Jones in 1914, began to develop a research program on the diseases of cereals with partial funding from the USDA. Unfortunately, Johnson's tenure was short lived and in 1922 he left Wisconsin to take a position with the USDA in Washington, D.C.; his place was taken by J. G. Dickson, a student of Johnson's who had just finished his degree. Interestingly, while he was a graduate student, he had been an agent with the USDA. Once on the staff, Dickson, like Johnson before him, received both program and partial salary support (half time) from the USDA. This arrangement continued until his retirement in 1961, although the percentage of salary support supplied by the USDA declined with time. Others in his group who also received USDA support were Grace Weiland and Helen J. Johann.

Walker first worked for the USDA in the Bureau of Markets, Inspection Service. In the fall of 1917 while still a student, he was given a war-time assignment in New Orleans to help train the vegetable inspectors there in plant pathology. The following year he received his Ph.D. and began a part-time assignment under Orton, and in cooperation with Wisconsin, to develop a national program of breeding for disease resistance in cabbage and onions. This assignment lasted until 1945.

Orton also provided support for Fred R. Jones, who had received his Ph.D. from Wisconsin in 1917. The following year Jones started working on the diseases of canning peas but soon shifted his attention to bacterial wilt of alfalfa and its influence on winter hardiness—the work he is most remembered for. This project provided one of the major underpinnings for R. A. Brink's alfalfa breeding program in genetics out of which came the cultivar Vernal. The introduction of Vernal signaled the establishment of alfalfa as the major forage crop in the upper Midwest. After more than thirty years Vernal is still the dominant variety being grown and portions of its germplasm are part of almost every variety in current usage.

H. H. McKinney came to the department in 1918 and, with L. R. Jones' guidance, began to study wheat diseases, particularly the etiology of wheat rosette. The following year he started working for the USDA. He received the M.S. degree in 1920 for his research on rosette. It was while doing this work that he became involved in the controversy about the existence of "intercellular bodies" and the causal role they might have in diseases we now know to be caused by viruses. McKinney took the position they were artifactual. This he proved while working with Sophia Eckerson of Boyce Thompson Institute in C. A. Kofoid's laboratory at the University of California–Berkeley, and at Madison. Also, based on work initiated at Madison with yellows strains of TMV, McKinney was probably the first person to demonstrate that plant viruses could mutate. He remained here, continuing to work on virus and cereal diseases and progress toward the doctorate until 1925. At this time the USDA transferred him to Washington, D.C., where he remained until retirement.

One of Dickson's students, Paul Hoppe, was stationed in the department by the USDA in 1929 after his graduation to work on corn diseases in the northern part of the cornbelt. Over the years, he studied ear rots, stalk rots, seedling diseases, northern corn leaf blight and bacterial top rot. He retired in 1966.

Starting in 1928 A. J. Riker's early work on bacterial diseases of rosaceous root stocks began to receive USDA support. Included in this research were his pioneering studies on crown gall and hairy root. As the resident expert on bacteria, Riker also involved himself with several other USDA projects: bacterial wilt of sweet corn with Hoppe, 1933–34; and root and crown rot of corn with Dickson, 1934–35.

In 1930 Dickson made an extended trip to the Soviet Union at the invitation of the USDA. One of the main things he did while there was to collect seed from cereals, and to some extent forage grasses, that might have disease resistance. Some of these materials were used to advantage later in the breeding programs at Wisconsin and elsewhere.

The USDA stationed R. G. Shands, (Ph.D. 1929), a student Dickson was co-advisor for in agronomy, to carry out a cooperative breeding program in wheat and barley. Shands, or 'R. G.' as he was known to his friends, was particularly successful in breeding new wheat and barley cutivars. One of the plant materials Dickson had brought back from the Soviet Union was P.I. 94587, a tetraploid durum wheat largely incompatible with hexaploid *Triticum vulgare,* the wheat of commerce. Shands managed to produce several fertile F_2 individuals from his initial crosses with commerical varieties, but sterility continued to be a major problem. He perservered, however, and ultimately was able to incorporate a major source of leaf and stem rust and mildew resistance from P.I. 94587 into commercial wheats. The sterility factor he had found later provided the basis for the production of hybrid wheats. His cultivar Timwin brought *T. timopheevi* leaf rust resistance into winter wheats for the first time; it had stem rust and bunt resistance too. Shands also developed the cultivars Black Hawk, winter wheat, Russell, Lathrop, and Henry spring wheats and Moore barley. After his death in 1967, R. G.'s younger brother Hazel finished up 'Kenosha' and another introduction, 'Argee', still the dominant winter wheat variety.

Hazel Shands, (Ph.D. 1932), who also had had Dickson as a co-advisor, was in charge of the Department of Agronomy's program for small grain improvement for many years. Although not directly supported by the USDA, he kept close contact with Pat Murphy, the ARS investigations leader for oats, and Dickson. Through Murphy, Hazel ran his advanced material in the USDA's uniform oat nurseries, gaining valuable information on adaptation and disease resistance. During his tenure Shands developed ten to fifteen cultivars, among them Branch, Lodi, Garland, and his two most enduring cultivars, BeeDee and Dal, each with good kernel and yield characteristics as well as good tolerance to leaf and stem rusts and smuts and the last with high protein.

By the time prohibition was repealed, the old-line barley cultivar Oderbrucker had been replaced by the smooth-awned 'Wisconsin Barbless'. The maltsters were concerned whether this new variety would be suitable for making beer, so a group of them contacted Dickson, asking for his help. Dickson responded and was instrumental in forming what has been touted as probably the first federal-state-industrial cooperative research venture in agriculture. This was the USDA Barley and Malt Laboratory, established in 1934. It was situated in the basement of Moore Hall in space assigned to plant pathology. Dickson secured a yearly grant from the industrialists, who had banded together to form the Malt Research Institute. For convenience sake, this grant was for many years "funnelled" through the department. Alan Dickson, J. G. Dickson's brother, was already working for the USDA with Karl Paul Link in biochemistry on the emetic factor in scabby barley, and he was asked to take over the directorship of the new laboratory. The unit remained in Moore Hall until 1949 when it moved to its present building on Walnut Street.

Oliver F. Smith came to the department in 1930, working with Dickson as a joint major with agronomy. He received his M.S. in 1932 and Ph.D. two years later. Smith was then asked to take part in a cooperative USDA-state red clover disease resistance program with James Torrie of agronomy. He accepted and remained at Wisconsin until 1940 at which time he was transferred to Nevada to initiate an alfalfa breeding program there. Lewis Allison came from Minnesota in 1940 to continue Smith's program. In 1943 the state took over partial financial support of this program and as assistant professor, Allison broadened his research to include other forage diseases. In 1946 he moved to a USDA administrative position at Beltsville, MD. When he left, his position was filled by Earle Hanson, a USDA transfer from Minnesota. Hanson received his salary from the USDA until 1961 at which time the state took over full responsibility. Hanson continued the cooperative red clover project, but he soon branched out into studying disease resistance in forage grasses with Etlar Nielsen, a USDA cytogeneticist, and D. C. Smith in agronomy, and alfalfa with R. A. Brink. Hanson also served for many years as the campus coordinator for USDA programs.

In the early 1940s, because of WW II, much of the vegetable seed resources for the allies were lost. The United States had an established industry in the Pacific Northwest, but a severe winter in 1942–43 had virtually eliminated its prospects for a 1943 crop. In addition, yields had been very low due to serious disease problems. So in 1943 Walker was requested by the USDA to make a trip through the west coast seed-growing areas, and see what could be done to improve the situation, especially in cabbage. Two of the things that came out of this trip were a plan to establish a joint USDA/Washington State Vegetable Seed Laboratory at Mt. Vernon, WA and an offer to G. S. Pound to become the USDA's research scientist there. Pound accepted this wartime assignment, remaining in Washington until 1946 at which time he returned to Madison to assume a state position.

With Walker's retirement from the USDA in 1945, the program support he had enjoyed was shifted to R. H. Larson, a Walker student (Ph.D. 1934), and he in turn became the chief USDA vegetable pathologist at Wisconsin. Larson had already taken over the cooperative cabbage and onion work in 1943, and somewhat later began to spend an increasing proportion of his time studying potato viruses. In 1945 his salary source was shifted from the university to the USDA; this support continued until Larson's death in 1961.

In the mid 1950s, Wisconsin suffered a severe infestation of the potato rot nematode in the northern seed-growing areas. The identity of the parasite was confirmed by Gerald Thorne, senior ARS nematologist stationed at Salt Lake City, Utah. The department then invited Thorne to come to Wisconsin to provide counsel on how best to control the pest. Thorne came and during his stay here was asked if he would be interested in holding a half-time professorship for five years (after which time he would reach the mandatory retirement age of seventy). To the delight of all, Thorne accepted the offer. The department obtained his stipend from the Research Committee out of funds from the University Houses Fund. Since there were no nematology resources on campus, zoology was invited to share the appointment, so Thorne was appointed professor of plant pathology and zoology in 1956. Thorne, together with Henry Darling, started the first nematology course in the department. Thorne's book, *Plant Nematology,* which was published in 1961, was the first book of its type.

With Thorne on board, Pound negotiated with Alan Taylor, head of ARS Nematology Investigations, to station additional manpower at Wisconsin. This Taylor did by transferring Vernon Perry here from Florida to head the ARS Nematology Laboratory. Perry, however, did not take to Wisconsin winters and soon returned to the south after receiving his Ph.D. in 1958. He was replaced by Gerald Griffin, who received his Ph.D. in 1962 and a short time later returned to Utah. The USDA support for nematology was then withdrawn.

As with the other members of the "Big Four", the fruit tree pathologists also received government support. However, like Riker's group, it was not of long duration. G. W. Keitt and D. M. Boone's apple scab resistance project with Purdue was supported between 1957 and 1965. J. D. Moore's research on virus diseases of stone fruits was supported between 1955 and 1971. From 1957 to 1966 Moore was a salaried employee of ARS and from 1966 until 1971 he was a collaborator receiving research support. Also, Earl Ehlers, who assisted Moore at Sturgeon Bay with his virus program, was an agricultural aid and research technician with ARS from 1955 until his death in 1968.

Following Orton's lead, his successor in ARS, H. A. Edson, had continued the USDA's close cooperation with Wisconsin. However, Edson's successor, E. C. Ouchter, who became the first administrator of ARS—then titled Agriculture Research Administration—in 1942, chose not to follow this course of action.

There are many reasons for this. The administrative hierarchy that Jones and his USDA counterparts faced in the early days was direct and simple. The contact was man to man, and it was between scientists of good faith who knew one another. This remained very much the case into Pound's tenure as chairman, but increasingly ARS became administratively more complex and cumbersome to deal with, and no longer were scientists able to make major decisions as in earlier times. The impersonalization of the association, together with changing philosophies and personalities, tight federal budgets, and more competition for what resources were available all contributed to an overall lessening of USDA involvement in the department. More and more when government scientists retired or were transferred they were not replaced. This trend has continued, the establishment of the Plant Disease Resistance Research Unit notwithstanding. Perhaps it will change. A recent study on new research directions in bioregulation notes that ARS groups associated with university campuses profit greatly from this association, and it recommends that more ARS scientists be coupled with academia.

Eugene Van Arsdel took his Ph.D. degree with Riker, graduating in 1954. After a stint in the army, he returned to the department attached to the USDA, Forest Service, Lake State Forest Experiment Station. While here he studied the microclimatic relationships of white pine blister rust spread in relation to control procedures. Gene was transferred to the St. Paul, MN station in 1962.

Before J. G. Dickson retired in 1961, the department strongly entreated the USDA to maintain its program here in field crops. Out of these negotiations came an offer from Murphy to station an oat pathologist here to study *Septoria* stem and leaf blotch. This position was filled by Arthur Hooker in 1954, an earlier student of Dickson's who had come back from Iowa State. Hooker's stay was short lived, however, as was that of his successor, Leon Wood (1958–61). As another part of the effort in field crops, the USDA transferred Maurice J. Kauffman from Illinois where he had been with the Regional Soybean Laboratory. He began to study forage grass pathology but soon left to become an agricultural missionary.

Murphy, with Pound's encouragement, then altered the oat pathologist's position description to permit the establishment of a full-time, fundamental research program. It was in this context that Richard Durbin came from Minnesota to take the position in 1962.

The Plant Disease Resistance Research Unit came into being in November, 1964. The impetus for this unit largely originated with Pound, then departmental chairman. He had felt that a basic, broad-gauged attack on the physiological and biochemical bases of disease resistance was timely, and over several years had attempted to interest the ARS in placing such a group at Wisconsin. His arguments were forceful: the department already had a long history of effective research in the area, particularly that of Walker's group; L. Sequeira and P. H. Williams had just been hired to continue this thrust; there were strong supporting departments of biochemistry, botany, and genetics at Wisconsin; and Durbin was already developing a program in disease physiology. Pound's persuasive manner, his knowledge of Washington bureaucracy and his reputation for getting things done helped immeasurably. Furthermore, his idea fitted into ARS's concept of developing small groups, then called "Pioneering Research Laboratories," which would focus on discrete research areas where it was felt progress could be made—in today's jargon they are called "thrust areas." Pound's efforts, aided by the new chairman Arthur Kelman, reached a climax with a dinner at the Cosmos Club in Washington, D.C. with H. A. Rodenhiser, deputy administrator for Farm Research of the ARS, where in Pound's words, "a meeting of the minds" was achieved.

The group was envisioned as a four-person effort with individual expertise in disease physiology, plant physiology and biochemistry. Durbin was to serve as leader of the group (but when he transferred, the oat position was lost). The candidates were screened for employment through both the USDA and university, and in return were given regular faculty appointments with all rights and privileges. Pound was very insistent that ARS scientists should not be "second-class citizens," neither should they be second-rate scientists!

Just before the laboratory's formal inception, Pound became dean of the College of Agriculture and his place in the department was taken by Arthur Kelman, who helped guide the group through its formative years. The two administrators—Kelman and Durbin—soon developed an informal arrangement which integrated the USDA scientists into the department while still retaining their USDA affiliation. Serving two masters was certainly made easier for the group with Kelman's help. The close cooperation has continued under the chairmanships of J. E. Mitchell and D. P. Maxwell. This is no small matter, for over the years the administrative structure of the USDA within which the group operated, as well as their superiors, changed drastically a number of times.

Christen Upper and John Helgeson both arrived in 1965; John Kemp in 1968. Each was supported by one assistant. Somewhat later a part-time secretary was hired. In 1982, Kemp resigned for a position in the newly founded biotechnology firm, Agrigenetics, and his position was taken by Sally Leong, who is developing transformation vectors for phytopathogenic fungi.

The scientific projects have varied widely over the years. Initially, there was an effort to understand the parameters influencing plant tissue culture growth, and to use this information to study disease resistance, most notably *Phytophthora parasitica* var. *nicotianae*. Kemp's group conducted early studies on the molecular biology of the *Agrobacterium tumefaciens* Ti plasmid. They defined several of the unusual amino acid conjugates—the octopines and nopalines—coded for by the plasmid and, in cooperation with Timothy Hall in horticulture, used the plasmid as a vehicle to transfer the gene coding for the phaseolin storage protein from bean to sunflower.

What started out as a study of resistance to northern leaf blight of maize by Paul Hoppe with Deane Arny and later with Chris Upper has grown into an understanding of frost damage by ice nucleation-active bacteria (Chapter 14) and, by using this activity as a screen, the ecology of epiphytic bacterial pathogens in general. Susan Hirano, first working with Upper and then independently has continued to move this latter area forward.

The tissue culture studies of Helgeson have evolved into collaborations with Robert Hanneman of the USDA and the Department of Horticulture on the development and application of novel methods to combine important genetic characters from wild *Solanum* spp. with the commercial potato. A recent result from this project was the incorporation for the first time in potato of leaf roll resistance from *S. brevidens*. Durbin has studied the role of toxins in disease development, especially those which condition virulence by affecting chloroplast function. Tentoxin, produced by *Alternaria alternata,* and tabtoxin and tagetitoxin produced by *Pseudomonas syringae* pv. *tabaci* and pv. *tagetis,* respectively, have been most thoroughly investigated.

Many of these projects have been cooperative efforts with other members of the department: Arny, Boone, de Zoeten, Hirano, Kelman, Rouse and Sequeira. Barchet of meteorology, Rich of the School of Pharmacy and Nordheim, Constantinidou and Kozlowski of forestry also were cooperators.

The department made one more attempt to forge an alliance in nematology with the USDA when Victor Dropkin came from Beltsville in 1966 for a year's study leave. But as with previous arrangements, a long-term solution to our nematology needs could not be found via the USDA and the department was finally forced to establish a state position.

Over the years the USDA has provided partial or short-term support for some of the department's technical and service staff. The people supported in this way include: Alma Steinmetz, the first departmental secretary; Ada Conolly, a secretary who worked mostly for Dickson; George Farr, who worked in the greenhouses for Earle Hanson and Dewey Moore; Chester Barlow, a greenhouseman who played a major role in developing the famous Wisconsin soil-temperature tanks, plant growth and inoculation chambers and the automatic vents and air circulation equipment in the temperature-controlled greenhouse where the tanks were located; Wally Reiner, who at first worked for the vegetable pathology group and then later managed the greenhouses after Al Steinmetz's retirement; and Edward Meier, Allen Turk and Dale Frame, additional greenhousemen. Parts of the greenhouse complex back of Moore Hall and the pathologium were also built with ARS help.

Besides staff support, the USDA has provided graduate student stipends. The first was to G. W. Keitt, who worked summers for the USDA in the peach orchards of Georgia. He subsequently received the first advanced degree in the department, an M.S. in 1911. USDA support was also extended to Florence Coerper, an M.S. student of L. R. Jones, and E. W. Roark, a student of Keitt who was killed in WWI. Eugene H. Varney (Ph.D., 1952), a student with Keitt and Moore, was a USDA agent as a graduate student in 1952–53. Many of the graduate students and post-doctoral associates in the Plant Disease Resistance Research Unit were supported by USDA funds even though they seldom realized it. This came about through the use of the "broad form cooperative agreement", a legal instrument set up between the USDA and the College of Agriculture to allow the university to bill the government directly for the services of temporary people employed by the unit.

Pound also had another interaction with the USDA, but it was of quite a different nature from those I've recounted up to now. It came to be called "The Pound Report." This report, issued in 1972, was the first of a series of external studies which attempted to critically and constructively comment on the USDA's operating philosophy and long-range goals. The "Pound Report" has since become a benchmark of the genre.

What Secretary of Agriculture Clifford Hardin's feelings were when he commissioned the National Academy of Sciences to make the study is unknown, but I surmise that some of his lower level management were not particularly anxious to have a rigorous review. The orientation they provided for the committee was minimal and they also tried to straight jacket the project by requesting that the committee, which had been appointed by the academy, pass their report through the USDA. This the committee refused to do.

When the study was completed, copies were mailed to all the deans of agriculture at land-grant universities; most of the remaining copies were turned over to the USDA. At first there was little response, but once the report began to receive public attention there was a great to-do, both pro and con.

In retrospect, the report was not overstated, but rather it was forthright and focused attention on key issues. Nevertheless, it represented a viewpoint many people in the USDA were then not ready to embrace, and it did point up some internal shortcomings. However, when all the dust had settled, the USDA, to its credit, moved to implement many of the recommendations and they have continued the practice of requesting outside expertise.

Of all the recommendations in "The Pound Report", the most significant one to me is embodied in number ten, which requested the USDA to establish a competitive grants program to support basic research. Several areas were cited where such basic knowledge was especially needed (e.g., photosynthesis, nitrogen fixation, human nutrition and waste management). Out of this has come the Competitive Grants Program which currently is providing 16.5 million dollars for basic agricultural research each year.

Viewed in its entirety, the USDA's involvement with the department must surely be considered a significant factor during our early, as well as present-day, development. Through the decades it has served as a model for government-university cooperative efforts which few, if any other, departments of plant pathology can match. It has helped to enlarge the staff with first-rate scientists and to provide program support and salaries. The people and programs supported by the USDA have brought forth many of the seminal concepts and research for which Wisconsin is known. It also served as a "pipeline" for many Wisconsin graduates to enter government service and in so doing, to further enrich the department. Most important, it kept Wisconsin in tune with national programs and has given credence to the "Wisconsin Idea" that service does not stop at the borders of our state or nation (Chapter 23).

On the other hand, it has augmented the ARS staff, placed its scientists in an intellectually exciting environment where they can be highly productive, and provided them with facilities which otherwise would be unattainable.

CHAPTER 22

Interdisciplinary Research

Eugene B. Smalley

As a graduate student at the University of California–Berkeley I was continually made aware of the historic importance of Wisconsin as a founder and great leader in the field of plant pathology. These views, expressed in classes and privately, came firsthand since many of the Berkeley professors had received advanced degrees at Wisconsin (e.g., M. W. Gardner [Jones] 1918, T. E. Rawlins [J. Johnson] 1922, C. M. Tompkins [J. Johnson] 1955, W. C. Snyder [Walker] 1932, C. E. Yarwood [Dickson] 1934, and R. D. Raabe [Pound] 1956). Even though my major professor, H. N. Hansen, was not himself a Wisconsin graduate he was strongly influenced by his colleague W. C. Snyder. He and Snyder often spoke of Wisconsin's great strengths and particularly of its great traditions of cooperative research, which served as a model for so many other plant pathology departments across the country.

In writing about these traditions Pound said that "from its early years, the department shared appointments with other departments in order to cover needed areas of teaching and/or research." Thus, he said, "E. M. Gilbert and M. P. Backus taught PP 101; E. M. Duggan, P. J. Allen and R. F. Evert broadened their department's interest in plant pathology and served as advisors on many of our students' research programs; G. H. Rieman tied our interests to onion and potato breeding with genetics and horticulture; W. W. Hare and D. J. Hagedorn shared an appointment with agronomy because of our joint interest in pea breeding, and D. C. Arny had a joint appointment in agronomy in the grain breeding program". R W. Fulton and E. W. Hanson were also tied intimately to their respective interest areas in horticulture and agronomy and James Johnson was a plant pathologist throughout his career, but his appointment was in horticulture. J. G. Dickson was also a strong proponent of interdisciplinary research. Hanson and Arny wrote that early in his career Dickson became one of Wisconsin's strongest exponents of cooperation and he firmly believed in the interdisciplinary approach to solving complex problems. His research and graduate training program involved close cooperation with agronomy, bacteriology, biochemistry, botany and genetics. His leadership efforts resulted in the formation of the Industry-U.S. Department of Agriculture (USDA) sponsored Barley and Malt Laboratory and his brother A. Dickson (a biochemist) served as its director for many years. The laboratory became a source of funding for many kinds of research relating to diseases and quality of barley for malting.

Although G. W. Keitt (with D. M. Boone) was a pioneer in the study of fungal genetics, his technical publication record gives little indication of interest in interdisciplinary research; his principle involvement in interdepartmental researh involved studies (with C. C. Leben) on the structure and activity of the antifungal antibiotics (antimycin and helixin) done in collaboration with F. M. Strong (biochemistry).

A. J. Riker was involved in interdisciplinary research throughout most of his research career and he cooperated with individuals in botany, bacteriology, entomology, horticulture and forestry. Riker along with R. A. Brink (genetics) was a major force in the separation of the Department of Forestry from Wildlife Ecology (formerly Wildlife Management), and to aid the developing forestry department's programs, all of us with research assignments on trees received joint appointments; similar joint appointments also went to interested staff in entomology, soils, botany and economics. We all participated in the selection of the new forestry staff and for a time R. F. Patton served as its temporary chairman. J. G. Berbee (with D. M. Benjamin, entomology) carried out most of his teaching responsibilities in the forestry department's curriculum. All of us have benefited from the forestry department association and in many ways we have been as much at home in forestry as in plant pathology. My longterm association with D. T. Lester (forest genetics) in our elm breeding program came about as a direct result of my participation in the beginnings of the forestry department.

At the present time, ten of our active faculty have one or more joint appointments or relations to other departments or institutes. These include P. G. Ahlquist (biophysics), J. G. Berbee (forestry), M. K. Clayton (statistics), G. A. de Zoeten (University Industry Research Program), A. H. Ellingboe (genetics), A. Kelman (bacteriology), R. F. Patton (forestry), D. I. Rouse (Institute for Environmental Studies), L. Sequeira (bacteriology), and E. B. Smalley (forestry and the Center for Environmental Toxicology). In addition, the department has approved joint appointees from botany (R. F. Evert) and Adjunct Professors from the USDA Forest Products Laboratory (H. H. Burdsall and M. J. Larsen). All of the members of the USDA Plant Disease Resistance Research Unit (R. D. Durbin, J. P. Helgeson, C. D. Upper and S. A. Leong) have regular faculty appointments in the department, and with the exception of Durbin were trained in fields outside plant pathology and constitute an in-house interdisciplinary expertise.

FIRST THIRTY-FIVE YEARS—1910–1945

As a non-Wisconsin product, my view of the early years of the department are at best hazy and I am clearly left with only the permanent records and the memory of a few elderly survivors upon which to base my conclusions. In any case, up to the end of WW II the publications of L. R. Jones, his early staff and the Big Four (J. C. Walker, A. J. Riker, G. W. Keitt and J. G. Dickson) indicate modest interdisciplinary cooperation mainly with the Departments of Botany, Agronomy and Biochemistry (Table 1). Based on the publication records alone the interdisciplinary efforts for this period were not as great as the Wisconsin image might have indicated. Of the almost 360 technical publications produced by the department since 1910 having authors from other Wisconsin departments only 70, or 19 percent, appeared during the first 35 years. This constitutes an average of two interdisciplinary technical publications per year. These figures are somewhat misleading, however, since the early students often published their research without their advisors included as joint authors. The cooperators also often published the important parts of their joint research independently which gives a limited view of the actual scale of the interdisciplinary efforts taking place.

Thirty-three percent of the joint publications during this period involved cooperation with agronomy, 27 percent with botany, and 23 percent with biochemistry (agricultural chemistry). Major cooperation with agronomy is understandable since many of the new agronomy staff members were students of Dickson (including H. L. Shands, R. G. Shands, J. H. Torry, D. C. Arny, and P. A. Drolsom). As agronomists, they must have made ideal cooperators with such good training in plant pathology.

From the point of view of my own research, some of Dickson's early interdisciplinary research is of considerable interest. In working on the improvement of small grains the development of scabby barley and wheat (*Fusarium* sp.) proved to be a serious problem not only from the point of view of grain quality, but because the pigs eating contaminated grain either vomited or rejected the grain altogether. Dickson's initial cooperative work with K. P. Link (biochemistry) involved attempts to define the active principle causing emesis (and subsequent hyperestrogenism). James G. Dickson and his brother, Alan D. Dickson of the USDA Barley and Malt Laboratory, with Gustav Bohstedt of meat and animal science, continued this project at a low level for many years, but they never succeeded in identifying the toxic principles. The problem was partially solved in the early 1960s when competing groups at Purdue and Minnesota identified the estrogenic component produced by *Gibberella zeae*. The solution to the emetic problem did not come until the early 1970s with the work of R. Versonder and associates at the Northern Regional Research Laboratory at Peoria. One wonders why the cooperation with K. P. Link was not continued, since the solution to the problem was probably within the grasp of the technology of that time.

As in the case of Dickson, J. C. Walker functioned as an all-purpose plant pathologist, plant breeder, geneticist and teacher. The strong programs on the physiology and biochemistry of plant disease which developed later in the department had their origins in Walker's initial interdisciplinary research. These studies began, not with a disease of cabbage, but with a minor disease of onions (onion smudge—*Colletotrichum circinans*). Walker's collaboration with Link (biochemistry) and their student H. R. Angell demonstrated, perhaps for the first time, the chemical basis for resistance to a plant disease.

Walker talked to me about how this project started:

> I ran across the fact that onions with colored scales were resistant to the blots (smudge) and I tried to do a little myself chemically but got nowhere. At this time, one of my earliest graduate students, H. R. Angell, assigned to me about 1920 following his return from the army in the British West Indies, was looking for a problem. (Actually Angell, who received his degree in 1928, was the third of Walker's students to do so.) Angell had taken his undergraduate work at Montreal at the Agricultural Institute and then came here to do his graduate work. I had an assistantship on onion diseases which he took over to work on the purple blotch disease (*Alternaria porri*). He was a rare good worker, but only once in my lifetime did he come to me to say that he had run out of something to do. "Well", I said, "if you can't find enough to do on *Alternaria*, let's go back to the plots! Maybe you can find out what occurs in onion scales that produces resistance. It's a chemical problem, and I suggest that we go over and get acquainted with Karl Paul Link who has just returned from a year's postdoctorate in Switzerland with one of the noted organize chemists of his time—I forget his name." So, we got together and formed a sort of three-man team. I had them take the Ford truck to Racine County and collect as many bagfuls of the dried-out scales as they could find. We teamed up and they stored all that stuff over in the basement of agricultural chemistry, since in plant pathology we had only the upper floor of the Horticulture Building and we didn't have any other storage space. (The stored onion scales apparently had a very strong smell.) They started a water extraction on the different onion scales. As the fractionation proceeded, they would bring it over and we'd test it in my lab to see if they still had the toxicity and they finally got it down to a clear substance only present in the red or yellow onion scales which contained the toxicity. This clear concentrate, however, would not crystallize. About this time, the son of the chairman of agricultural chemistry came back from Europe with some fine Russian liqueur and he and Karl Paul went out on the town, and Karl took sick! His wife put him to bed, and he was in bed three or four days before he could come back to work. He had left the active concentrate in an evaporating dish and while he was away, it crystallized. (There is no doubt a lesson to learn from this story.)

Walker's cooperation with Link apparently ended during the time when the patents for Warfarin (rat poison) were being worked out. Walker said that "at that time Mark Stahmann (Stahmann had worked jointly with Walker and Link during graduate training on a research project involving clubroot of cabbage) and Link began to fight, and "Link damn near killed Stahmann in his office, and so from then on I didn't have any further dealings with Link and he went on to other things."

The cooperative work with Stahmann on clubroot was published in 1940, and this was the beginning of a relationship which lasted more than 20 years and involved a range of studies on the biochemistry of disease resistance in plants. Walker's name appeared in over 40 technical papers having interdisciplinary aspects, mainly with Link and Stahmann.

A. J. Riker began his career a few years later than Walker, but they retired the same year. Much of Riker's published research involved interdisciplinary collaboration with colleagues in bacteriology, botany and biochemistry. Over a span of twenty-five years, he authored almost fifty technical papers with people in departments other than plant pathology. In later years, many of these publications were co-authored with A. C. Hildebrandt. Beginning about 1934, he collaborated with I. C. Baldwin and O. N. Allen in bacteriology, B. M. Duggar in botany, T. C. Allen in entomology, W. H. Peterson and R. B. Burris in biochemistry, and B. Struckmeyer in horticulture. His collaborative investigations on the nature of crown gall and the related plant tissue culture work received long-term funding from the American Cancer Society.

POSTWAR—1945–1955

Interdisciplinary research in the department increased remarkably following the end of World War II (Table I). The number of interdisciplinary publications increased from two per year to eight per year. Less cooperation took place with botany (seven percent) and agronomy (twelve percent), but a great increase developed in joint publications with biochemistry (forty-eight percent). This, no doubt, reflected the new technologies in chemistry available as a spin-off of research during WW II.

Over the thirty years of A. C. Hildebrandt's career, he published over forty interdisciplinary technical publications with collaboration in botany, horticulture, bacteriology, and biochemistry. With the exception of Hildebrandt, who continued the collaboration programs begun by Riker, very few of the new staff members added in the early 1940s had research interests or assignments which encouraged development of interdisciplinary programs. During this time, intradisciplinary research within the department flourished and, indeed, became a way of life. J. E. Kuntz, in his forestry research on herbicides for fire lane weed control collaborated with T. T. Kozlowski (forestry) and D. J. Hagedorn, retaining his contacts after his appointment changed from pea breeder to pea and bean disease investigator; he published a number of joint publications with E. T. Gritton (agronomy), L. K. Binning (horticulture), and others. D. C. Arny, one of Dickson's students and originally joint with agronomy, cooperated principally with H. L. Shands and later with Lonquist and R. A. Forsberg. Deane indicated to me that he was never entirely satisfied with his input in these programs because Shands of course was also trained as a plant pathologist. Arny said that in the early days, he helped to develop a machine for loose smut inoculations which they are still using.

OUTSIDE INVADERS—1955–1975

In the years after 1955, staff additions reflected new and less provincial attitudes. When I was hired to work on Dutch elm disease in 1957, I was almost unique in not having received my degree at Wisconsin. E. W. Hanson, G. Thorne and I constituted a rare contingent of foreigners. These hiring trends continued during the next twenty years, and about 45 percent of the new staff came from outside Wisconsin.

From 1955 to 1965, interdisciplinary publications continued to emphasize biochemistry (33 percent), but cooperative efforts with forestry (21 percent) and horticulture (19 percent), showed dramatic increases. These trends also continued through the next decade (1965–75), with biochemistry (27 percent) still the most popular area for cooperation. New areas of cooperation such as veterinary science (12 percent) began to appear during this period reflecting the broadening interests in areas such as mycotoxicology. An average of more than seven interdisciplinary publications per year appeared over the two decades from 1955 to 1975 and reflected a slight decline from the peak post-war period (1945–55).

My own interdisciplinary research began around 1960 and came about accidentally. As with many things in our department, it came about indirectly as a result of space limitations. When I accepted the position to work on Dutch elm disease, no one told me that they really didn't have a place for me to work—not an office, not a laboratory, not even a desk! For a while after I arrived, they let me sit in a small laboratory in the Horticulture Building next to Riker's office. I shared this space with Bill Muir, a postdoc working for Hildebrandt. It was a dirty and difficult place to work, and I was told *several times* not to get into the cabinets or move things around! Since I spent most of that first summer working in the field in Milwaukee, the lack of space didn't cause many problems, and I even managed to bootleg some pure culture work with *Ceratocystis ulmi* at my desk. Jack Berbee and Gene Van Arsdel, who came at about this same time, also had similar space problems, and they shared crowded quarters in Moore Hall. Although I didn't know this at the time, the department was in the planning stages for a new building which would take care of our space problems for the foreseeble future. The move into Russell Labs didn't actually take place for seven more years (also the time necessary for a final tenure decision). With the help of Riker and Dickson, we acquired the central part of T-18, a WW II army hut located at the present site of Russell Labs which had been a classroom. The east end was occupied by several plant pathology graduate students (G. L. Worf and P. H. Williams, K. R. Barker and others as I recall) along with the Artist-in-Residence of the College of Agricultural and Life Sciences, Ahron Bohrod, and later Gerald Thorne and the nematology group. The western one-third of the building was assigned to Roy Nichols (veterinary science) and his old Guernsey cow "Lulu". With Dickson's help, we spent several weeks constructing partitions, shelves, and laboratory benches and other necessary fittings for furniture essential for our work. In square feet by today's standards, our space would be considered luxurious, but it had its drawbacks. Heavy summer thundershowers usually resulted in floods, often a foot or more deep. Needless to say, equipment could not be left on the floor and work had to be curtailed until the water subsided. The building's concrete slab floor had no drains and the water ultimately ran out into the lawn in the rear through the doors and cracks.

This space ultimately housed myself, Berbee and Van Arsdel on one side of the partition, and M. Kaufmann and L. Wood of the USDA oat program on the other. All in all, we were a patient, good-natured group and with our regular noon bridge games, we became good friends. Nichols often stopped to talk and watch our games and kibitz (he never played). Nichols was probably a little lonesome since he worked by himself; veterinary science was also awaiting a new building and their faculty occupied whatever space was available. The location of the mens room in T-18 at the east end of the building also required that Nichols walk through our space. During these stops, Nichols told many stories about his work, interests and early jobs. His area was veterinary physiology, but he was also interested in the control of bloat and various feed-related disorders. He used Lulu to test out antibloat chemicals and also to check the toxicity of feed samples sent in for analysis. Lulu was equipped with a fistulated rumen so that if she refused to eat the sample, Nichols would simply dump it directly into the rumen. If she started to get sick, he could remove the rumen contents and simply flush it out.

Nichols brought us in one time to see Lulu having a severe salivation episode after eating a sample of red clover hay. Neither Berbee nor Van Arsdel were especially interested, so I volunteered to look at the hay. It proved to be invaded with masses of heavy, dark brown mycelium which looked like matted horse hair. I isolated this fungus and identified it as *Rhizoctonia legumenicola* and the cause of the black patch disease in red clover. After several failures to get cows to eat large quantities of mycelium from pure cultures, we managed to reproduce the symptoms in guinea pigs and later in cows using pure cultures and extracted concentrates from the mycelium. Nichols suggested that maybe we should apply for a grant to study this problem. Our 1960 grant from the National Institutes of Health was apparently the first mycotoxin project funded by that agency and for me it began an interdisciplinary program which still goes on after twenty-five years, occupies about half my research time, and pays for about 75 percent of the bills.

Reaction by the department to my mycotoxin research activities was mixed, and I was more than a little concerned about this since not only was I an "outsider" at Wisconsin, but my job description as defined to me by Noble Clark (associate director of the experiment station) was to solve the Dutch elm disease problem, if I could. I had successfully obtained a grant to do interdisciplinary research on a subject without a departmental priority, and, in fact, overlapping the forage and field crop areas where we already had competent staff (Hanson, Arny and Dickson). In additon, I hadn't even consulted with Riker or Pound about applying for such a grant (the grant was processed through the veterinary science office).

Riker's reaction to the successful grant was complimentary and he never questioned my spending time working in this new area. I never heard Pound's reaction, but I know he called me into his office about this time to tell me that he had added three hundred dollars to my next year's salary so that I could buy better looking clothes to wear around the department.

The question of appropriateness of doing research on mycotoxins, however, has come up on many occasions, even in connection with the present book. When my first graduate student on this subject, Chris Rabie (from South Africa) came to his final examination, M. P. Backus (botany) asked Chris, "What does all this have to do with plant pathology?" The question provided quite a discussion among the committee, and took up a lot of time, but I must say it produced a rather weak answer from the candidate. In the discussion following the examination, I asked the committee if they were willing to sign the warrant. A long period of silence ensued, but ultimately Backus raised no objections and signed.

My efforts to isolate the active salivation factor in the *Rhizoctonia* mycelium was only partially successful and as Walker had done with Link thirty years before, I soon arranged a meeting with a biochemist, F. M. Strong, to talk about a cooperative project. I had been advised that he was the only person in biochemistry interested in working on such natural plant product problems. Frank wasn't especially interested in our salivating guinea pigs, but he agreed to assign one of his beginning students (D. P. Rainey) to have a look at the problem. Rainey also had other duties in another of Strong's cooperative projects. With our supplies of *Rhizoctonia* mycelium, Rainey and I later with Barbara Whitlock, were able to isolate the active alkaloid and a structure was published. A group at Illinois (Broquist and Aust) also published the structure at about the same time. Both structures turned out not quite right, and the Illinois group later published the corrected structure and also named the compound slaframine.

After this, our program became quite popular with veterinarians and county agents since the north central corn crop of this time was encountering a series of serious moldy corn epiphytotics brought on by unfavorable weather and possibly through use of especially susceptible corn genotypes. During these years (1962–65) many animal deaths were attributed to mycotoxin episodes following ingestion of moldy corn invaded with species of *Fusarium*. The joint work with Nichols and Strong lead to many publications, many grants and many interesting discoveries, especially concerning the class of mycotoxins called trichothecenes. Our work also provided the basis for "yellow rain", the chemical warfare agent used in Southeast Asia in the early 1980s proven to be T-2 toxin which our team had isolated and characterized in 1969.

NEW GENERATION—1975–1985

The past decade (1975–85) has seen a noticeable shift in interest areas for cooperative research. Interdisciplinary research with the School of Pharmacy produced the highest number of technical publications (27 percent), mainly due to R. D. Durbin's research with Daniel H. Rich and colleagues on the biochemistry of bacterial-induced yellows and chlorosis. Cooperative research with agronomy also increased (21 percent) while cooperation with biochemistry dropped markedly to only 7 percent of the total interdisciplinary publications for the decade. The overall interdepartmental effort declined to an average of five and one-half technical publications per year. These changes no doubt reflected shifts in job descriptions for our new staff to less traditional subjects (e.g., ecology, molecular biology, biophysics, statistics and quantitative epidemiology). These new staff members perhaps provide a kind of in-house interdisciplinary capability which makes going outside for cooperation less necessary or desirable.

Interdisciplinary research in the solution of problems still provides important benefits for those wishing to take the time necessary to seek out interested cooperators. It can extend the horizons of research manyfold and provide much more rapid solutions to difficult problems. As R. D. Durbin told me: "I think the big problem is to find a person or group with whom you can be personally compatible with and who has a similar interest, but from a different viewpoint." In this way, you can be truly cooperative and each can bring their own expertise to bear on the problems; but, of course, you need to find someone that has the time to pursue the problem—more or less at the same rate that you are able to carry it forward. When examined carefully, I think that our department's true cooperative ventures at any one time have probably been relatively small and have lasted for only short periods of time. What's good for today for both cooperators may not necessarily be so later as interests or responsibilities change.

Interdisciplinary cooperation also has its negative side. Long-term cooperation usually seems to lead to less innovative research as times progress. The tendency to "keep the program going" is very great, since it is the solution to the perpetual need for funding. Failure to publish by one or another of the cooperators can also be a serious problem and in the long run destroys the team effort. (My personal guilt feelings arise at this point.) Actual personality conflicts seem to have been rare among the plant pathologists, but well-known long-term feuds have developed in other less well-adjusted departments.

Large interdisciplinary programs which involve many departments and cooperators develop from time to time and most of the staff have participated in one or more of these. Although the record is far from clear on this point, I suspect that most of these fail in accomplishing their goal of fostering real, innovative, interdisciplinary research. Too many people seem to come along for the free ride and the task of bookkeeping is usually left to the most innovative. I once attempted to put together a large program grant covering all aspects of mycotoxicology. It was a large undertaking; it took months of time to collect the information and prepare the necessary documents. It was an impressive document, but NIH rejected it—we didn't even get a site visit.

For the future, our new generation seems well trained and equipped to set up interdisciplinary teams when they find the need. The rush to molecular biotechnologies and the high priorities given to these areas by funding agencies seem to assure a bright future for interdisciplinary cooperation—one can only hope that there will be enough cooperators to go around. Clearly, Sally Leong won't be able to do it all. I urge the new staff to do this whenever problems develop outside their general expertise. It's the fastest way to solve problems and, after all, even the most billiant young plant pathologist can't be a specialist in every field, although I know that most will try. The opportunity is there even for the senior faculty. Arthur Kelman told me just the other day that he was in the middle of a large interdisciplinary project involving several departments, and although the technical publications weren't yet available, he assured me that they will be forthcoming.

TABLE 1

Technical publications from the Department of Plant Pathology having authors from other departments at the University of Wisconsin.[1]

Department	1910–45 Number	%	1945–55 Number	%	1955–65 Number	%	1965–75 Number	%	1975–85 Number	%	Total Number	%
Letters and Science												
Botany	19	27.1	6	7.1	7	9.3	6	8.1	5	8.9	43	12.0
Meteorology					1	1.3					1	0.3
Health Sciences												
Oncology							1	1.3			1	0.3
Preventive Medicine									2	3.6	2	0.6
School of Pharmacy							3	4.0	15	26.8	18	5.0
Agricultural and Life Sciences												
Agronomy	23	32.9	10	11.9	4	5.3	4	5.4	12	21.4	53	14.8
Bacteriology	7	10.0	13	15.5	3	4.0	6	8.1	2	3.6	31	8.6
Biochemistry	16	22.9	40	47.6	25	33.3	20	27.0	4	7.1	105	29.2
Entomology	2	2.9	4	4.8	3	4.0	5	6.8	2	3.6	16	4.5
Family Resources							1	1.3			1	0.3
Food Science					1	1.3	1	1.3			2	0.6
Forestry					16	21.3	10	13.5	7	1.8	33	9.2
Genetics	3	4.3							2	3.6	5	1.4
Horticulture			11	13.1	14	18.7	8	10.8	1	1.7	34	9.5
Veterinary Science					1	1.3	9	12.2			10	2.8
Statistical Sciences									4	7.1	4	1.1

Total	70	84	75	74	56	359
Number per year	2.0	8.4	7.5	7.4	5.6	4.8

[1]Summaries compiled from various departmental records and files. A complete listing of departmental publications was not available; publications with joint authorship usually are counted as a single entry. Data can thus be considered only as an approximation of the department's interdisciplinary research efforts.

CHAPTER 23

Plant Pathology and the Wisconsin Idea

Glenn S. Pound and Douglas P. Maxwell

The University of Wisconsin, early in its history, became deeply committed to research and to the extension of research information to the people of the state. This dual thrust of a university mission was begun by President T. C. Chamberlain, but it was during the presidency of Charles A. Van Hise (1905–18) that the "Wisconsin Idea" flourished and became full blown. In his inaugural address of 1905, Van Hise boldly proclaimed the research mission: "If the University of Wisconsin is to do for the state what it has a right to expect, it must develop, expand, strengthen creative work at whatever cost. It cannot be predicted at what distant nook of knowledge, apparently remote from any practical service, a brilliantly useful stream may spring." In a 1905 address to the Wisconsin Press Association, Van Hise declared, "I shall never be content until the beneficent influence of the university reaches every family in the state". Thus, the Wisconsin Idea, in its simplest terms, stated that "the borders of the campus are the borders of the state".

The Wisconsin Idea gave the university such a public service thrust that it came to have a unique reputation among universities. The president of Harvard in 1908 referred to the University of Wisconsin as "the leading state university". Universities across the land sent delegations to Madison to study this institution firsthand.

While the concept of making the resources of the university available to the state's citizens included all of the university's programs, it was the programs of the College of Agriculture that rapidly and specifically implemented the policy. The appointment of Harry L. Russell as dean of the college in 1907 set the stage for this to be. Russell was a strong supporter of fundamental research, but was dedicated to the research needed for the state's development.

The influence of Dean Russell on the development of the Department of Plant Pathology cannot be overemphasized. He believed in, and wanted, strong professors. He wanted strong departments. The atmosphere, therefore, for freedom for the professor and department was unexcelled. There were no fences built around departments to keep anyone in or out, or to establish academic territories. This is illustrated by the fact that pea breeding came to be located in agronomy, but tobacco research was in horticulture. Professors and departments were completely free to establish collaborative research and teaching whenever and wherever the programs would be served best.

Plant pathology is in itself interdisciplinary. It has strong dimensions of microbiology, plant anatomy and physiology, biochemistry, and genetics. The atmosphere described above encouraged the department from the outset to establish strong interdisciplinary relationships in both teaching and research with botany, agronomy, genetics, and biochemistry. The programs of the department, therefore, permitted the strongest relationship to the college, the campus, and the state.

The implementation of the Wisconsin Idea was predicated upon three fundamental policies:

1) The university would have an effective partnership with the people of the state that would result in a spirit of mutualization of resources.

2) The university would give priority attention to economic and developmental needs of the state in establishing its research. This does not suggest that the university's research was primarily applied—quite the contrary was true—but it did mean that in seeking answers to problems there would be no limits on fundamental research.
3) The university would have a deep commitment to programs that would effectively communicate its research information to the public.

How did plant pathology relate to the Wisconsin Idea? Was it a functional part? Indeed, it was!

LIMITED PARTNERSHIPS

When L. R. Jones came to Wisconsin in 1910, it would have been logical for him to have continued his Vermont research on soft rot of vegetables, potato late blight or even forest diseases, but instead, his first effort was to attack the *Fusarium* yellows disease of cabbage that had become so destructive in Racine and Kenosha Counties. Fresh with knowledge of the success which one of his former students, W. A. Orton, had achieved in developing resistance in cotton to *Fusarium,* he used this approach to the cabbage problem. In the fall of 1910, he made selections for resistance and asked the local farmers to assist him, for they knew the desired horticultural type better than he. Thus, plant pathology, at the very outset, started a partnership with the farmers. This was to be repeated over and over again as crop after crop was brought into the program. The concept of the professor building on what the farmer already knew was fundamental in an effective partnership.

The farmers had other effective inputs. For years thereafter, when legislative hearings on the university budget were being carried on in Madison, the farmers would travel to Madison to support university research. This type of support reached its ultimate fruition in lobbying for the department's new building request in the late 1950s (Chapter 3).

R. E. Vaughan had begun his graduate work in Vermont, but transferred to Wisconsin when L. R. Jones left Vermont. Professor Jones assigned him to work on diseases of canning pea, the canning industry's number one problem. In 1911, the Wisconsin Pea Packers provided money for a fellowship for R. E. Vaughan, this being the first industrial support of research in the College of Agriculture. This effectively extended the partnership to the canning industry. Monetary support from the Wisconsin Pea Packers (now the Wisconsin Food Processors Association) has continued throughout the years, and, currently, four research programs are supported.

The selections of cabbage for resistance to *Fusarium* yellows disease promised immediate control. The next step was the propagation and marketing of seed of the resistant varieties. The first effort at this was for the farmers to produce their own seed by lifting mature plants in the fall, storing them through the winter, and transplanting in the field again the next spring. The ground gained against the yellows disease was almost lost at the outset by epidemics of blackleg (*Phoma lingam*) and black rot (*Xanthomonas campestris*). Both of these diseases were aided by the warm, rainy springs of the Midwest. Furthermore, the etiology of the blackleg disease was unknown.

M. P. Henderson, a graduate student in plant pathology, completed a doctoral thesis on blackleg in 1918 that elucidated the seed-borne nature of the pathogen. This pointed up the necessity of producing disease-free seed by either seed treatment or by cultural means. J. C. Walker entered the cabbage program about this time, and he performed a simple experiment that led to an unusual nationalization of the department's program. In the early 1920s, Walker planted infected seed at Racine and at Mt. Vernon, Washington, where a seed-growing area was developing because of the mild winter climate. What attracted Walker to the area was almost complete absence of rainfall from June through October, so inoculum would not spread in the plant beds or onto seed pods. Seed grown in this Puget Sound planting, even from infected stock seed, was free of infection. This led to control of the two seed-borne diseases, and became a significant impetus to the development of the vegetable seed industry of the Pacific Northwest.

The Puget Sound area served the nation well, but it faced near disaster during World War II from epidemics of virus diseases in both beet and cabbage. Cultural practices used for both crops resulted in 100% infected plants in the seed fields. Yield reductions were very great.

Again, plant pathology from Wisconsin brought a solution to the problem. Glenn S. Pound was stationed at the Northwest Washington Vegetable Seed Laboratory, 1943–46. He developed cultural strategies that rapidly eliminated the diseases from the area (Chapter 3).

R. E. Vaughan, in his early work on pea diseases, particularly *Ascochyta* leaf and pod spot and bacterial blight, had shown that the two pathogens were seed borne and that seed grown in Idaho resulted in greatly reduced losses from the diseases in Wisconsin. This was an exact counterpart of the cabbage situation.

Demonstrating that western-grown seed was advantageous to Wisconsin farmers was one thing. Educating the farmers to depend upon pathogen-free seed and insisting that the seed industries participate was something else. In this, the leadership of J. C. Walker was superb. He educated and monitored farmers and seedsmen alike and never compromised with truth. There was built, therefore, a bridge between the department, the farmers, and the seed industries that has never ceased to flourish. As the department increased its program to include breeding of pea, bean, radish, spinach, and cucumber, the confidence that existed permitted free exchange of genetic materials with the seed industries.

The confidence bridge could have been shattered by the cabbage problems had it not been for the integrity of J. C. Walker. The National Kraut Packers Association was interested in the dependability of the supply of seed of cabbage yellows resistant varieties, yet the business was almost a nuisance item for the large seed companies. They encouraged the development, therefore, of a small company, the Wisconsin Cabbage Seed Company, whose sole function was to produce and market seed of these varieties. The original company had three partners: W. J. Hansche, Sam Walker, and Martin Meeter. Sam Walker was the father of J. C. Walker and he died in the early years of the company. J. C. Walker, in order to preclude any conflict of interest, refused to accept any interest in the seed company as an inheritance. This left him free to deal with all seedsmen and really established him in a position of confidence which he respected and nurtured.

Relations with the processors of vegetable crops were similarly mutual and just as rewarding. The National Kraut Packers bought a 1925 pickup truck for the department, and they have continued monetary support to the department to this day. About 1960, J. C. Walker, R. H. Larson, Glenn S. Pound, and Paul H. Williams spent a day in Racine County with the research committee of the National Kraut Packers Association looking at the performance of the breeding lines for tip burn resistance in cabbage. Tip burn had become a troublesome problem for the processors, and the breeding approach looked promising. "How can we help move this along so that we can have the new variety in production?", they asked. Our reply was that our schedule was dictated by available greenhouse space. They immediately assessed themselves money to build the "J. C. Walker Greenhouses", which they built on university-owned land and then gave to the university in order to avoid the time-consuming regulations of the state building commission.

The Department of Plant Pathology has been in more of a supporting than lead role in breeding corn, small grains, and forage crops than has been true of vegetable crops[1], but its contributions have been monumental, nonetheless. Wisconsin releases of disease-resistant varieties of oats, wheat, and barley have been primary products of H. L. Shands and R. G. Shands who, although in agronomy, had received Ph.D.'s in plant pathology under James G. Dickson and were *bona fide* plant pathologists. They were ably assisted by D. C. Arny (Chapter 10).

The establishment of alfalfa as the main forage crop underpinning the dairy industry was predicated on the discovery of bacterial wilt and its role in winter hardiness by Fred R. Jones (plant pathology—USDA).

Norman C. Neal, professor of agronomy and Wisconsin's premiere corn breeder who provided spectacularly successful inbred lines for hybrid production, was a joint appointee in plant pathology during his early professorial years.

COMMUNICATING RESEARCH TO THE PUBLIC

The Department of Plant Pathology at the University of Wisconsin has always had an inadequate number of extension personnel and from 1910 to 1963 it had only one general extension specialist. Why was this so, and how could the department have been so effective? The answers lie in the spirit and work schedule of the research personnel. If the university was to be an effective partner with the public and if research was organized around public needs, then the researchers themselves had to be a part of the extension mechanism, and, indeed, they were, even though without salary. For years, the Departments of Plant Pathology and Entomology provided a day-long program in early March for the vegetable growers of southeastern Wisconsin during which researchers were the speakers. This was followed by field days in the summertime where experimental plots were observed. Special field days were held for breeders of the seed companies where everyone was privileged to see the performance of breeding lines, their own as well as those of the university.

In January of each year, a three-day short course was held for the field men of the canning and freezing companies at which scientists of all disciplines updated the field foremen.

In the late summer of each year, J. C. Walker spent his vacation at his summer home in Door County, Wisconsin. He regularly used this time for visitations to cucumber fields and to visit pickle packers.

One day in 1958, a representative of one of the large canners of beet brought to my office samples of their canned product. The beets showed dark blotches of dead tissue. The company did not know the nature of their problem and they were very alarmed that their position in the market might be in jeopardy. I could not account for the lesions being due to boron deficiency or to any other known disease. Robert Shephard was a senior student with me at the time and was a good chemist. I asked him to accompany me to the plant to critically examine the canning process. In the course of discussion, we learned that the plant manager had recently reduced the number of heating vats from three to two in order to increase productivity. It was Shephard's idea that this change might have resulted in a heating process that was inadequate to inactivate phenol oxidative enzymes. We immediately restored the third vat to the process line to determine whether

1. I think it a fair historical assessment to offer the following as an explanation as to why Wisconsin was so active in breeding disease-resistant varieties of vegetables. Until the era of Warren Gableman, the Horticulture Department was only extension oriented in regard to vegetable crops. In fact, under the chairmanship of J. G. Moore, it was almost anti-research. In this void, therefore, plant pathology had both an open door and a compulsion to program in this area. In contrast, the Department of Agronomy showed no such default and assumed the lead role in breeding.

or not this was so. The sample products were completely free of the black spots. The cause of the problem was identified and the company's market had been secured. I relate this incident to illustrate how a spirit of public service involved the research personnel in extension activities.

The above activities were always in cooperation with extension personnel who, in addition, had many faceted programs of their own. The above descriptions of participating in the Wisconsin Idea are only illustrative. It can be said in summary that many facets of Wisconsin agriculture, including its agricultural industries, have been saved and nurtured by plant pathology. For the past seventy-five years, Wisconsin has been the repository of information about cabbage. Yellows, blackleg, black rot, clubroot, mosaic, and tip burn have all been kept under control by breeding and cultural control. Even the minor crop, radish, important to only a few farmers, has been bred for resistance.

The pea industry was saved by a series of new varieties resistant to wilt and near wilt, and inroads have been made against the troublesome root rot problems. When the cucumber pickling industry moved north to escape the ravages of mosaic, it encountered another devastating disease (spot rot). Again, the new mosaic-resistant, spot rot-resistant varieties developed by J. C. Walker saved the industry.

The sugar beet industry and canning beet industry were saved from the losses from boron deficiency by the simple technology of soil amendment with borax.

The development of Idaho Refugee and Wisconsin Refugee beans resistant to bean mosaic by Walker and Walt Pierce, together with recent developments by D. J. Hagedorn, provided a genetic base on which the giant snap bean industry of the Central Sands area was built.

Wisconsin's elite potato seed industry and its important production of potato table stock have been the result of the Potato Seed Foundation Farm, the production and use of disease-free seed by certification[2], and the breeding of new varieties. G. H. Rieman (potato breeder, horticulture) was a joint appointee in plant pathology. When the potato seed industry was threatened by an outbreak of potato rot nematode disease in the 1950s, the Department of Plant Pathology led a state-wide regulatory program under H. M. Darling and J. C. Walker that quickly eradicated the pathogen. An important facet of this program was the addition of Gerald Thorne, an internationally known nematologist, to the department's staff.

The cherry and apple industries have been served throughout the history of the department by a multifaceted program of chemical control, epidemiology, and virus identification studies. Similarly, for the past two decades, Wisconsin has been kept at the top in cranberry production by a program of identifying and controlling fruit rot diseases.

EXTENDING THE WISCONSIN IDEA BEYOND THE STATE TO THE NATION'S AGRICULTURE

Wisconsin staff personnel and Wisconsin training have played monumental roles in the development of our national agriculture. Perhaps the event of the greatest historical significance was the stemming of the tide of epidemics of the curly top disease of sugar beets in our western states, a program primarily of the U.S. Department of Agriculture. Eubanks Carsner and N. J. Giddings, both graduates of the department, and F. V. Owen (Ph.D. in genetics) were the leaders of this team. Coming into the picture later were C. W. Bennett and James Duffus, both departmental

2. It should be pointed out that the legal authority for seed certification regulatory procedures rested with the state Department of Agriculture which, in turn, assigned these to the university.

trainees, who were stationed throughout their careers at the USDA Sugar Beet Laboratory at Salinas, California. Ancillary to the control of curly top were the control measures worked out by Glenn S. Pound at the Northwest Washington Seed Production Laboratory for mosaic diseases of beet, sugar beet, and mangel seed crops.

The vegetable canning and fresh market crops of the nation have been widely served by Wisconsin research and Wisconsin-trained researchers. The movement of W. H. Pierce, Mel Anderson, Merle Stubbs, Jack Adams, Dalton Ozanne, Steven Warnock, Pat Crill, W. J. Virgin, W. C. Hatfield and Hasib Humaydan into the seed or vegetable processing companies has greatly aided the industry side. The leadership of W. J. Zaumeyer of the USDA served the entire nation's bean industry.

The great production centers of the California inland and Imperial valleys have been monitored and protected by W. C. Snyder, R. G. Grogan, Dennis Hall, Albert Paulus, Seymour Van Gundy, and Ivan Thomason. William T. Schroeder provided similar protection to New York.

The existence of a complex of virus diseases of citrus in California was diagnosed and elucidated by E. C. Calavan and Lewis G. Weathers.

The glasshouse tomato industry of the Lake States was protected by L. J. Alexander. Pat Crill, in Florida, was successful in developing tomato varieties with greatly improved transit qualities[3]. Steve Warnock is a breeder of tomatoes for the Campbell Soup Co.

Minnesota and the Dakotas (R. L. Kiesling) have been traditional centers of strength of research in the hard red spring wheat area. The more southern winter wheat areas of the Midwest have been largely served by the programs of Wisconsin trainees at Purdue (Caldwell, Patterson, Schafer) and Wisconsin (Hazel L. Shands, Deane C. Arny). The Canadian provinces have been greatly served by Wisconsin trainees: Gordon Green, Robert Tinline, Marshall Grant, Jack LeBeau, William McDonald, William Skoropod, Robert Copeman, Solke De Boer, Ronald Howard, Howard Harding, Gordon Bonn, Dennis Lachance, and Andres Reyes. Charles Schaller has been a very productive breeder for the University of California–Davis.

In the area of oat improvement, Wisconsin (under the leadership of Shands, Arny, and R. A. Forsberg) has been the standout center. The production of 'Vicland' oats brought it great publicity, but more important than that is the fact that as late as 1970, over twenty percent of all oat acreage grown for certified seed in North America was of varieties developed in Wisconsin.

The above have been detailed merely to portray the intensity and diversity of the contributions to our national agriculture that are attributable, directly or indirectly, to Wisconsin.

EXTENDING THE WISCONSIN IDEA BEYOND THE STATE TO THE NATION'S UNIVERSITIES

Every time the Department of Plant Pathology placed one of its trainees on the staff of another university it both multiplied its own resources and enlarged the mission of the Wisconsin Idea. The composite influence of graduates who became administrators (department chairmen, directors of research, deans or presidents) is impressive, indeed. In Table 1, a list of such persons is detailed.

3 Incidentally, a tomato from Florida became the object of a political tirade against the land grant colleges about 1970 (*Hard Tomatoes, Hard Times* by James Hightower) in which the agricultural experiment stations were indicted for displacement of farm workers by mechanization.

EXTENDING THE WISCONSIN IDEA BEYOND THE STATE TO THE U.S. DEPARTMENT OF AGRICULTURE

As our nation's agriculture developed, the U.S. Department of Agriculture played a most significant role in providing a coordinated national research program. The agricultural research experiment stations in the individual states were coordinated with the national research effort of the USDA by the Hatch Act, Memorandums of Understanding, Cooperative research, shared staff positions, and others. At the time of the founding of the Department of Plant Pathology in 1910, the USDA was the largest and, in many ways, the most prestigious employer of agricultural scientists.

From the very beginning, the department maintained strong relationships with the USDA, such that the USDA supported many on-campus programs (e.g. the professorships of J. C. Walker and J. G. Dickson and the present Plant Disease Resistance Research Unit—Richard D. Durbin, Sally A. Leong, John P. Helgeson, Christen D. Upper) and the department provided many trained scientists for the USDA. Many graduates of the department began careers with the USDA and many spent their entire careers with them and became key leaders in their program areas. A partial list of University of Wisconsin trainees who were associated with the USDA for part or all of their careers is given in Table 2.

TABLE 1
Wisconsin Trainees who served as administrators in universities.

Name	Institution	Position Held
Streets, R.	Univ. of Arizona	Chairman of Department
Gries, G.	Univ. of Arizona	Chairman of Department
	Okla. State Univ.	Dean of Letters and Science
Nelson, M.	Univ. of Arizona	Chairman of Department
Young, V. H.	Univ. of Arkansas	Chairman of Department
Slack, D. A.	Univ. of Arkansas	Chairman of Department
Crowley, M.	Univ. of Arkansas	Chairman of Department
		Director, Agricultural Experiment Stations
Gardner, M. W.	Univ. of CA–Berkeley	Chairman of Department
Snyder, W. C.	Univ. of CA–Berkeley	Chairman of Department
Grogan, R. G.	Univ. of CA–Davis	Chairman of Department
Kendrick, J. B., Jr.	Univ. of CA–Riverside	Chairman of Department
	Univ. of CA–system	Vice President for Agriculture
Weathers, L. G.	Univ. of CA–Riverside	Chairman of Department
	Univ. of CA–Riverside	Director, Agricultural Experiment Stations
Keen, N. T.	Univ. of CA–Riverside	Chairman of Department
Thomason, I.	Univ. of CA–Riverside	Chairman of Nematology Dept.
Van Gundy, S.	Univ. of CA–Riverside	Chairman of Nematology Dept.
	Univ. of CA–Riverside	Director, Agricultural Experiment Stations
Dimond, A. E.	Conn. Agri. Expt. Sta.	Chairman of Department
Tisdale, W. B.	Univ. of Florida	Chairman of Department
Weber, G.	Univ. of Florida	Chairman of Department
Owen, J.	Ga. Agri. Expt. Sta. System	Director

TABLE 1 *Continued*
Wisconsin Trainees who served as administrators in universities.

Name	Institution	Position Held
Hungerford, C. W.	Univ. of Idaho	Chairman of Department
Bever, W.	Univ. of Illinois	Chairman of Department
Caldwell, R.	Purdue Univ.	Chairman of Department
Shay, J. R.	Purdue Univ.	Chairman of Department
Stevenson, E. C.	Purdue Univ.	Chairman of Dept. of Horticulture
	Oregon State Univ.	Assoc. Dean, College of Agri.
Melhus, I. E.	Iowa State Univ.	Chairman of Department
Smith, F.	Iowa State Univ.	Chairman of Department
Epstein, A. H.	Iowa State Univ.	Chairman of Department
Schafer, J.	Kansas State Univ.	Chairman of Department
Pirone, T.	Univ. of Kentucky	Chairman of Department
Hare, W. W.	Miss. State Univ.	Chairman of Department
Goss, R. W.	Univ. of Nebraska	Chairman of Department
	Univ. of Nebraska	Dean of Grad. School
Allington, W. B.	Univ. of Nebraska	Chairman of Department
Reinking, O.	NY State Ag. Expt. Sta.	Chairman of Department
Hamilton, J. M.	NY State Ag. Expt. Sta.	Chairman of Department
Jensen, J. H.	N.C. State Univ.	Chairman of Department
	Iowa State Univ.	Provost
	Oregon State Univ.	President
Winstead, N. N.	N.C. State Univ.	Provost
Kiesling, R.	N.D. State Univ.	Chairman of Department
Carter, J.	N.D. State Univ.	Chairman of Agronomy Dept.
Owen, C. E.	Oregon State Univ.	Chairman of Department
Halpin, J.	Clemson Univ.	Director, Agricultural Experiment Stations
	Coop. States Res. Serv.	Southern Regional Dir.
Richards, B. L.	Utah State Univ.	Chairman of Department
Shaw, G.	Wash. State Univ.	Chairman of Department
Gallegley, M. E.	Univ. of West VA	Dir. Biology Div.
Keitt, G. W.	Univ. of Wisconsin	Chairman of Department
Pound, G. S.	Univ. of Wisconsin	Chairman of Department
	Univ. of Wisconsin	Dean & Director, College of Agricultural & Life Sciences
Mitchell, J. E.	Univ. of Wisconsin	Chairman of Department
Hagedorn, D. J.	Univ. of Wisconsin	Acting Chairman of Department
Conant, G.	Triarch Slides	Owner and Manager
Bancroft, J.	Univ. of Western Ontario	Dean of Science

TABLE 2
Some graduates of the Department of Plant Pathology or faculty who were associated with the U.S. Department of Agriculture.

Name	Area of Research and Location
	Small Grains
A. G. Johnson	Office of Cereal Crops and Dis. Investigation, Washington, D.C.
R. G. Shands	University of Wisconsin
W. Bever	University of Idaho
G. W. Bruehl	South Dakota State University and Washington State University
E. L. Kendrick	Smut Disease Lab., Washington State University (later Div. Field Crops Res. Beltsville, Southern Div. SEA-AR New Orleans, Office of Competitive Grants Washington, D.C.)
M. Futrell	Texas A & M University
J. F. Schafer	Cereal Rust Laboratory, University of Minnesota
	Forage Legumes
F. R. Jones	University of Wisconsin
O. Smith	University of Wisconsin
R. A. Kilpatrick	University of New Hampshire
L. K. Edmunds	Kansas State University
	Corn
A. J. Ullstrup	Purdue University
P. E. Hoppe	University of Wisconsin
	Cotton
A. B. Wiles	Mississippi State University
N. D. Fulton	University of Arkansas
	Tobacco
E. E. Clayton	Beltsville Agricultural Research Center (BARC)
E. L. Moore	BARC (later SEA National Program Staff, Washington, D.C.)
H. Heggested	BARC
H. H. McKinney	BARC
C. E. Main	Tobacco Res. Sta. Oxford, NC
R. Sievert	USDA Tobacco Expt. Sta. Greeneville, TN
H. W. Spurr	USDA, North Carolina State University
	Oil Seeds
W. B. Allington	Soybean Research Center, Urbana, IL
J. Kliesiewicz	University of California–Davis
D. W. Chamberlain	Soybean Research Center, Urbana, IL
	Beet/Sugar Beet
E. Carsner	Sugar Beet Investigations, Washington, D.C.
N. J. Giddings	Sugar Beet Investigations, Washington, D.C.
C. W. Bennett	USDA Sugar Beet Laboratory, Salinas, CA
J. Duffus	USDA Sugar Beet Laboratory, Salinas, CA
G. S. Pound	Vegetable Seed Lab., Mt. Vernon, WA
E. Ruppel	Colorado State University
	Bean/Pea
W. J. Zaumeyer	BARC
E. Echandi	Interamerican Institute of Agri., Turrialba, Costa Rica
J. R. Stavely	BARC

TABLE 2 *Continued*
Some graduates of the Department of Plant Pathology or faculty who were associated with the U.S. Department of Agriculture.

Name	Area of Research and Location
	Cabbage/Onion
J. C. Walker	University of Wisconsin
E. C. Tims	USDA, Washington, D.C.
R. H. Larson	University of Wisconsin
G. S. Pound	Vegetable Seed Lab., Mt. Vernon, WA
	Cucumber
S. P. Doolittle	BARC
	Potato/Tomato
F. L. Wellman	BARC, also Inter-american Institute of Agriculture, Turrialba, Costa Rica
R. E. Webb	BARC
	Fruits and Nuts
P. W. Miller	Oregon State University
J. Carpenter	Date Palm Res. Center, Indio, CA
	Forestry/Nurseries/Ornamentals
B. Henry	U.S. Forest Service, Gulfport, MS
D. Houston	U.S. Forest Service, Hamden, CT
R. Krebill	U.S. Forest Service, Logan, UT
J. Riffle	U.S. Forest Service, University of Nebraska
D. Coyier	Oregon State University
E. Gerry	Forest Products Laboratory, Madison, WI
C. A. Richards	Forest Products Laboratory, Madison, WI
T. Scheffer	Forest Products Laboratory, Madison, WI
R. W. Scott	Forest Products Laboratory, Madison, WI
W. R. Phelps	U.S. Forest Service, Atlanta, GA
J. Pronos	U.S. Forest Service, San Francisco, CA
K. R. Shea	U.S. Forest Service, Washington, D.C.
C. Gabriel	BARC
D. W. Johnson	U.S. Forest Service, Lakewood, CO
J. Kliejunas	U.S. Forest Service, San Francisco, CA
P. E. Thomas	U.S. Forest Service, Prosser, WA
W. G. Thies	U.S. Forest Service, Corvallis, OR
C. H. Walkinshaw	U.S. Forest Service, Gulfport, MS
	Hops
E. C. Stevenson	BARC
	Other
H. Smith	SEA-Extension, Washington, D.C.
H. Waterworth	Program Staff, Beltsville, MD
G. Griffin	Nematology, Utah State University
R. H. Kurtzman	Western Regional Res. Lab., Albany, CA
R. D. Rands	Bureau of Plant Industry, Beltsville, MD
F. E. Kempton	Bureau of Plant Industry, Beltsville, MD
G. D. Easton	Prosser, WA
W. Fett	USDA Eastern Regional Res. Center, Philadelphia, PA
P. Tooley	Plant Disease Research Laboratory, Ft. Detrick, Frederick, MD

CHAPTER 24

Contributions of Faculty to Agriculture in Foreign Nations

Earle W. Hanson

From its earliest years the Department of Plant Pathology has been deeply committed to an international involvement in agricultural programs. Not only has the department provided training for hundreds of students from many countries, but its faculty members have spent many years on both short- and long-term assignments in foreign nations conferring with scientists and seedsmen, making disease surveys, collecting disease-resistant plant materials, participating in meetings, exchanging research data and ideas, and in helping to establish new universities and programs.

L. Ralph Jones

The importance of relationships with scientists and programs in foreign nations was appreciated by L. R. Jones who six years before our department was established spent several months visiting the leading biology laboratories in England, France, Belgium, the Netherlands, and Germany becoming acquainted with many of the leading plant scientists. In Europe, Jones collected about ninety varieties of potatoes for use in breeding programs in the United States. He was one of the founders of the Tropical Plant Research Foundation and served as its president from 1924 to 1943. He went to Cuba to advise on problems of sugar-cane culture and in 1926, he went to Hawaii as a consultant on problems of pineapple. He visited Puerto Rico in 1930 as an advisor on agricultural development. In 1930, he returned to Europe in an extensive tour that also included European Russia. On this tour he was able to renew associations with many of his former students. This visit included participating in the Fifth International Botanical Congress in Cambridge, England, where he served as chairman of the Section of Mycology and Plant Pathology. In 1931 and 1932, Jones traveled extensively in the Far East and the Islands of the Pacific with special attention to Japan, Korea, China, the Philippines, and Hawaii.

George W. Keitt

G. W. Keitt received world-wide recognition for his research on epidemiology of fruit tree diseases, aerial dissemination of plant pathogens, stone fruit viruses, chemical control of plant diseases, and genetics of pathogenicity of the apple scab fungus, *Venturia inaequalis.* Being chairman of the Department of Plant Pathology at the University of Wisconsin for twenty-five years (1930–55), he traveled less than other members of the "Big Four". However, he received many invitations to participate in international meetings. In 1950, he was vice-president of the Phytopathological Section at the Seventh International Botanical Congress in Stockholm, Sweden, and prepared an invitation paper. In 1951, he visited the Imperial College of Science and Technology of the University of London, the Rothamsted Experimental Station, the University of Cambridge, the University of Bristol, and the East Malling Research Station. During this trip, he also attended the meetings of the British Association for the Advancement of Science in Edinburgh, Scotland to give an invitation paper. In 1959, he attended the International Botanical Congress in Montreal.

John Charles Walker

J. C. Walker's greatest contributions to world agriculture were the wide application of the results of his research, his books on plant pathology which have been translated into several languages, and his many students. He had a profound impact on the productivity of vegetable crops grown throughout the world. His research into plant disease resistance made vegetable production possible in many areas where previously diseases had decimated crops and reduced yields. He was internationally known for his research on plant disease physiology and on the environmental factors that cause and foster plant disease development. He tended to stay close to his laboratory and plots in Wisconsin, but did manage to keep in touch with other workers in many parts of the world. In 1952, he was a visiting professor at the Instituto Biologico in Sao Paulo, Brazil. In 1955, he visited workers in Cambridge, England; Wageningen, the Netherlands; Basle, Switzerland; Vienna, Austria; and Paris, France. In 1960, he spent more time in Europe visiting laboratories in Spain, Portugal, Germany, England, Scotland, Italy, Austria, and the Netherlands. In 1960, he also received an Honorary Doctor of Science degree from the University of Göttingen in Germany. He was invited to participate in many international congresses. Some of these were the International Plant Science Congress in 1926; the International Botanical Congress in 1935; the International Genetical Congress in 1939; the International Microbiological Congress in 1939; the International Horticultural Congress in 1955; the International Botanical Congresses in 1959 and 1964; and the First International Congress of Plant Pathology in 1968. He was chairman of the International Rice Virus Disease Conference in 1967. Further evidence of the high regard foreign colleagues had for him was his election to honorary memberships in the British Association of Applied Biologists in 1954 and the Indian Phytopathological Society in 1967. In April, 1978, he was in Israel to receive the Wolf Foundation Prize in Agriculture, which he shared with geneticist George F. Sprague. The Wolf Foundation Prize is awarded annually to outstanding candidates in physics, chemistry, medicine, agriculture, and mathematics.

James G. Dickson

James Dickson was one of four Americans invited to Winnipeg, Canada, to attend the 1924 Rust Conference at which it was decided to found the now renowned Winnipeg Rust Research Laboratory. In 1930 Dickson spent most of the year in the Soviet Union collecting seeds of cereals and grasses of use to plant breeders. While there he made detailed observations on the influence of environment on plant and disease development. It was on this trip that he became well acquainted with the noted Soviet plant geographer and plant breeder, N. I. Vavilov. Between 1950 and 1959, he spent one to three months annually in Mexico, Central America, and South America as an agricultural advisor on research. His interest in these countries was mainly in cereal diseases and corn genetics.

In search of greater winter hardiness and disease resistance, Dickson also made extensive surveys of forage legumes and grasses in Alaska. At the time of his death, he was traveling to his plots in the Philippines where he was evaluating barley, wheat, oats, corn, sorghum, soybeans, alfalfa, and various other crops for use in that country. He had similar nurseries in Spain. Dickson was one of the university's most effective and successful cooperators. He had cooperative projects in many places in and out of the United States, with the U.S. Department of Agriculture, with industry, and with the Rockefeller Foundation. He also kept in touch with his many former students scattered all over the world.

At the time of his retirement from the University of Wisconsin in 1961, Dickson was already a consultant for the San Miguel Brewing Company in the Philippines. He was highly regarded and widely known in that country, and it was en route to his plots that he was killed in a plane crash in Surigao del Sur Province on March 1, 1962. To honor him and two of his Philippino colleagues, also killed in the crash, a scholarship fund was established at the University of the Philippines. The scholarships, called the "Dickson, Lim, and Rillo Foundation Scholarships" were "for the purpose of promoting knowledge useful to Philippine agriculture" and were funded by the San Miguel Brewing Company and Colonel Andres Soriano, personally. Glenn S. Pound, then chairman of the Department of Plant Pathology in Madison, represented our department and the Dickson family at the presentation ceremonies on January 25, 1963.

A. Joyce Riker

Riker earned his Ph.D. at Wisconsin in 1922 with research on the crown gall disease, and soon became a world authority on tumor development in plants as well as on the nutritional and physical requirements on diseased cells and how they may differ from those of normal cells. His results were presented at numerous scientific meetings including the International Botanical Congresses held in Paris, Montreal, and Edinburgh. He spent a year of study, and sharing of his knowledge and talents, in London and Paris in 1926–27 as an International Education Board Fellow.

He was an important contributor to both basic and applied research. He was active in world wide studies of internationally dangerous tree diseases, how they might be controlled and their relation to natural resources, especially in developing countries. As a specialist in tree diseases, Riker, in 1959, visited eighteen countries in Europe, Asia, and the South Pacific in an attempt to determine how the international movement of tree diseases might be slowed down or prevented. Similar studies took him to South and Central America in 1962 and 1964. Stimulated by Riker's work, the Food and Agricultural Organization of the United Nations held a symposium on the subject at Oxford, England, in July, 1964. He was part of the United States delegation to the Atoms for Peace Conference in Geneva, Switzerland in 1955 where he described how root grafts may be a factor in tree-to-tree spread of such diseases as oak wilt and Dutch elm disease.

As chairman of the Section of Botany of the National Academy of Sciences from 1959 to 1962, Riker carried much responsibility for the Section's report on "Opportunities and Challenges in the Plant Sciences". He was selected to lead the worldwide discussion on "Botany—the present crisis and the future outlook" at the Tenth International Botanical Congress in Edinburgh. He presented an invitation paper on the physiology of plant tumors induced by insects, bacteria, fungi, tobacco mosaic virus, and certain environmental conditions at the International Tissue Culture Conferences at Briancon, France, in 1958. The U.S. Forest Service supported and assisted Riker in many of his activities—national and international.

Henry M. Darling

Henry Darling was involved in the production of disease-free potatoes all of his professional life. He was not only in charge of potato seed certification in Wisconsin, but was active in national and international programs. Prior to his retirement in 1976, he served on the Potato Certification Committee of the International Crop Improvement Association. In 1960, he visited research laboratories in the Netherlands, Denmark, Norway, Germany, and England, and spent three months at Wageningen studying nematological problems with Drs. Oostinbrink and Seinhorst. In 1964, he traveled to Mexico for the Rockefeller Foundation to consult with local workers relative to nematodes, diseases, and other problems related to seed potato production. He also made a survey of the nematodes in some important seed-producing areas. He returned to Mexico in 1965 for more consulting. In 1968, he spent three months in Peru as a visiting professor to evaluate potato pests in relation to a certification program for the production of foundation seed and to collect germplasm. This mission was sponsored by the U.S. Agency for International Development (USAID). Also in 1968, he gave an invitational paper on potato virus research in the United States at the Triennial Conference on the European Association of Potato Research Workers held in Zurich, Switzerland. In a project sonsored by the International Potato Center in 1978, Darling spent several months in South Korea conducting a school on potato production and assisting the South Korean government in establishing an effective seed potato program. He returned to South Korea in 1979 to render further assistance. Following his 1978 trip to Korea, he visited the Philippines to consult with potato growers and scientists and to inspect research on seed potato production.

Deane C. Arny

Deane Arny served two years in Nigeria, Africa (discussed later). From September 1968 to March 1969, he worked with J. Zadoks at the Agricultural University of the Netherlands, Wageningen, in studies of the effects of light on infection of corn by *Helminthosporium maydis.* In 1975, Arny spent three weeks in Kenya as a member of a team reviewing USAID-sponsored research on food crops.

J. Duain Moore

Dewey Moore also served on the Nigerian project (discussed later). In 1977, he returned to that country to spend a month as a consultant to the American Council on Education and to USAID on the staffing of thirteen universities. During January 1981, he traveled to the Cross River State in Nigeria with Wayne Kussow of Wisconsin International Programs and Milton Sunde of the University of Wisconsin Poultry Science Department to study the feasibility of a contract between the University of Wisconsin–Madison and the University of Calabar to assist this new Nigerian university develop a Faculty of Agriculture. Moore was in Indonesia during March and April of 1981, along with Robert W. Bray, associate dean & director of the College of Agricultural and Life Sciences at the University of Wisconsin, to assist the Bogor Agricultural University develop the research aspects of a program of higher education in agriculture. Moore also worked with a Bogor staff on the University of Wisconsin–Madison campus for six weeks during July and August 1981. This was part of a USAID project involving exchanges of University of Wisconsin and Bogor Agriculture University staff through 1984.

Glenn S. Pound

Soon after becoming chairman of our department, Pound also became more and more involved in international programs. He spent May and June of 1959 assessing the research and organization of agricultural research institutions in Europe. In 1960, he was invited to join the Board of Consultants of the Rockefeller Foundation for their agricultural sciences programs. In this capacity, he traveled extensively in Latin America, the Orient, and Africa. In Africa, he was asked specifically to look at University College (later to become the University of Ibadan) in Ibadan, Nigeria, and a paper organization for another university, the University of Ife. The latter applied for developmental assistance from USAID. After preliminary investigations in 1962 and 1963, the USAID mission in Nigeria contracted an interdisciplinary team from the University of Wisconsin to study the feasibility of assisting the University of Ife develop its Faculty of Agriculture. Pound was chairman of that team. The idea was approved and a contract granted to the University of

Wisconsin, effective December, 1964. Five team members had already begun work at the new university in September of that year with Rockefeller Foundation support.

The University of Ife Project

A basic goal of those who conceived the Nigerian project was to establish through the Ife Faculty of Agriculture a system of educational service to the community similar to that of the land-grant universities of the United States. Although the system could not be fully implemented since the extension and research functions in Nigeria rested with state governments, project personnel hoped the separate responsibilities could be coordinated. The University of Wisconsin was to administer the contract through its office of International Agricultural Programs in the College of Agricultural and Life Sciences. The duration of the contract was ten years.

The specific objectives of that project were: 1) to help develop a Faculty of Agriculture with six departments: Agricultural Economics, Agricultural Engineering, Animal Science, Extension Education and Rural Sociology, Plant Science, and Soil Science; 2) to help develop appropriate curricula, syllabi, and other teaching materials, and to develop courses (the programs, courses, and teaching materials were to be relevant to southwestern Nigeria); 3) to train Nigerian staff to instruct students by modern teaching methods, to carry on research, and to administer the faculty. All staff members were to participate in faculty decision making; 4) to increase the enrollment of students in agriculture; 5) to help develop a research program relevant to Nigeria's needs and useful for teaching, and 6) to help develop the required facilities for teaching and research, including a research farm with buildings, to obtain equipment and teaching materials for laboratories and the farm, and to make sure textbooks were available to students at reasonable prices.

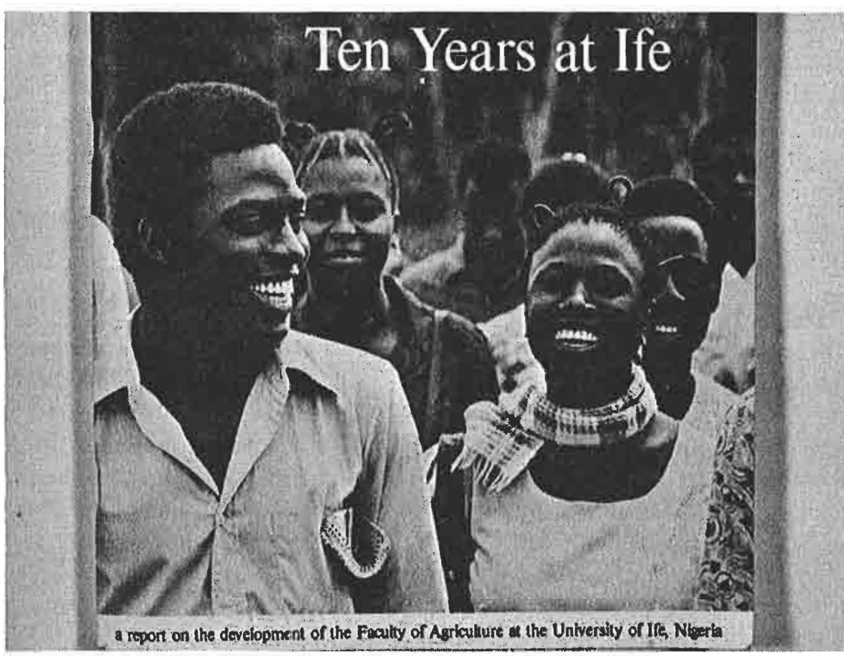


Figure 24.1 Ten Years at Ife.

When the first members of the University of Wisconsin team arrived at the University of Ife in the fall of 1964, the Faculty of Agriculture was operating as the "Department of Agriculture". Two Nigerians and two expatriates were teaching thirty-nine agricultural students. That year, the first small contingent of Wisconsin contract staff (four persons for most of the academic year and five additional persons for two to three months each) taught twenty-six courses. There was little opportunity for research.

In the early years the staff concentrated on educating students, often improvising to meet instructional needs. For example, Richard Corey (soils) taught basic chemistry courses in addition to soils, Emmett Schulte (soils) taught geography among other subjects, and Jack Berbee taught several botany courses as well as plant pathology and agronomy. By 1966, the first Nigerian trainees were returning from United States graduate schools and assuming teaching and research duties. Within a year, the faculty formed into five departments. Agricultural Engineering was started as a sub-department of Plant Science and became a full-fledged department in 1971 when it was transferred to the Faculty of Technology. Similarly, the Department of Food Science and Technology was a part of the Animal Science Department prior to its transfer to the Faculty of Technology. At first, the Wisconsin staff attempted not to get involved in the administration of the university but that policy was abandoned early in the contract at the request of the Nigerian staff. There were simply not enough Nigerians to fill leadership roles. Therefore, Wisconsin team members assumed department headships, committee chairmanships, and even the deanships of the faculty and graduate school. The dean of the faculty is nominated by the Faculty Board and approved by the University Senate. He normally serves for two years. Department heads are appointed by the vice-chancellor and serve indefinite terms.

Wisconsin contract personnel spent a total of 97.75 man-years in Nigeria; 70 of these years were provided by University of Wisconsin faculty and 27.75 years by recruits from other states. These figures do not include the contributions of the International Programs staff located on the Madison campus, the one-month feasibility study made prior to the contract by a six-member team of University of Wisconsin faculty headed by Glenn Pound, the visit of Arthur Kelman as an external examiner and consultant, E. E. Heizer's regular visits, or the visits of other University of Wisconsin faculty and administrators. Because of Pound's involvement in setting up the program, he remained close to it after becoming dean of the College of Agricultural and Life Sciences at the University of Wisconsin.

Our Department of Plant Pathology played a major role in the development of the University of Ife's Faculty of Agriculture. As mentioned, Pound was chairman of the committee that made the feasibility study leading to the contract. Five faculty members spent two to four years each in Nigeria for a total of more than thirteen man-years:

Personnel	*Arrival*	*Departure*
J. G. Berbee	October 7, 1964	June 30, 1967
D. C. Arny	August 30, 1966	September 14, 1968
E. W. Hanson	September 27, 1967	October 29, 1971
J. D. Moore	September 4, 1968	November 17, 1970
J. E. Kuntz	September 1, 1970	August 31, 1972

All of the long-term persons mentioned above had teaching and research responsibilities. In addition, each was a member of the university senate, each served on many committees, and each had numerous administrative responsibilities. Berbee was the first member of our department to arrive on the scene. In addition to his heavy teaching load, he served as acting chief-of-party, acting dean of the faculty, and advisor to the Ministry of Agriculture for the first several months of his tenure. O. B. Combs (horticulture) joined the team on April 9, 1965, to become the team's first chief-of-party. Deane Arny was the first head of the new Plant Science Department. This department included agronomy, plant breeding, horticulture, plant pathology, entomology, and agricultural engineering (until 1971). As this department's staff and programs increase, it is expected that the department will be divided into several departments. J. Duain Moore succeeded Arny as head of the Plant Science Department and he was followed by James Kuntz. So for six consecutive years this department was headed by Wisconsin plant pathologists. Moore also served as dean of the Faculty of Agriculture and was the university's first Graduate School dean. Moore also planned and supervised the construction of three modern greenhouses. Kuntz finished some of the wiring, installation of water systems, drainage, etc., after Moore's departure. Much progress was made during this period in the development of an experimental farm for teaching and research and in equipping laboratories. Land had to be cleared, drainage provided, buildings erected, equipment purchased, and electricity and water installed. Kuntz built and equipped a modern photographic laboratory.

Earle Hanson served as chief-of-party from 1968 to 1971. This involved keeping the USAID office in Lagos, Nigeria, and the International Programs Office in Madison, Wisconsin, informed of progress, problems, and needs of the program; looking after the housing, health, and other requirements of team members; keeping track of sea freight shipments; lending an ear to the vice-chancellor and other administrators so that the Wisconsin team could contribute fully in the development of the new university; and initiating cooperative research between staff members of the Faculty of Agriculture of the University of Ife (UNIFE) and the staffs of other Nigerian agencies, including the Federal Department of Agricultural Research (FDAR), the Western State Ministry of Agriculture and Natural Resources (MANR), the Cocoa Research Institute of Nigeria (CRIN), the International Institute for Tropical Agriculture (IITA), the University of Ibadan, and others. All of our team members were involved in off-campus research with one or more of these agencies. In 1968, a special committee to the governor of the Western State recommended that the MANR research division, along with the ministry's sub-professional agricultural schools (used in training extension workers), be grouped in an Institute of Agricultural Research and Training (IAR&T) under the University of Ife. The transfer was made in 1971 and the University of Wisconsin assumed responsibility for organization of the new institute.

The contract team began early to single out promising students and staff for advanced study in the United States under the USAID Participant Training Program. These "participant trainees" were to become the core of the Faculty of Agriculture's staff. The program financed graduate degrees for thirty-eight members of the staff, including four at the IAR&T. Many of the participants attended the University of Wisconsin–Madison, and almost all earned doctorate degrees; two earned their degrees in plant pathology. All five departments offered Master of Philosophy degrees and all but Agricultural Economics had Doctor of Philosophy programs when the contract ended (1975).

Contributions of Spouses of Faculty Serving in Nigeria

It would be remiss not to acknowledge the support, and assistance of the wives of the faculty who served in Nigeria. Not only did these ladies give up their Wisconsin homes and many of the conveniences of living in America for long periods of time to establish a home for and give moral support to their husbands in a foreign land, but they contributed in many other ways to the project. This can be said for all the ladies who were associated with the Wisconsin team in Nigeria; they can never be adequately thanked.

Special mention will be made here only of the plant pathology wives. Maryan Hanson spent four years in Nigeria and as the wife of the chief-of-party for three of those years she was the official hostess for the team and frequently had to share her home for several days at a time with visitors to the new university. These visitors were VIPS from the American Embassy, the U.S. Congress, the USAID Offices in Lagos and Washington, D.C., the University of Wisconsin in Madison, and various other places. It was a privilege to meet so many interesting people and to be able to be of assistance in this way, but it also required planning, willingness, dedication, and considerable effort under the circumstances. Maryan performed her duties well and was a credit to the team.

Edith Arny, Flora Berbee, Doris Moore, and Helen Kuntz also served the project with distinction. They planned activities for Americans and Nigerians, entertained, helped new team members get settled and acclimated, taught English, crafts, and other subjects, and served the community in many ways. All of our wives also helped their husbands with their university work. Some typed reports, some graded exam papers, some helped in the research laboratories. Helen Kuntz developed a library for the Faculty of Agriculture, taught English and other subjects to natives, and assisted her husband in his research and teaching. All of our wives deserve all the credit we can give them.

Further Contributions of Earle W. Hanson

After presenting an invitation paper and serving as official American Phytopathological Society (APS) representative at the International Grassland Congress in Helinski, Finland, in 1966, Hanson spent much of the remainder of that summer inspecting fields and plots of forage legumes, grasses, and small grains in Northern Europe (Finland, Sweden, Norway, the Netherlands, Denmark, England, and Scotland) and in consulting with plant breeders, pathologists, agronomists, and seedsmen. From 1968 to 1971 he served on the Nigerian project. During 1970 and 1971 he also saw much of the agriculture and visited many plant scientists at universities and research stations in Egypt, Ethiopia, Uganda, Kenya, Tanzania, Israel, Lebanon, southern Europe, India, Japan, Taiwan, and the Philippines. He gave several seminars in these countries. He has also attended scientific meetings and traveled extensively in Canada and Mexico.

James E. Kuntz

Jim Kuntz has traveled widely, both prior to and following his two-year stay in Nigeria. In 1957, he visited universities, research institutes, and field stations concerned with general plant pathology, forest pathology, forestry, and tree improvement in thirteen European countries. In 1964, he presented three papers at the FAO/IUFRO Symposium on "Internationally Dangerous Forest Diseases and Insects" in Oxford, England. Also in 1964, he took part in the Tenth International Botanical Congress at the University of Edinburgh, Scotland, and the IUFRO Work Conference and Symposium in Rome, Italy. In 1971, he was asked to organize and chair a symposium on forest tree diseases for the Second International Symposium on Plant Pathology of the Indian Phytopathological Society in New Delhi, India. In 1976, he presented three papers at the XVI World Congress of FAO/IUFRO in Norway. In 1975 and 1976, he presented invitation research papers at the Central International Forest Insect and Disease Conferences and chaired the session on "Canker Diseases of Northern Hardwoods". He also presented an invitation paper at the International Conference on Peaceful Uses of Atomic Energy in Geneva, Switzerland. In 1968, he was in London, England, to participate in symposia on "Teaching of Plant Pathology" and "The Use of Audio-visual Aids in the Teaching of Agriculture".

Before leaving Africa in 1972, Kuntz traveled to Liberia to represent the University of Wisconsin Department of Forestry in evaluating Liberian personnel, research facilities, and programs in forestry, and to assess the possibilities for cooperative research between Liberia and the University of Wisconsin. He spent more than two weeks in the country and saw most of the research in progress as well as many of the larger rubber and forest tree plantations.

Robert W. Fulton

Bob Fulton has been an international authority on fruit-tree viruses for many years. He has served continuously on the Executive Committee of the International Society of Horticultural Science Working Group on Fruit-Tree Virus Diseases from 1977 to the present. He was a member of the International Working Committee on Ilarviruses in 1979. He chaired a paper session at the Tenth International Symposium on Fruit-Tree Viruses held in Heidelberg, Germany in 1976. He gave an invitation paper on "Inheritance and Recombination in Tobacco Streak Virus" at the Second Congress of Yugoslav Microbiologists held at Opatija, Yugoslavia in September, 1972. He gave two papers at the Seventh European Symposium on Fruit-Tree Viruses held at Aschersleben, East Germany in 1967. One paper was on "Interrelationships of Ringspot Viruses of Prunus" and the other was on "Serology of Apple and Cherry Viruses". Fulton spent two months in Europe during the summer of 1960 visiting universities, research stations, greenhouses, field plots, and commercial cherry orchards, and conferring with virologists, plant pathologists, horticulturists, breeders, and growers. Among the places visited were the East Malling Research Station in Kent, the Rothamsted Agricultural Experiment Station, Cambridge University, the Wellesbourne Vegetable Research Station, and the Glasshouse Crops Research Institute at Little Hampton in Sussex. From England he went to Dundee, Scotland to attend a symposium on soil-borne viruses. He also visited the Scottish Plant Breeding Station at Pentlandfield. From Scotland he traveled to Copenhagen, Denmark to attend the Fourth Symposium on Virus Diseases of Fruit Trees in Europe and to present a paper on "Characteristics of a Virus Endemic in wild Prunus". After this four-day symposium he took part in a five-day post-symposium excursion to see institutions and programs in Denmark where plant pathological and horticultural work was being done. Subsequently, he went to Braunschweig, Germany to visit the Institut für Virusserologie and to talk with Carl Wetter and J. Brandes. Next he went to Amsterdam and Wageningen in the Netherlands to inspect plots and consult with workers. He spent most of one day at the Institute for Flower Bulb Research at Lisse discussing serological techniques with H. M. van Slogtern. Then he traveled to Wadenswill, Switzerland to inspect a number of cherry orchards with G. Schmid.

Donald J. Hagedorn

Donald Hagedorn has served on various legume disease assignments in Europe, Brazil, India, New Zealand, and South Africa. In 1957, supported by a National Science Foundation Senior Postdoctoral Fellowship, he spent a little more than four months in Europe. His headquarters were at the Institute for Phytopathological Research in Wageningen, the Netherlands, where he studied pea viruses, particularly red clover vein-mosaic virus. He spent several weeks during the summer surveying pea diseases in the Netherlands, Switzerland, West Germany, Sweden, and England.

He also visited a few fields in Belgium, France, and Denmark. In addition to his observations on disease incidence, he found several diseases previously unreported in these countries.

In 1968 he spent three months at the University of Rio Grande do Sul in Porto Alegre, Brazil, where he made a disease survey of soybean and corn and tested various seed treatments on beans. In 1970, he spent two weeks collecting soybean viruses in Brazil. In 1979, he traveled to Hyderabad, India, to serve as consultant to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) on legume viruses. The academic year of 1980–81 was spent at the Division of Scientific and Industrial Research (DSIR), Lincoln Research Center, Christchurch, New Zealand, working with pathologists and breeders on root rots of peas and on the evaluation of breeding lines in infested soils. Since 1982, Hagedorn has been involved in a Title 12 Program, sponsored by USAID, for bean research with the Brazilian Center for Bean and Rice Research in Goiania, near Brazilia. In January 1985, Hagedorn spent three weeks in South Africa. He gave the keynote address at the Annual Congress of the South Africa Society for Plant Pathology and presented a series of lectures at several universities and research stations throughout the Republic of South Africa.

Albert C. Hildebrandt

A. C. Hildebrandt was a pioneer and leader in plant cell and tissue culture for more than thirty years. Many scholars spent time in his laboratory to learn his techniques and enlarge their expertise in this highly specialized field. He was a member of the International Association of Plant Cell and Tissue Culture as well as a member of the International Society of Horticultural Science. In 1964 he gave a paper on his work at the International Botanical Congress at Edinburgh, Scotland. In 1965 he participated in a summer course on tissue culture in the Department of Anatomy and Cancer Research at the University of Saskatoon in Saskatchewan, Canada. In 1955 he presented a paper at the Third International Congress of Radiation Research at Cortina d' Ampezzo, Italy. In 1968 he served on the organizing committee for the International Symposium on Plant Tissue Culture held at Strasbourg, France. He was also a member of the organizing committee for the 1970 International Conference at Strasbourg. He was a speaker at the 1969 symposium of the International Society for Cell Biology at the Center for Theoretical Biology, State University of New York, Buffalo, New York. In 1970 he was in London, England to participate in the First International Congress of Phytopathology and the International Congress on Organic Synthesis. In 1971 he participated in the Tissue Culture Conference in Bellagio, Italy, sponsored by the Rockefeller Foundation Conference on Crop Improvement held in Taipei, Taiwan. He also contributed a paper at the Third International Conference on Plant Cell and Tissue Culture at the University of Leicester in England in 1974. He served as external examiner for several foreign Ph.D. candidates whose theses involved tissue culture. He was a world source of information in his field.

Robert F. Patton

Robert Patton has participated in many international meetings. In 1967, he gave a paper at the International Union of Forestry Research Organization (IUFRO) Congress held in Munich, Germany. In 1968, he presented another paper at the First International Congress of Plant Pathology in London, England. In 1976, he gave a paper and chaired a session on "New Developments in White Pine Blister Rust in Japan and Korea" at the IUFRO XVI Congress in Oslo, Norway. In 1979, he was in Florence, Italy, to give an invitation paper on white pine blister rust to the IUFRO

Research Group on Rust Diseases of Pines. In 1980, he participated in the IUFRO North Atlantic Treaty Organization Third International Workshop on the Genetics of Host-Parasite Interactions in Forestry at Wageningen, the Netherlands. In 1982, he was in Seoul, Korea, to give an invitation paper on forest tree rusts and research on white pine blister rust resistance at a joint seminar of United States and Korean scientists, sponsored by the National Science Foundation.

Donald M. Boone

Donald Boone is nationally and internationally known for his expertise on cranberry production. Since his retirement in 1983, he has been a consultant not only to several large growers in the United States but also to growers and government officials in the Soviet Union who are interested in establishing a cranberry industry in their country. Boone traveled to Moscow in October, 1983, and again in January, 1984, to assess the potential for such production. In October, 1984, he was invited to return and help select a site for a demonstration bog. A site was selected near the city of Pinsk, about 600 miles from Moscow. Don returned to supervise the planting of the bog (about twenty-five hectares) in June of 1985 and returned again in July and December of 1985 to check progress and assist in the management of the bog. He is committed to continue this assistance through 1990.

John E. Mitchell

From January to July, 1975, Jack Mitchell spent research leave with Albert Rovira and Gwynn Bowen at the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Adelaide, Australia studying root colonization of microorganisms in *Eucalyptus spp.* From January to March, 1984, Mitchell was in Bangkok, Thailand, as a consultant to the Department of Agriculture on soil-borne diseases.

Eugene B. Smalley

Eugene Smalley is a world authority on Dutch elm Disease and in 1980 he was asked to come to London, England, to help promote the "Elms Across Europe" program and to consult with local workers on the propagation and growing of disease resistant trees. The Pitney-Bowes Company has been active in promoting the planting of resistant elms in Europe and Smalley's visit was made possible through a Wisconsin Alumni Research Foundation contract with Pitney-Bowes. The resistant elm developed by Gene Smalley and Donald Lester of the Department of Forestry, 'Sapporo Autumn Gold', is now being propagated in commercial nurseries in England and West Germany. Smalley is probably our only faculty member who has come to the personal attention of royalty. The photo below records the planting of Smalley's tree by Prince Philip, Duke of Edinburgh at the Windsor palace grounds. Hopefully, it will replace the thousands of susceptible elms killed by the disease. Smalley has returned to Europe several times to check the progress of this program and as a consultant. In 1983 Smalley spent four months in the People's Republic of China lecturing and researching forest tree diseases as a grantee of the U.S. National Academy of Sciences program for Advanced Study and Research in China. He traveled extensively in the provinces of Heilonjiang, Hebei, Shandong, Jiangsu, Anhui, Henan, Shaanxi, and Gansu from April 22 to August 28. He examined major diseases in the forests for the purpose of identifying possible new or virulent races of well known pathogens, as well as other pathogens which might show unexpected virulence on new hosts outside of China. He was particularly interested in the diseases and problems of elms (*Ulmus* spp.) and suggested methods for detecting Dutch elm disease which is not now recognized in China. He visited several colleges and institutes and gave twenty-two formal lectures.

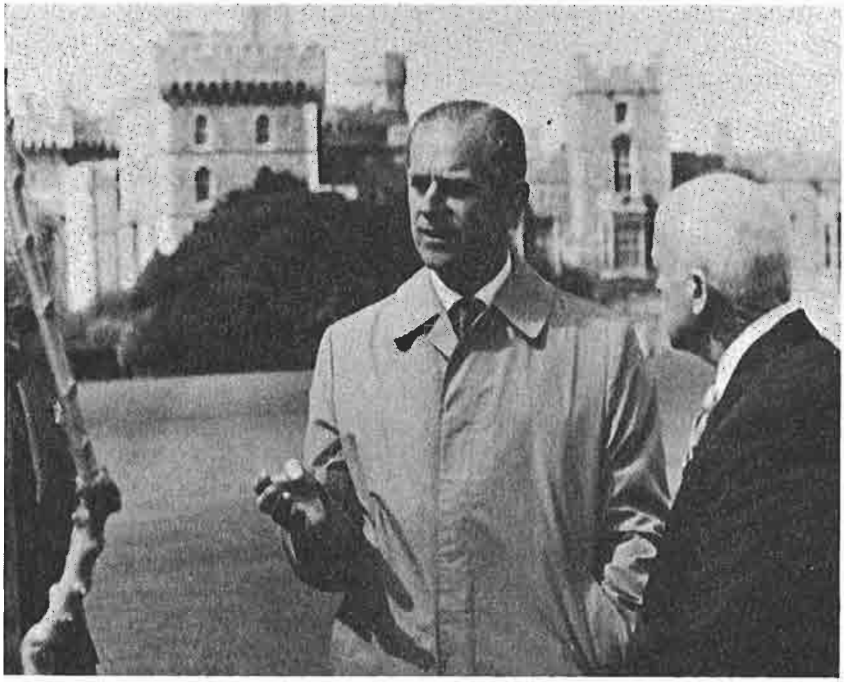


Figure 24.2 Prince Philip, Duke of Edinburgh, Eugene Smalley and 'Sapporo Autumn Gold' at Windsor Palace.

John G. Berbee
Berbee was the first plant pathologist to join the faculty of the University of Ife in Nigeria and played an important role in the early development of its Faculty of Agriculture. He devoted two and three-fourths years to the project.

Luis Sequeira
Luis Sequeira, a native of Costa Rica, came to Wisconsin in 1961 and has been involved continuously since that time as a consultant to many universities, industries, foundations, and agencies in Mexico, Central America, and South America. He has made more than twenty-five trips to these countries to inspect cooperative projects and render assistance. He has served as a consultant to the Standard Fruit Company in Honduras; Bandeco (owned by Del Monte) in Costa Rica; USAID in the Amazon Valley of Peru; Winban in Grenada; and the Rockefeller Foundation in Colombia, Costa Rica, and Mexico. His efforts have been directed mostly to bacterial wilt problems of bananas and potatoes, but he has also been concerned with *Fusarium* wilt of bananas and plantains and various other diseases. From 1967 to 1971, Sequeira worked with the Rockefeller Foundation Project on bacterial wilt of potato, which includes the testing of breeding materials, in Costa Rica, Colombia, and Mexico. Since 1971, the project has been sponsored by the International Potato Center in Lima, Peru. Sequeira spent one year of research leave (1970–71) at the University of Redding in England working in the laboratory of J. B. Harborne on plant phenolics and disease resistance. He taught a course in phytobacteriology in Chile in 1983 under sponsorship of United Nations Educational, Scientific and Cultural Organization (UNESCO). Through the

years he has attended many international congresses and meetings in Europe, Australia, and elsewhere. He attended the NATO meetings in Sardinia (1975) and Greece (1980). His contacts have brought many foreign graduate students and postdoctoral scholars to Wisconsin.

Paul H. Williams

Paul Williams has been involved in crucifer and cucurbit breeding and production for over twenty-five years. His research, which has centered on the development of technology for multiple disease resistance (MDR) screening of large seedling populations of vegetables, has been of interest to breeders, pathologists, and seed companies throughout the world. The MDR technology together with more than thirty released MDR crucifer cultivars and inbred lines, has been widely used in the development of many of today's commercial cultivars. As a consequence, Williams has been sought by various countries and institutions for his expertise. Beginning in 1974 with a trip which coincided with the first International Congress of Microbiology in Tokyo, Williams visited a number of Japanese vegetable seed companies. This trip was to establish a growing relationship between Japanese seed company breeders and pathologists and the University of Wisconsin in which Williams has worked to reduce the risks of long distance spread of seedborne diseases from Japan. Williams has returned to the Orient on various occasions visiting Japan, Korea, and Taiwan in 1980 and the People's Republic of China in 1977 and 1980. In each of the visits to China, Williams traveled widely, participating in numerous consultations and providing lectures on the improvement of vegetable production and breeding for disease resistance. In 1980 in Beijing, he presented a three-week course in resistance breeding to more than 100 scientists. As the result of his contacts in the Orient, scientists and scholars have spent considerable time in his laboratory. Beginning in 1980 with the visits of Professor Li Chia Wen from Shandong Agricultural College and Niu Xin Ge, Chinese cabbage breeder from the Ministry of Agriculture in Beijing, in 1981, other scholars have followed. Professor Chen Shi Ru came in 1982 from Southwest Agricultural College, Yin Yan came in 1983 from the Beijing Ministry of Agriculture, and in 1984 Xu Xao Hua came from the Department of Plant Protection in Beijing Agricultural University. Each of these scholars spent a year in the department as part of the University of Wisconsin's effort establishd through Chancellor Shain's office to assist China in recovering the technological losses that were incurred as the result of the Cultural Revolution. In 1984 Williams spent a month at the Asian Vegetable Research and Development Center in Taiwan and the Philippines as part of a quinquennial research and program review panel. Though most of Williams' efforts in foreign agricultural programs have centered in the Orient, he also spent a month in 1974 touring the vegetable and forage breeding institutes of the United Kingdom, and seed and vegetable production organizations in South Africa in 1983. Plans for 1986 involve a month's trip to India under the auspices of FAO to lecture and assist vegetable seed producers in the development of programs to reduce the threat of seed-borne bacterial diseases in crucifer, tomato, and pepper.

Richard D. Durbin

Richard Durbin spent one year (1972–73) at the Toxin Institute at the University of Bari, Italy, where he worked with Gian Ercolani and Zoltan Klement (from Hungary) on the mode of action of fusicoccin and on hypersensitivity induced by bacteria. He also assisted Professor A. Graniti organize the NATO conference on toxins held in Sardinia in 1973. After the International Congress of Plant Pathology in Munich, Durbin spent one month in the Soviet Union arranging research projects on biological control between scientists of the Soviet Union and the United States Department of Agriculture. He also participated in the organization of the United States-Japan

Conference for establishing cooperative projects and exchanging personnel. The first conference was held in Japan in 1966. Subsequently, there have been three conferences in the United States and a second conference in Japan (May 1985). Durbin attended all of these conferences. In 1979, he was in Bellagio, Italy, as a member of the organizing committee that developed an international conference on "Graminaceous Downy Mildews".

Gayle L. Worf

Most of our extension specialists do all the traveling they care to do in Wisconsin and the United States, but in 1984 Gayle Worf went to the Canary Islands to review the operations of the Fischer Pelargonien Company in developing and maintaining relatively pathogen-free stocks of geraniums.

Arthur Kelman

Arthur Kelman came to Wisconsin in 1965 to serve as chairman of the Department of Plant Pathology. He soon became nationally and internationally recognized for his work on bacterial diseases of potato. He also became known for his leadership, his ability as a spokesman for scientific research, and his talent for organizing and stimulating cooperation among scientists. He was a member of the Organizing Committee of the Second International Congress in Plant Pathology from 1969 to 1973. He visited India in 1971 as a consultant to the Ford Foundation on agricultural development. He spent a year during 1971–72 as a National Science Foundation Fellow and Visiting Professor in the Department of Biochemistry in Cambridge, England. In June, 1972, he served as external examiner and consultant on academic matters in the Plant Science Department of the University of Ife in Ife, Nigeria. He helped organize the International Society for Plant Pathology (ISPP) and was its president from 1973 to 1978. During August and September of 1974, he was in China as a member of a plant science delegation sponsored by the Committee on Scholarly Communication with the People's Republic of China, of the National Academy of Sciences, to assess the status of agricultural research in China. In November and December of 1975, he was a member of a panel to review the program of the International Rice Research Institute at Los Banos in the Philippines for the Technical Advisory Committee of the Consultative Group for International Agricultural Research. The panel also reviewed the work in Thailand on this trip. In December 1979, he was in Bellagio, Italy, as a member of the organizing committee that developed an international conference on "Graminaceous Downy Mildews". This assignment was sponsored by the ISPP and the Rockefeller Foundation. In 1980 he was in Rome, Italy, as a member of an advisory panel on "Postharvest Losses in Root and Vegetable Crops" for the Food and Agriculture Organization. During January and February of 1981, he presented five papers at various universities and research centers in South Africa. During 1982–83, he was a member of the Committee on National Programs for Advanced Study and Research in the People's Republic of China (CSCPRC/NAS). In February 1982, he was in Lima, Peru, to participate in a Centro Internacional de la Papa (CIP) meeting on "Internal Factors Affecting Development of Bacterial Soft Rot". During March and April of 1982, he attended meetings of the Executive Committee of ISPP in Baarn, the Netherlands. On this trip he also traveled to Wageningen, Dundee, Cambridge, and London for additional conferences. From July 24 to August 1, 1982, he was in Tokyo and Kyoto, Japan, to address the Japanese Phytopathological Society and to consult with workers on bacterial diseases. In August, 1983, he gave a paper at the International Congress of Plant Pathology in Australia on "Postharvest Pathology". He also visited research laboratories in New Zealand. In May, 1984, he attended a meeting at the Rockefeller Archives Center concerned with science and medicine in the People's Republic of China. In June, 1984, he traveled to Edinburgh to attend an International Conference on Bacterial Soft Rot and to present a paper on "Isolation and Identification of Erwinia". From Edinburgh he traveled to Dundee, to London, and then to Interlaken, Switzerland, where he attended a meeting of the European Association for Potato Research. He also made laboratory visits in Basel and Zurich, Switzerland, and in Brussels, Belgium, before returning to the U.S. In August, 1984, he attended the APS meetings at Guelph, Canada, and gave the plenary address entitled "Plant Pathology at the Crossroads".

John P. Helgeson

John P. Helgeson, along with Gustaaf A. de Zoeten, and Robert E. Hanneman (horticulture), has a joint project with West German scientists to develop novel ways of modifying potatoes (genetic engineering, etc.) and to exchange germplasm. Funds for exchange visits between the participating scientists are provided by the Office of International Cooperation and Development (OICD). The three Americans made trips to Germany in 1982 and 1983. Helgeson and Hanneman also have a project with the International Atomic Energy Agency in Vienna, Austria. This is an effort to use tissue culture techniques to modify root and tuber crops for use in the tropics. They made trips to Vienna in 1983 and 1984 and to Thailand in 1984 relative to this project. Another program to exchange scientists between Canada, France, Great Britain, and the United States was started in 1984, and Helgeson was selected by the Agricultural Research Service of the USDA to spend twelve to fifteen months in the Cell Biology Laboratory in Versailles, France, working with Drs. Bourgin, Tepfer, and others.

Gustaaf A. de Zoeten

Gustaaf de Zoeten traveled throughout Europe in 1968, visiting laboratories and consulting with virologists. In 1972–73, he spent a year in the virus laboratory at Wageningen, the Netherlands, with Dr. van Kammen investigating the replication complex of cowpea mosaic virus. In 1977, he was invited to review the potato pathology program at the International Potato Center in Lima, Peru. In 1978, USAID sent him to Brazil for two months to work with Miguel Porto on viruses of soybean. In 1980, he consulted with virologists in France and served on the examination committee of Philippe Nicot who was a candidate for an advanced degree at the University of Paris. In June, 1985, he traveled to West Germany to consult on cooperative studies on cross protection to plant viruses in potatoes, molecular biology, and other aspects of the cooperative project.

Douglas P. Maxwell

Douglas Maxwell spent a year (1976–77) working with Dr. Gerd Hänsler at the Institut für Physikalische Biologie in Aachen, West Germany, where he investigated fungal cytology and made progress on the characterization and cytochemical localization of enzyme systems in plant pathogenic fungi. During his stay in Germany, Maxwell also gave lectures in the departments of phytomedicine at Göttingen, Bonn, and Stuttgart, and at the annual meeting of the Bavarian Phytopathological Society. He also gave a series of lectures on the genetics of host-parasite interactions at the institute in Aachen. Since 1982, Maxwell has also been involved in a Title 12 Program, sponsored by USAID, for bean research with the Brazilian Center for Bean and Rice Research in Goiania, near Brazilia.

Steven A. Slack

Steven Slack spent a week in the Netherlands with colleagues on seed potato production prior to attending the Third International Congress of Plant Pathology in Munich, West Germany, in 1978. In July and August of 1980, he was a member of a technical review panel for the Regional Potato Program (PRECODEPA) to evaluate seed potato programs in Mexico, Guatemala, and Costa Rica. In February of 1982, he was the plenary speaker for the First International Potato Congress, hosted by the International Potato Center, in Lima, Peru. Following this Congress, he participated in a review of the virology programs of the International Potato Center. In February and March of 1983, he was a member of a consulting team in Beijing and Tianjin, People's Republic of China.

Walter R. Stevenson

Walter Stevenson visited Israel in 1985 to participate in a bi-national Agricultural Research and Development workshop dealing with the use of computers in the transfer of technology of potato growers.

Sally A. Leong

Sally Leong spent two weeks in France during May of 1984 to review federal and university biotechnology programs and to assess the potential for cooperative research. She was accompanied in this assignment by Leo Walsh, dean of the College of Agricultural and Life Sciences, University of Wisconsin–Madison.

Albert H. Ellingboe

A. H. Ellingboe spent four weeks in China during the spring of 1985 to consult with scientists and give a series of lectures on host-parasite interactions.

A TYPICAL YEAR OF FOREIGN INVOLVEMENTS

From the above it is apparent that the Department of Plant Pathology has been active in virtually all aspects of international cooperation. It has trained foreign graduate students and visiting scientists. Its staff members have served as advisors and program reviewers for international research centers, have accepted foreign assignments with USAID projects, have developed cooperative research programs with scientists in many foreign countries, have presented many invitational papers at international meetings, have exchanged germplasm, techniques, and ideas, and have helped organize workshops, symposia, and exchange of personnel to facilitate the rapid exchange of information. The year 1980 is a good example of the extent of our participation. In that year: 1) Fulton presented an invitation paper at the NATO Advanced Studies Institute, Cape Sounion, Greece; 2) Kemp presented an invitation paper at the NATO/FEBS workshop-course in Edinburgh, Scotland and was also a visiting professor for one month at the College of Agriculture, Mansoura University, Egypt; 3) Patton presented an invitation paper at the NATO/IUFRO Workshop in host-parasite interactions in Wageningen, the Netherlands; 4) Slack served as a member of the technical review committee for the seed potato production program (PRECODEPA) in Mexico, Guatemala, and Costa Rica; 5) Sequeira reviewed the bacterial wilt program for the International Potato Center at Turrialba, Costa Rica, served as the representative of the Ministry of Agriculture of Costa Rica at a meeting of PRECODEPA, and presented an invitation paper at the NATO

Advanced Study Institute held at Cope Sounion, Greece; 6) Andrews presented a paper at the Third International Congress on Microbiology of Leaf Surfaces in Aberdeen, Scotland; 7) Hagedorn was in New Zealand studying diseases of peas and other vegetables; 8) Kelman reviewed the program and projects supported by the International Potato Center; 9) Ou visited Beijing, Nanjing, and Canton in the People's Republic of China and gave seminars on rice diseases; 10) Williams consulted with vegetable specialists at the International Symposium on Chinese Cabbage at Tokyo, Japan, at the Korean Horticulture Experiment Station in Seoul, Korea, and at the Asian Vegetable Research and Development Center in Taiwan, attended the International Clubroot Working Group Conference in Wageningen, the Netherlands, consulted with the National Seed Development Organization of the United Kingdom in Cambridge, England, provided information to FAO, International Board for Plant Genetic Resources (IBPGR) in Rome, Italy on germplasm resources for crucifer crops, and gave a one-month workshop on breeding for resistance in vegetables in Beijing and; 11) de Zoeten consulted with virologists in France and served on an examination committee in Paris.

This report summarizes most of our staff's foreign involvement, but is certainly not a complete report nor does it give adequate attention to the large amount of correspondence between our staff members and workers in other countries.

CHAPTER 25

Foreign Students and Their Impact at Home

John E. Mitchell

The Department of Plant Pathology at the University of Wisconsin–Madison has been greatly privileged over the years to have among its students many individuals from forty-one countries around the world. These students have brought a wealth of insights and perspectives to share with the faculty and with their fellow students. They have also brought a variety of problems and challenges to the department as it has attempted to educate those who would become plant pathologists in parts of the world with agricultural practices quite different from those in Wisconsin. This education has emphasized the importance of the basic concepts and ideas, and has taught these concepts using the crops and problems at hand. It has been the hope of the faculty that those who come from abroad will perceive the basic truths of the discipline and apply them in the cropping systems and environments they find in their home nations.

The greatest challenge in the education of students from foreign countries, however, has been faced by the students themselves. They come to a land, strange to them, with strange customs and speaking a strange and difficult language as though it was the only language in the world. To these students, often with a minimum skill in oral and written English, there is a period of transition when there is a necessity to translate back to their native language in which they can comfortably think, and then, with the thought digested, translate the reply back again into English. This period slowly passes over a few months time. As the ability to think in English develops, the need for translation diminishes.

The language problem is only one of many which the foreign student faces. The environment is strange. Food, dress, and social customs that are encountered require periods of readjustment and adaptation and tolerance both on the part of the student and the host faculty and student body. The achievements of the many who have come are all the more notable because of the fact that these handicaps have been overcome. Those who have grown up with English as their native language must pay special tribute to those visitors from afar who have come and succeeded. They have contributed much to our department.

There is yet another dimension to the educational experience that both foreign and American students are exposed to at Wisconsin during their period of graduate studies. This is best expressed in the words of Theo Staub, a former student who has traveled widely around the world as part of his successful career with Ciba-Geigy Corporation in Basal, Switzerland:

> I just would like to mention an aspect concerning foreign students that I think belongs to an account of people and events that influenced the department and of those who were influenced by it. The department has had a tremendous influence on plant pathology worldwide through the graduates from other countries. This becomes evident whenever I travel and meet graduates from Madison who received their education in plant pathology there. All "Wisconsinites" outside the United States are proud to be part of the illustrious family that celebrates the seventy-fifth anniversary of their department this year. They in turn teach what they were taught and apply in other ways the Wisconsin heritage. The latter appears to me to be at least as important as the scientific-technical knowledge. This is the tradition of cultural openness and tolerance that stays with everyone who

experienced this side of the graduate education in Madison as I was privileged to do. This contribution to the better understanding between people from different cultural, political, and social backgrounds should not remain unmentioned in your account.

This chapter is mainly an appraisal of the past as it takes a brief look at the numbers of foreign students who have come over the seventy-five-year period; the countries from which students have come to study at Wisconsin; the source of support that has made it possible for them to come, to stay, and to complete their work; and finally a consideration of the impact they may have on their own countries.

Educating students from foreign countries did not loom large in the activities of the fledgling department founded by L. R. Jones in 1910. During the first decade of its existence, the department granted seventy-five graduate level degrees, of which forty-six were for the M.S. and thirty for the Ph.D. degree. L. R. Jones was the advisor for sixty-five of these degrees. A. G. Johnson, G. W. Keitt, and E. M. Gilbert guided the other six. Since nine who earned the Ph.D. degree also earned an M.S. along the way, there were sixty-six students in all who completed requirement for degrees during this period. One of these Dimitri Atanasoff, came from Bulgaria to study with L. R. Jones. He would be the first of many foreign students who would follow during the next sixty-five years. They would come from every continent and would represent forty-one countries. Most would return to teach and to solve problems in their homelands.

Students from foreign countries continued to be but a small fraction of the students attracted to Wisconsin during the first three decades (Table 1). The total number of degrees granted each year increased substantially during this period, held steady during the war years of 1941–45, and then doubled during the years from 1951–65 as veterans of World War II finished college and continued on in graduate school. Both the numbers and proportion of degrees granted to foreign students increased during the period until the degrees they earned represented 47 percent of the Ph.D. degrees and 48 percent of the M.S. degrees granted between 1956 and 1980. During the periods from 1956 to 1960 and 1965 to 1970, slightly more than half the degrees granted were earned by students from foreign countries.

A total of 189 foreign students received degrees from the department through 1984; of these, 39 (20.7 percent) earned an M.S. degree only, 36 (19.0 percent) took both an M.S. and a Ph.D. degree, while 113 (60.2 percent) focused their efforts solely on the Ph.D. degree. Thus a total of 79.4 percent of the foreign students earned a Ph.D. degree. The comparable data for domestic students (Table 2) differs only in that a slightly larger proportion took only an M.S. degree.

Students have come from all geographical areas of the world to pursue studies in plant pathology at Wisconsin (Table 3). With this diversity of origins, it is apparent that they came with a wide range of cultural and academic backgrounds that challenged not only themselves but also the faculty of the department as they sought to accommodate their needs. The majority of the foreign students (82.5 percent) have returned to their home countries once they completed their degrees. A large proportion of those who did not return came from areas of the world where professional opportunities were extremely limited, and by one means or another the individuals were able to find employment in the United States or some other country.

The financial support that enabled these students to come to Wisconsin has been from diverse sources. Some have come supported by national programs designed to increase their competence as scientists, with the intent that they would return home to work more effectively. Others received educational support through the international programs of organizations such as the Rockefeller Foundation, The International Potato Center, the W. K. Kellog Foundation and other agencies. Students receiving foundation support are generally exceptional individuals who had come to the attention of the representatives of the international agencies working in an area and who, in many cases, qualified for educational grants through a competitive process.

Another means by which students have been brought to this country is through programs supported by the United States government such as the Agency for International Development (AID). During the last thirty years, the University of Wisconsin has been involved in national development programs of two countries that have resulted in a substantial number of students coming to the department for graduate study. One such program was in Nigeria in which faculty from this department went to that country and actively participated in development of the academic curriculum and the physical facilities for the newly authorized University of Ife. In a country long dominated by the British educational philosophy, the University of Ife was patterned after the American system. To provide a minimum cadre of faculty who were educated under the American system, many students in disciplines of agriculture came to this campus for graduate level education. As part of this program, eight Nigerian students came to the Department of Plant Pathology.

The other national program in which the College of Agricultural and Life Sciences played a major role has been Brazil. In earlier stages, the Brazilian program was operated through the University of Rio Grande do Sul, but later this was broadened and became a national program under Empresa Brasileira de Pesquisa Agropequaria, (EMBRAPA). In both cases individuals currently on the staff of research institutions or faculties of colleges were selected for graduate training that would enhance their ability to develop programs in specific areas and with specific crops. These students came from various institutions and with financial backing that permitted their pursuit of either the M.S. or Ph.D. degrees.

Programs financed by the United Nations Development Program through the Food and Agricultural Organization (FAO) provided the funds for students to come from Thailand for graduate study.

Many of the students who initially were supported by their own countries or from personal resources ultimately were forced to seek help from the resources of the university to finish their research and write their theses. The Wisconsin Alumni Research Foundation through the Graduate School has proven to be an invaluable resource that has enabled many foreign students to complete their objectives. During the two decades between 1950 and 1970 when resources available to support graduate research programs were relatively abundant, many foreign students applied directly to the department for research assistantships. In many cases those that qualified under the requirements of the department and the graduate school were selected by faculty members who had grants for specific projects. The students selected were expected to work in specific research programs or research areas on projects which provided, as well as possible, the opportunity to develop their individual interests.

Financing is only one of several factors that have determined the programs with which the foreign students would become associated. Some came because they wanted to work with specific crops and with the faculty associated with the crops. Most simply wanted an opportunity to do the research and academic work required for a graduate degree. There have been thirty-one faculty members over the years who have participated by advising one or more of the foreign students.

Students can be grouped according to crops of interest to them. Forty-five worked with vegetable crops (J. C. Walker, Glenn S. Pound, Donald J. Hagedorn, and Paul H. Williams), thirty with field crops (James G. Dickson, Earle W. Hanson, Deane C. Arny, and Craig R. Grau), eighteen with forest trees (A. J. Riker, James E. Kuntz, Robert F. Patton, and John G. Berbee), and thirteen with fruit crops (George W. Keitt, J. Duain Moore, and Donald M. Boone). The remaining fifty-four students worked with faculty on problems that are not readily grouped into identifiable crop categories such as phytobacteriology, nematology, virology, disease physiology, epidemiology, tissue culture, and soil borne plant pathogens.

It is a matter of great satisfaction to the faculty of this department that the impact many of the foreign students who gained higher degrees from our department have on their home countries has been enormous. By becoming part of educational institutions within their homelands, through teaching and research they have had the opportunity to pass on the attitudes and approaches to research, teaching and service that they learned during their graduate studies. Those who returned to educational systems are in a position to multiply the impact as they teach an increasing number of students on their own campuses. Those in research programs have the opportunity to share techniques and approaches with their colleagues and thus increase the impact of the training they received while in Madison. Wisconsin is, of course, only one of many institutions in this and other countries that have developed programs through which students from developing countries have been given the opportunity to obtain an academic and research experience that would be impossible for them to obtain at home.

Our nearest neighbor to the north, Canada, is one with agriculture most similar to our own, and one from which the largest number of foreign students have come. Hence it is the country in which the Wisconsin impact might be expected to be the greatest. Wisconsin alumni are working at nineteen locations and are found in every province of Canada (Table 4). The majority (three-fourths) are located at one or another of the many facilities of Agriculture Canada or of the provincial governments. The remaining ten are involved in academic pursuits at seven institutions of higher education across Canada. The largest number of these students came to Madison during the 1950s and 1960s, the period when Canada was engaged in a major expansion of its research and educational systems.

The educational efforts of these individuals, along with their colleagues, have gone a long way towards meeting Canada's needs for plant pathologists. It would be hoped that there might be a continuing relationship such as existed with the University of British Columbia, where Cecil Yarwood, John Bancroft, John Shaw, Paul H. Williams (now at Wisconsin), Robert J. Copeman, and Solke H. DeBoer represent a succession of students who have come to study at Wisconsin (another from British Columbia is currently (1985) a student in the department). Many have assumed leadership positions in their institutions (Bancroft, dean of science at Western Ontario University, G. J. Green in Agriculture Canada). Several have been elected president of the Canadian Phytopathological Society (W. A. Scoropad, 1968–69; C. B. Willis, 1982–83; and J. Martins, president-elect, 1985–86).

The University of Ife in western Nigeria arose *de novo* out of the jungle in the 1960s aided substantially by the members of the faculty of the College of Agricultural and Life Sciences who spent time there (Chapter 24). While the faculty were in Nigeria, students from Nigeria were in Madison studying for advanced degrees. They since have returned, and Ladipo and Oniserosan at Ife and Maduewesi, now dean of the College of Agriculture at the University of Nigeria at Nsukka, continue the efforts of those who aided in the establishment of the institution. They are building an effective program of education that is providing substantial numbers of trained agricultural scientists to solve the problems of Nigeria. Those at research institutions—Adegbola, Oyekan, Omuemu and Otoide—are likewise contributing to the efforts to solve food problems of that country.

The University of Wisconsin was a major factor in stimulating modern agricultural research in Brazil through AID-supported program that later was succeeded by the Brazil-dominated EM-

BRAPA program similar to the U.S. Department of Agriculture (USDA) of this country. Plant pathology has not had a dominant part in this program but has consistently contributed to the research on bean production. Graduates of this department are found in many institutions throughout the country. Raul Ribiero is head of plant pathology at the University of Rio de Janeiro and Miguel Porto at the University of Rio Grande do Sul. Reifschneider and Faria, are part of EMBRAPA organization and are active in Center Nacional de Pesquisa de Hortalicas (CNPH) and Center Nacional de Pesquesa Arroz, Feijao (CNPAF) respectively.

The close association that this department has had with South and Central America with respect to the research on *Pseudomonas solanacearum* by Sequeira and Kelman has resulted in several scientists from Colombia, Peru, and Chile coming here for their graduate work and research on various aspects of that most important disease. These have all returned to assume responsible positions in South America where many have continued contacts with the potato disease research program at Wisconsin. Notable in this regard is L. Gonzales in Costa Rica, who provided valuable assistance in cooperative tests on resistance of potato selections to *Pseudomonas solanacearum* before he became dean of the College of Agriculture at the University of Costa Rica. G. Granada heads the pathology program at the Colombia Ministry of Agriculture (ICA) and C. Lozano is responsible for a pathology program on casava centered at the International Center for Tropical Agriculture (CIAT) at Cali, Colombia, that has involved workers on casava wherever the crop is grown in the world.

Another program that has been of enormous benefit to South America as well as other coffee growing countries in the world is the Coffee Research Institute in Portugal. This program was conceived by F. L. Wellman as a means of establishing the resistance of species of coffee to the rust pathogen. Carlos Rodrigues has been a productive member in this program for a number of years and is currently director of the institute.

Three individuals from the Philippines were among the first of the students from outside of this country to do their graduate work in the department during the 1920s. Ocfemia and Teodoro received Ph.D. degrees under Dickson and Fajardo did his master's work under the direction of L. R. Jones. Fajardo then had the distinction of being the first student to earn a Ph.D. degree under Walker. Ocfemia returned to the Philippine Bureau of Plant Industry and then joined the University of the Philippines with C. J. Humphrey, a student of Jones. He later became the first Philippino to be named head of the plant pathology department there and became a world renowned plant pathologist and leader in the field. His research dealt with virology and he was responsible for many discoveries in the early stages of the science in that area.

Far to the south, a Wisconsin plant pathologist in New Zealand contributed to the discovery of the real cause of facial exema of sheep. This has been traced to a plant parasite by the work of G. Latch working at the Grassland Research Station of the Department of Scientific and Industrial Research (DSIR) at Palmerston North, New Zealand.

Wisconsin plant pathologists are contributing in a variety of ways to this profession in Australia. G. C. Marks with the Victoria Forest Commission has had a major role in developing an understanding of the epidemiology of *Phytopthora cinnamomi* on eucalyptus in Victoria and in Australia in general.

During the turbulent years of the 1930s and 1940s a number of Chinese students came to the department and obtained degrees. C. T. Wei, S. H. Ou, and Chuang Wang all studied under Walker and later returned to China. C. T. Fang later earned his Ph.D. degree under Riker. Wei and Fang returned to the University of Nanking where, as a consequence, the University of Wisconsin had a major impact on the development of plant pathology. These men and their students have been a major factor in the resurgence of plant pathology in China since the cultural revolution. On a broader geographic scale, S. H. Ou returned to China after completing his degree at Wisconsin but left during the war years to work in Taiwan, Iraq, and Bangkok with the FAO until 1961. At this time the International Rice Research Institute was established at Los Banos in the Philippines; Ou was selected to head the rice disease research and became one of the leading authorities in the area of rice pathology.

There are six plant pathologists in Thailand who have received degrees from this department, and are making major contributions to agriculture in that country. R. Syamananda is deputy director of agriculture in the Department of Agriculture of Thailand; another, C. Y. Yang, based in Bangkok, developed and directed the Southeast Asia Outreach Program of the Asian Vegetable Research and Development Center and provides a significant contact with plant pathologists in the People's Republic of China. S. L. Wasuwat has been responsible for the development and coordination of research on rubber production in Thailand for many years. A. Chantarasrikul and S. Tantyoporn are active leaders in the plant pathology research in the Department of Agriculture and in the Kasetsart University.

Seven students have come to Madison from South Africa to study and all have returned to assume responsibilities for teaching and research in agriculture. P. Knox-Davies has chaired the plant pathology program at the University of Stellendosch while LeRoux, formerly with the same university, is now director of a commercial corn breeding station south of Pretoria. J. Mildenhall teaches at Fort Hare University, one of the colleges for black students, and is developing biological means of controlling prickly pear cacti. W. Marasas has become widely respected for his work on mycotoxins and knowledge of the genus *Fusarium*. C. Raabe is also involved in this program and J. Heyns is the nematologist with the Division of Nematology, Department of Agriculture, Pretoria.

Some twenty-three students came from India to study at Wisconsin. The thirteen who returned to India have contributed in a variety of ways to life in that country. Thirumalachar became an authority on antibiotics and fungal mycoses in man. Many, including R. K. Grover, K. S. Thind, M. S. Paugi, and J. N. Chand, have had a career of teaching at various universities. Others are making equally significant contributions at various research institutions in India.

It is, of course, not possible to adequately reflect the contributions all Wisconsin graduates have and are making throughout the world. The names and activities given above are but a few examples. Table 5 lists all students we have been able to identify who came from other countries to study at Wisconsin. Our apologies go to any we may have failed to include. We hope that any omissions will be brought to our attention.

The extent to which the department will continue to have an impact on the training of students from foreign countries is a moot question. The substantial number of students from foreign countries that was experienced during the previous three decades has dwindled to a small number at the present time. Economic pressures in developing countries preclude them from the expenditure of resources for this purpose. Pressures on faculty of the department to be productive, in the sense of producing publications, demands research assistants who are prepared to assume responsibilities for research programs with little delay. Students from developing countries are rarely able to do this due to language difficulties or lack of adequate preparation in academic areas of importance. This is an unfortunate circumstance, for the department loses an opportunity to establish rapport with young scientists in countries around the world. Wisconsin has become well known because of the work of its faculty, and this work will unquestionably continue to be among the best in the world. Wisconsin is also well known because of the students who have come from around the world to study with that faculty and to gain the inspiration found in sharing the life of an active and interactive student body, such as this department has fostered. One hopes that resources can be found to keep alive this important facet of Wisconsin tradition. One also hopes that seventy-five years hence, someone can recount with pride at least an equal number of Wisconsin alumni who are working in countries around the world to solve problems that restrict production of food and agricultural products needed for better living.

TABLE 1
Number of graduate degrees granted by the Department of Plant Pathology to foreign and domestic students during the years of its existence.

Years	All Students			Domestic Students			Foreign Students		
	Ph.D.	Ph.D. & M.S.	M.S.	Ph.D.	Ph.D. & M.S.	M.S.	Ph.D.	Ph.D. & M.S.	M.S.
1911–15	15	1	12	5	1	12	0	0	0
1916–20	10	11	14	10	10	13	0	1	1
1921–25	17	12	17	16	11	16	1	1	1
1926–30	16	7	8	15	5	8	1	2	0
1931–35	26	10	8	26	10	7	0	0	1
1936–40	22	3	5	21	2	3	1	1	2
1941–45	22	2	0	21	2	0	1	0	0
1946–50	34	4	4	27	4	4	7	0	0
1951–55	53	9	7	45	5	6	8	4	1
1956–60	47	13	11	28	3	4	19	10	7
1961–65	56	11	15	33	4	10	23	7	5
1966–70	37	6	7	19	3	1	18	3	6
1971–75	27	14	11	13	9	7	14	5	4
1976–80	25	8	27	11	6	17	14	2	10
1981–84	27	3	18	20	3	17	7	0	1
Totals	424	114	164	310	78	125	114	36	39

TABLE 2
A comparison of the numbers of domestic and foreign students receiving degrees.

Degree received	Total receiving degrees	Domestic Number	Domestic Percent	Foreign Number	Foreign Percent
Ph.D. only	424	310	60.4	114	60.3
Ph.D. & M.S.	114	78	15.2	36	19.1
M.S. only	164	125	24.4	39	20.6
Total	702	513	73.2	189	26.8

TABLE 3
Geographical areas and countries from which students have come.

Geographical area	Students from areas (percent)	Students from countries in areas (number)
North America	15.5	Canada (29)
Central America	5.9	Mexico (5) Costa Rica (3) Guatemala (1) Trinidad (1) Jamaica (2)
South America	12.3	Brazil (8) Colombia (5) Chile (4) Peru (3) Venezuela (3)
South Asia	13.4	India (23) Pakistan (1) Nepal (1)
East Asia	14.8	China (7) Taiwan (14) Korea (3) Japan (3) Hong Kong (1)
Southeast Asia	9.7	Thailand (6) Indonesia (2) Malaysia (2) Philippines (7) Burma (1)
Near East	3.8	Iran (1) Egypt (2) Lebanon (4)
Europe	10.6	England (5) Greece (2) Switzerland (2) Germany (4) Netherlands (3) Portugal (1) Bulgaria (1)
Africa	9.5	Nigeria (8) Ghana (1) South Africa (7) Tanzania (1) Ethiopia (1)
South Pacific	4.3	Australia (6) New Zealand (2)

TABLE 4
Location in Canada of Wisconsin alumni.

Province and location	Location total	Provincial total
British Columbia		5
Vancouver	3	
Okanagan Valley	2	
Alberta		5
Edmonton	3	
Lethbridge	1	
Brooks	1	
Saskatchewan		2
Saskatoon	2	
Manitoba		3
Winnipeg	3	
Ontario		17
Sault Ste. Marie	2	
Harrow	2	
London	2	
Guelph	3	
Vineland	1	
Toronto	1	

TABLE 4 *Continued*
Location in Canada of Wisconsin alumni.

Province and location	Location total	Provincial total
Peterborough	1	
Ottawa	5	
Quebec		4
Montreal	2	
Quebec	2	
Maritime Provinces		4
Fredericton, N.B.	3	
Charletown, P.E.I.	1	

TABLE 5
Foreign students and the countries from which they have come, their advisors and date of degree.

Country	Name	Degree–Date	Advisor
Australia	Magee, C. J. P.	M.S.–1927	Jones
	Helms, K.	Ph.D.–1954	Pound
	Williams, B. J.	Ph.D.–1960	Boone
	Marks, G. C.	Ph.D.–1963, M.S.–1961	Riker
	Friend, R. J.	Ph.D.–1968	Boone
	Murray, G.	Ph.D.–1975	Maxwell
	Irwin, J.	Ph.D.–1980	Maxwell
Brazil	Porto, M. D.	Ph.D.–1974	Hagedorn
	Cardosa, J.	Ph.D.–1977	Hildebrandt
	Lopez, C. A.	M.S.–1977	Hagedorn
	Ribeiro, M. I.	M.S.–1977	de Zoeten
	de Assis, M.	M.S.–1978	Hildebrandt
	Ribeiro, R.	Ph.D.–1978, M.S.–1969	Hagedorn
	Reifschneider, F.	Ph.D.–1979	Arny
	Faria, J.	Ph.D.–1982	Hagedorn
Burma	Thaung, M. A.	Ph.D.–1956	Walker
Bulgaria	Atanasoff, D.	Ph.D.–1920	Jones
Canada	Simmonds, P.	Ph.D.–1928	Dickson
	Yarwood, C. E.	Ph.D.–1934	Dickson
	Hamilton, D. G.	M.S.–1940	Dickson
	Grant, M.	Ph.D.–1949	Dickson
	Green, G. J.	Ph.D.–1953, M.S.–1950	Dickson
	MacLachlan, D. S.	Ph.D.–1953, M.S.–1949	Larson
	Pelletier, R. L.	Ph.D.–1953	Keitt
	McKinnon, J. P.	M.S.–1953	Larson
	Berbee, J. G.	Ph.D.–1954	Riker
	MacDonald, W. C.	Ph.D.–1954, M.S.–1951	Dickson
	Tinline, R. D.	Ph.D.–1954	Dickson
	Bancroft, J. B.	Ph.D.–1955	Pound

TABLE 5 *Continued*
Foreign students and the countries from which they have come, their advisors and date of degree.

Country	Name	Degree–Date	Advisor
	Scoropad, W. P.	Ph.D.–1955	Arny
	Bagnall, R. H.	Ph.D.–1956	Larson
	Busch, L. V.	Ph.D.–1956	Walker
	Shaw, J.	Ph.D.–1959	Larson
	Clark, R. V.	Ph.D.–1956	Dickson
	Seaman, W. L.	Ph.D.–1960	Larson
	Lortie, M.	Ph.D.–1962	Kuntz
	Williams, P. H.	Ph.D.–1962	Pound
	Willis, C. B.	Ph.D.–1962	Fulton
	Martens, J.	Ph.D.–1965	Arny
	Lachance, D.	Ph.D.–1966	Kuntz
	Copeman, R. J.	Ph.D.–1969	Sequeira
	Myren, D. T.	Ph.D.–1969	Patton
	Bonn, G.	Ph.D.–1973	Sequeira
	Howard, R.	Ph.D.–1975	Williams
	de Boer, S. H.	Ph.D.–1976	Kelman
	Gross, H.	Ph.D.–1976	Patton
	Reeleder, R.	Ph.D.–1979	Hagedorn
	Blenis, P.	Ph.D.–1982	Patton
Chile	Caglevic, M.	M.S.–1959	Arny
	Corcuera, L. J.	Ph.D.–1974	Upper
	Hepp, R. F.	Ph.D.–1976	de Zoeten
	Ciampi, L.	Ph.D.–1979	Sequeira
China	Wei, C. T.	Ph.D.–1937	Walker
	Ou, S. H.	Ph.D.–1945	Walker
	Wang, C. G.	Ph.D.–1947	Dickson
	Chiu, W. -F.	Ph.D.–1948	Walker
	Fang, C. T.	Ph.D.–1949	Riker
	Faan, W. -C.	Ph.D.–1950	Keitt
	Cheo, P. -C.	Ph.D.–1951	Pound
Colombia	Cardona, C.	Ph.D.–1956	Walker
	Garces, C.	Ph.D.–1956	Pound
	Lozano, C.	Ph.D.–1972, M.S.–1969	Sequeira
	Victoria, J.	Ph.D.–1977	Kelman
	Granada, G.	Ph.D.–1981	Sequeira
Costa Rica	Echandi, E.	Ph.D.–1955	Walker
	Gonzales, L.	Ph.D.–1962	Pound
	Alcanaro, R.	Ph.D.–1966	Hagedorn
Egypt	Megahed, E. S.	Ph.D.–1969	Moore
	Abo El-Nil, M.	Ph.D.–1974	Hildebrandt
England	Wilson, A. R.	M. S.–1934	Riker
	Schofield, E. R.	M.S.–1957	Walker
	Knight, B. C.	M.S.–1956	Walker
	Harding, H.	Ph.D.–1967	Williams
	Sutton, J. C.	Ph.D.–1969	Williams
	Hack, E.	Ph.D.–1980	Kemp

TABLE 5 *Continued*
Foreign students and the countries from which they have come, their advisors and date of degree.

Country	Name	Degree–Date	Advisor
Ethiopia	Kifle, L.	M.S.–1974	Arny
Germany	Hansen, A. J.	Ph.D.–1958	Larson
	Orlob, G. B.	Ph.D.–1959, M.S.–1957	Arny
	Kollmer, G. F.	Ph.D.–1960, M.S.–1958	Larson
	Heye, C.	Ph.D.–1982	Andrews
Ghana	Kankam, J. S.	M.S.–1960	Arny
Greece	Biris, D. A.	Ph.D.–1968	Moore
	Gkinis, A.	Ph.D.–1977	Smalley
Guatemala	Schreiber, E.	Ph.D.–1959	Dickson
Hong Kong	Leung, H.	Ph.D.–1984, M.S.–1981	Williams
Indonesia	Hadi, S.	Ph.D.–1974	Berbee
	Modjo, H.	M.S.–1978	Mitchell
India	Bahadur, M.	M.S.–1922	Jones
	Thind, K. S.	Ph.D.–1948	Keitt
	Thirumalachar, M. J.	Ph.D.–1948	Dickson
	Singh, G.	Ph.D.–1958, M.S.–1956	Pound
	Srivastava, D. N.	Ph.D.–1958, M.S.–1956	Walker
	Nayudu, M.	Ph.D.–1959	Walker
	Grover, R. K.	Ph.D.–1960	Moore
	Pavgi, M. S.	Ph.D.–1960	Dickson
	Seghal, O. P.	Ph.D.–1961	Boone
	Patel, P. N.	Ph.D.–1962	Walker
	Shrivastava, K.	M.S.–1962	Walker
	Chand, J. N.	Ph.D.–1963	Walker
	Kumar, S.	Ph.D.–1963	Hildebrandt
	Nair, G. V. M.	Ph.D.–1964	Kuntz
	Amin, K.	Ph.D.–1965	Sequeira
	Bagga, H.	Ph.D.–1966	Boone
	Maheshwari, R.	Ph.D.–1966	Hildebrandt
	Singh, D.	Ph.D.–1967	Smalley
	Bagga, D.	Ph.D.–1968	Smalley
	Krupasagar, V.	M.S.–1968	Sequeira
	Shanmugasundaram, S.	M.S.–1971	Williams
	Bhalla, H. S.	Ph.D.–1973	Mitchell
	Kahn, M. A.	Ph.D.–1976, M.S.–1972	Maxwell
Iran	Rahemian M.	Ph.D.–1982	Mitchell
Japan	Sasaki, T.	Ph.D.–1959	Kuntz
	Tamaoki, T.	Ph.D.–1960	Hildebrandt
	Tanaka, H.	M.S.–1980	Sequeira
Korea	Lee, B. H.	Ph.D.–1961, M.S.–1959	Dickson
	Hahm, Y. I.	M.S.–1980	Slack
	Kim, W. -S.	Ph.D.–1958, M.S.–1956	Hagedorn
Lebanon	Saad, A.	Ph.D.–1964	Boone
	Saad, S.	Ph.D.–1969	Hagedorn
	Humaydan, H. S.	Ph.D.–1974	Williams

TABLE 5 *Continued*
Foreign students and the countries from which they have come, their advisors and date of degree.

Country	Name	Degree–Date	Advisor
	Abul-Hayja, Z. M.	Ph.D.–1975, M.S.–1974	Williams
Malaysia	Lim, W. L.	Ph.D.–1976	Hagedorn
	Lum, K. -Y	Ph.D.–1981	Kelman
Mexico	Cervantes, J.	Ph.D.–1960	Larson
	Martinez, E.	Ph.D.–1962	Hanson
	Teiliz-Ortiz, M.	Ph.D.–1965	Mitchell
	De Leon, C.	Ph.D.–1966, M.S.–1965	Pound/Williams
	Campos, A.	Ph.D.–1967, M.S.–1962	Darling
Nepal	Sah, D.	M.S.–1983	Grau
Netherlands	Wilmar, J. C.	M.S.–1963	Hildebrandt
	Klink, J.	Ph.D.–1968, M.S.–1965	Mitchell/Barker
	Khong, E.	M.S.–1981	Andrews
New Zealand	Wenham, H. T.	M.S.–1954	Hagedorn
	Latch, G.	Ph.D.–1960	Hanson
Nigeria	Maduewesi, J.	Ph.D.–1964, M.S.–1962	Hagedorn
	Adegbola, M. O.	Ph.D.–1968	Hagedorn
	Ladipo, J. L.	Ph.D.–1971, M.S.–1969	de Zoeten
	Oyekan, P. O.	Ph.D.–1971, M.S.–1969	Mitchell
	Onesirosan, P. T.	Ph.D.–1973	Arny
	Omuemu, J.	Ph.D.–1975	Berbec
	Otoide, V. O.	M.S.–1976	Patton
	Okeke, G.	M.S.–1978	Mitchell
Pakistan	Qazi, A.	M.S.–1958	Larson
Peru	Soto, M.	M.S.–1967	Darling
	Fribourg-Solis, C.	M.S.–1969	de Zoeten
	Ferandez-Northcote, E.	Ph.D.–1978	Fulton
Philippines	Teodora, N. G.	Ph.D.–1923, M.S.–1920	Walker/Jones
	Ocfemia, G. O.	Ph.D.–1923	Dickson
	Fajardo, T. G.	Ph.D.–1930	Dickson
	Reyes, A. A.	Ph.D.–1961	Mitchell
	San Juan, M.	Ph.D.–1961	Pound
	Pizarro, A. L.	Ph.D.–1965	Arny
	Darunday, Z.	M.S.–1966	Hanson
Poland	Wyszogrodzka, A.	Ph.D.–1984	Williams
Portugal	Rodrigues, C.	Ph.D.–1964	Arny
Puerto Rico	Alvarez-Garcia, L. A.	M.S.–1939	Riker
	Rivera, C.	Ph.D.–1962	Pound
South Africa	LeRoux, P. M.	Ph.D.–1954	Dickson
	Knox-Davies, P.	Ph.D.–1959, M.S.–1958	Dickson
	Heyns, J.	Ph.D.–1961	Thorne
	Rossouw, D. J.	Ph.D.–1961	Fulton
	Raabe, C. P.	Ph.D.–1965, M.S.–1958	Smalley
	Marasas, W. F.	Ph.D.–1969	Smalley
	Mildenhall, J. P.	Ph.D.–1971	Williams

TABLE 5 *Continued*
Foreign students and the countries from which they have come, their advisors and date of degree.

Country	Name	Degree–Date	Advisor
Switzerland	Pelet, F. J.	Ph.D.–1959, M.S.–1956	Hildebrandt
	Staub, T.	Ph.D.–1971, M.S.–1969	Williams
Sweden	Armolik, N.	Ph.D.–1955	Dickson
Taiwan	Chi, C. C.	Ph.D.–1959	Hanson
	Lii, S. L.	M.S.–1959	Arny
	Tsao, P.	Ph.D.–1961	Hagedorn
	Chen, P.	Ph.D.–1962, M.S.–1957	Hildebrandt
	Ling, K. C.	Ph.D.–1964	Pound
	Mee, M. L.	M.S.–1964	Moore
	Yang, C. Y.	Ph.D.–1964, M.S.–1961	Mitchell
	Yang, S. M.	Ph.D.–1965	Hagedorn
	Huang, L. -H.	M.S.–1965	Hagedorn
	Hsu, G.	M.S.–1966	Mitchell
	Leu, L. -S.	Ph.D.–1967	Boone
	Wang, T. -C.	M.S.–1967	Hagedorn
Tanzania	Mmbaga, M.	Ph.D.–1980	Arny
Thailand	Chantarasrikul, A.	M.S.–1957	Dickson
	Syamananda, R.	Ph.D.–1958, M.S.–1955	Dickson
	Prichakas, P.	M.S.–1960	Dickson
	Wasuwat, S. L.	Ph.D.–1960	Walker
	Pupipat, U.	M.S.–1961	Arny
	Tantyaporn, S.	Ph.D.–1974	Boone
Trinidad	Phelps, R. W.	Ph.D.–1967	Sequeira
Venezuela	Torrealba, P. A.	Ph.D.–1967, M.S.–1963	Darling
	Morales-Bence, F.	M.S.–1973	Moore
	Tortolero, O.	M.S.–1977	Sequeira

CHAPTER 26

Student Life

Melissa Marosy

The preceding chapters of this volume have provided documentation and analyses of the history of the department from a wide variety of perspectives. The origins, growth, and evolution of the department, the development of specific programs and personnel, and the impact of the department on plant pathology as a profession have been addressed. Together these chapters present a detailed, if incomplete, picture of the changing structure and direction of the department, from its inception in 1910 to the present.

One perspective which has not yet adequately been presented is that of day-to-day life within this structure. Such a perspective might best be presented through the eyes of the students, who operate within the structure without a need to understand the "larger picture". The department, through the eyes of a graduate student, is the focal point of one's existence during the four or five years spent in pursuit of an advanced degree. The department is therefore perceived in this context, not a broad or historical one, and the anecdotes provided by former students, for the most part, reflect this. They represent the most unusual, amusing, or otherwise memorable events of a very brief period in one's life.

I have attempted to draw—from the information and anecdotes provided by different people, of different eras, with different major professors and interests—a synthesis of student life as it has existed throughout the history of the department, as no one individual could do given only his or her own experiences. At the same time I hope I have sketched a picture of departmental life which is both entertaining and informative for the reader who is not a Wisconsin alumnus, while including a collection of specific, but representative, events intended to spark the memories of the department's numerous former students.

I appreciate the thoughtful contributions made to this chapter by the following individuals (name followed by year of graduation and major professor): J. C. Walker (1918 Jones), H. L. Shands (1932 Dickson), C. J. Nusbaum (1934 Keitt), J. A. Pinckard (1934 Riker), L. F. Roth (1940 Riker), D. C. Arny (1943 Dickson), J. E. Kuntz (1945 Walker), J. D. Moore (1945 Keitt), C. C. Leben (1946 Keitt), J. S. Boyle (1949 Keitt, Moore), J. F. Schafer (1950 Dickson), W. H. Sill (1951 Walker), R. E. Webb (1952 Larson), C. H. Beckman (1953 Riker), Nash N. Winstead (1953 Walker), I. J. Thomason (1954 Dickson), J. R. Parmeter (1955 Kuntz), J. B. Sinclair (1955 Walker), E. Schieber (1959 Dickson), C. H. Walkinshaw (1960 Larson), O. J. Dickerson (1961 Thorne), H. E. Waterworth (1962 Fulton), P. H. Williams (1962 Pound), E. G. Ruppel (1962 Hagedorn), J. R. Steadman (1969 Sequeira), W. G. Theis (1969 Patton), J. C. Watterson (1971 Williams).

AN INTRODUCTION TO THE DEPARTMENT AND LABORATORY LIFE

A graduate student is not in the Department of Plant Pathology very long before having one foot, if not both, firmly placed in the furrow. Professor Walker in particular seems to have had a penchant for this. He made the point quite clear to Webster Sill:

> The day I arrived with my wife and baby boy I was *on crutches* (bad ankle sprain) and had just been stung twice on the tongue by yellow jackets at a picnic lunch en route. I had never seen J. C. Walker. My tongue was so large and sore that I could not really talk. After an attempt at communication, Doc put a sheet of paper in front of me and said, "Write your answers. I hope you write better than you talk." Then he sent me down to the greenhouse, good suit and all, to pollinate cabbages and told me to work there until he came down. I sneaked off briefly and told my wife to wait at a friend's house. Doc did not come down until about 8:00 P.M. He invited me to go with him to Rennebohms for a grilled Danish. We talked some since the swelling in my tongue had diminished a bit. As we were walking back by the greenhouse, biochemistry, horticulture, and plant pathology buildings the lights in most of the labs were still on. He said quietly, "Mr. Sill, do you see those lights?" I said, "Yes." He said, "They never go out." And I got the message.

Nash Winstead had a similar experience: "On my first day at Madison, I showed up in my Sunday best. On arriving I went to meet Dr. Walker. He looked at me and said, 'We need to plant cabbage.' I did get to change clothes, but that was how I spent my first day at Wisconsin." Russell H. Larson, a student under Walker, must have been impressed by Walker's perseverance, and he is remembered as being a prime advocate of "furrowed feet". Charles Walkinshaw, one of Larson's students, recounts: "My arrival at the famous graduate school at Madison was acknowledged by orders to plant cabbage for several days. J. C. Walker sat on one side of the planter and I on the other. This became one of the first tests on air damage of clubroot of cabbage seedling *roots,* since several of my rows were planted upside down!"

Professor Larson is apparently remembered for more than that first week, for Walkinshaw continues:

> We had the cleanest greenhouse in the world and the coolest. Russ liked it about 60–65°F for the potatoes . . . a problem for the rest of us. We had so many locked cabinets to keep up with that it was usually better to borrow an item from Bob Fulton than to find our own. For my first two years the highlight of every Saturday was to wash clay pots in the hall separating the old greenhouses.

Raymond Webb adds, "Dr. Russell Larson, my major professor, was a strict and *very* fair disciplinarian. He was the living image of the "work ethic" and expected his graduate students to practice and enjoy the same. Therefore, Saturday was just as much a work day as Monday."

Larson's students were not alone on those Saturdays, however. In Walker's time, students typically spent seven days a week in the lab. Students from that time to the present remember long hours and long work weeks. In the words of John Parmeter, students "were in class all day, worked all night, and made media, washed glassware, and swept up in [their] spare time." As recently as the late 1960s, students were expected to be in the lab in the evenings, "even if you had no work to do . . . in case anyone showed up . . . even if you were just drinking." And occasionally they did—and you were, as in the instance Lewis Roth recalls: "Keitt did not come to the office and lab often at night. Why did he select the night we rolled a pony of beer into the third floor lab of the old agronomy building? Though not a man of violence, might I say he did not exactly approve."

Peer pressure played a part in the long hours as well, as illustrated by this tale provided by Earl Ruppel:

> Ray Hampton probably regrets to this day the time he put up the poster in the third-floor graduate office (Moore Hall) proclaiming that "The National Guard never sleeps!" Some of us wanted to test that claim, and did so by calling Ray at home every fifteen minutes for about four hours . . . beginning at 10:00 P.M. By the last call, he was awake all right but he was so spittin' mad that he didn't speak to anyone for over a week."

J. Duain Moore insists that students these days do not spend nearly as much time in the lab as they used to. If that is the case, it is also likely that when students are in the building these days, they are working. It is a rare evening, regardless of the hour, when at least a few lights cannot be seen shining from the east wing of Russell Laboratories. The apparent decrease in the amount of socializing within the walls of Russell Labs may trace its origin to the segregation of the department among eight floors. The 1966 *Wisconsin Pathogen* reported that the new building "has centrifuged people into their own narrow paths: last year remnants of fellowship carried over from the old building, but most of these were gone by the end of the summer".

When the department was housed in the Horticulture Building, student comaraderie grew from the close proximity of the offices at the north end of the second floor and later across from the library on the third floor of Moore Hall—the "bull pens". New students had desks on the third floor lab, while older students moved into the second floor lab office. John Parmeter describes these as:

> . . . incredibly drab rooms filled with desks and cabinets arrayed in a variety of uninteresting and unhandy configurations designed to minimize privacy. Needless to say, the crowding led to real camaraderie, considerable horse play, innovative practical joking, and surprisingly few cross words. Each room tended to develop its own subculture, but both rooms generally had a cast of characters suitable for a Hollywood youth epic. A few studious researchers, a small contingent of nerds, a befuddled foreign student or two, some clowns and cut-ups, a couple of know-it-alls, a sarcastic commentator, and various walk-ons (I won't identify myself). This cast played out the usual triumphs and tragedies of graduate life.

Ivan Thomason elaborates on the second floor "pen":

> In addition to nineteen desks and coat cabinets the room housed the transfer room (a steambath), the six refrigerators transformed into constant temperature incubators and, worst of all, the telephone for all plant pathology grad students on the second floor. Dr. Riker, whose office was close by, was incensed more than once as a busy student shouted at the top of his lungs for a student wanted on the phone by his girlfriend or wife. The rooms on the second floor looked like they were last painted during the depression. On the other side of the "bull pen" was the media preparation room—a polite term for a potato cooking factory. PDA was made in this room by the barrels—seemingly eighteen hours a day, seven days a week. The steamer for melting agar vented out an open window—a window open summer or winter. Potato peelings or agar constantly plugged the sinks—and needless to say there was no technician in white uniform to do a damn thing about it!

While numerous incubators, incessant phone calls, and agar-clogged sinks are characteristic of labs in the new building, there remains only one true legacy of the "bull pens" in Russell Laboratories—B70, a basement office housing ten new graduate students. As soon as space becomes available, most students move to offices closer to their respective laboratories and major professors; most who have had the opportunity agree, however, that the initial chance to interact with students from other programs within the department has been quite beneficial.

A "subculture" of the bullpens which existed from 1958 to 1962 deserves mention. This was a temporary classroom known as "T-18", located on the site where Russell Labs now stands. Plant pathology was situated between the Dairy Herd Improvement Association's computer and dairy scientist Roy Nichols with his fistulated cow. This relatively luxurious lab housed forest pathologists, nematologists, and forage plant pathologists. Here students "worked, played and studied together, willingly sharing what could be termed meager resources." Most ex-occupants remember T-18 for its occasional summer flooding, but an explanation of the benches used by nematology is what Joe Dickerson relates:

> We built the benches, etc., for the nematology laboratory in T-18. I was helping and made the statement that the benches should be high enough so that those of us about six feet would not have to bend over so far. Professor Thorne, who was about five feet and five inches, informed me . . . that he had had to sit at too-tall benches all his life and these benches were not going to be too high. When finished, they fitted Professor Thorne perfectly.

As T-18 was dismantled to make way for the new building and its occupants relocated, the November 1962 *Wisconsin Pathogen* described "The Saga of T-18":

> Once upon a time there existed on the University of Wisconsin campus a building known as T-18. In this building was housed a sundry assortment of segments of the university. One of these notable segments was a group from the Department of Plant Pathology. These inhabitants were almost divorced from the remainder of their colleagues, and certainly from the campus proper. There were even people in the main building who had no idea what T-18 was, and those who had a vague knowledge of this edifice and its relationship to plant pathology regarded it as a type of Siberia. However, the outcasts of T-18 went about their everyday lives in spite of this social stigma . . .

Russell Labs, once finally occupied, "felt like a castle" after the previous facilities, recalls James Steadman, and it was wondered if the department would ever experience that kind of crowding again. Of course it did (within about four years), and the hallways are again crowded with refrigerators, filing cabinets, and assorted experimental apparatus, as Howard Waterworth remembered them in the early 1960s.

TO EXPERIENCE THE REQUIRED WISCONSIN CURRICULUM

At least the first four semesters of a student's stay in Madison are spent fulfilling course requirements, and classes play a key role in the memories of alumni. Departmental courses were very time-consuming from their inception, especially PP 101, in which each student was required to prepare a fifteen- to twenty-page report each week on the diseases studied. Students spent long hours in the departmental library preparing these reports, as do present students writing reports for PP 611 or doing assigned reading or homework problems for PP 601 and PP 602.

By 1915 a core of courses had been established within the department which all students were expected to take. In addition to these courses (see Chapter 17) students often took plant physiology, bacteriology, and courses in botany, genetics and biochemistry. Most students minored in botany—either mycology or plant physiology. This common curriculum produced plant pathologists with very similar formal training. With the wide range of options available today, plant pathologists, in Walker's words, "can now be quite different from one another," and the trend seems to be leading toward even fewer common required courses.

Once the crops courses were phased out, the summer field course, first PP 659 and then PP 559, was established to take their place. Students have fond memories of field trips taken first in university fleet cars, then in the old army surplus Ford bus ("Old Rattletrap") and finally in the larger "White Whale". John Waterson recalls the course in the mid 1950s when it was run by Earle Hanson and Jim Kuntz: "Two more enthusiastic plant pathologists you'll never meet. I recall the great energy and excitement which they gave to this course. It was the first time that plant pathology came alive."

The course in later years, with Arny at the helm, took on an additional dimension. This tale captures the essence of field trips in the White Whale:

> One of the more memorable elements of PP 559—Diseases of Field Crops was Dr. Arny's driving. The entire class would pile onto a big white university bus every Friday morning in the summer and

go out to visit field crops *in situ*. Dr. Arny drove the white bus, lecturing through a microphone as we hurtled over the Wisconsin roads. We heard not only about the diseases of the particular crop we were about to see, but also about the cultural and geological history of the country we passed through, the other crops we might see, and various unusual flora and fauna along the roadside. Dr. Arny had a particular fondness for the historical markers beside the highway and the white bus never failed to stop at them so that our education could be broadened. When he suspected that students were not paying sufficient attention to the markers, Dr. Arny would read the text aloud over the microphone, in a measured and clear voice. Meanwhile, those of us toward the back of the bus would become aware of the traffic gathering behind us, unable to pass on the narrow two-lane road. In addition to the historical markers, Dr. Arny would also stop for wildflowers. On one occasion, he was pulling the bus from a minor side road onto a heavily travelled state highway. A big tractor-trailer truck was bearing down fast on the bus and his passengers were already beginning to be nervous when Dr. Arny spotted an especially interesting plant on the shoulder. He took his foot off the accelerator, opened the door of the bus, and began to explain the life history of this lovely little wildflower over the microphone. We were unable to listen, transfixed with horror as the truck descended on us at sixty miles an hour, brakes squealing and horn blowing. Everyone was braced for the impact when the truck miraculously slid past the bus with only inches to spare. Everyone, that is, except Dr. Arny, who had remained blissfully oblivious. He closed the door and put away the microphone, noting our audible sighs with satisfaction. He could tell we had all really appreciated that wildflower.

Memories of classes in other departments also remain. Eugenio Schieber's recollection of a genetics class one very cold morning in the late 1950s exemplified the academic atmosphere of which the Department of Plant Pathology is a part on the University of Wisconsin campus. "It was a seven o'clock class . . . our professor [Lederberg] started to say, 'Then my wife and I crossed culture "A" and "B" ' . . . and so on until filling all the board. The entire class followed him in silence . . . a silence you experience only inside a big cathedral . . . with so much reverence. At the end of the hour the professor very humbly put the chalk down, turned toward us and said, 'No classes next week', and very humbly left the classroom. Immediately we stormed Rennebohm's Drugstore on University Avenue to get our late breakfast. There on the floor, stacks of newspapers had the headline: Professor LEDERBERG wins the Nobel Prize!"

Of course, there have always been those times when the subject at hand was somewhat less stimulating. According to Webb:

> Dr. J. C. Walker's course in vegetable crops pathology was scheduled at 1:00 P.M. This was "nodding" time following lunch while in a warm room. We had a gentleman's agreement that "nodders" would be given the elbow to assure attention to such an elite professor on such a profound subject. Much "elbowing" ensued throughout the course.

Perhaps this gentleman's agreement had not yet been formulated ten years earlier, when a classmate of Lewis Roth's was queried, "Mr. Carpenter, what is an obligate parasite?" Carpenter (awakening from his sleep at the sound of his name, but still groggy) replied, "It's egg-shaped." Even with the agreement at hand, classmates were occasionally betrayed. Carl Beckman recalls:

> One day when it was particularly hot and stuffy and dark and droning, I leaned back in my chair along the back wall and dozed off. I came to just as Walker said, "mumble, mumble, mumble—BECKMAN?" Unfortunately, the sudden scramble and scraping of my chair were answer enough for Doc.

ON THE LIGHTER SIDE

After a long day or week of classes and lab work, a bit of relaxation has always been in order, whether it be an informal trip to the local hangout or an organized departmental affair. The earliest of the latter seems to have revolved around Professor Jones' birthdays. One such occasion in 1918 began at 5:00 P.M. at the end of seminar, when one student, disguised as a newsboy, tramped up the stairs to the second floor seminar room proclaiming, "Hail, hail, *The Wisconsin Pathogen* for sale!" Papers were sold to certain students who then read choice editorials, want-ads, and society column entries, all bristling with departmental gossip—"truths more or less adorned". The sports page featured a recent seminary argumentative debate between E. E. Clayton and James Johnson, written up as a prize fight. These stunts were followed by dinner, including individual birthday cakes, in the third floor lab.

Professors entertained students and other faculty in their homes much more frequently in the past than they do now. Particularly memorable were Dr. and Mrs. Walker's Sunday afternoon gatherings. Opera on the radio or records were normally the afternoon entertainment, during which all guests sat in strict motionless attention. Charlie Main found one such occasion particularly excruciating, after having spent the previous night celebrating a successful preliminary examination. His wife, Jane, not approving of his recent revelry, is said to have enjoyed watching him suffer in this manner! Such exercises in self-discipline were followed by wonderful catered dinners, which must have made even an afternoon of opera bearable.

Members of the Department of Plant Pathology were leading participants in the university-wide Graduate Club. Once per month the club rented the Great Hall of the Memorial Union, hired an orchestra for formal dancing and had a catered dinner. The department itself sponsored two social events annually. One, the fall social, was most often held in the Great Hall of the Memorial Union on a Saturday night. This was a formal affair, including a receiving line of senior faculty and their wives and dancing to a hired orchestra. Sometimes there were costume parties, and usually there was a theme attached. In the late 1950s, faculty members presented "travelogues", followed by brownies, ice cream and tea. These gatherings became less formal as time went on. Each floor of Russell Laboratories sponsored a game booth; square dancing and informal singing were added. In 1960 the traditional Wisconsin Union Great Hall concept of parties was, "by unanimous student choice and faculty concurrence," officially abandoned. The event was continued in some form for a number of years; in 1968 it was moved to the spring, when the department initiated a new "two-party system" including a fall picnic.

The department-sponsored picnic had its origins as early as 1920, when a big party on Picnic Point kicked off departmental social activities. Spring picnics became a cherished departmental tradition, put on by the secretaries, and attended by all faculty and students and their families. The 1966–67 *Wisconsin Pathogen* reported that "people who usually ride eight floors together without saying so much as hello, spoke or even smiled and laughed."

Annual picnics remain a stable part of departmental life, with a few organizational changes. The secretary-sponsored picnic now occurs in the fall. The spring picnic is sponsored by the Plant Pathology Colloquium Council (PPCC), a student organization, as is an annual Christmas party which holds the closest resemblance to the traditional fall party of years past.

The PPCC's role in organizing such social events evolved in response to the segregation which took place when the move to Russell Labs was made; social events necessarily became more structured and formalized. The PPCC had been formed in the fall of 1960 to (1) form a closer liaison between students and faculty; (2) provide information of developments within the department; (3) provide general information about plant pathology as a profession; and (4) establish a forum for the free interchange of ideas.

Figure 26.1 Picnics are always popular. A "pig roast" at Strandbergs.
L-R Suttons, Strandbergs and Hardings

The major undertaking of the PPCC in its early years was the presentation of weekly evening seminars which all faculty and students were expected to attend. Other activities included summer field trips to observe plant diseases, a color slide series of plant diseases, and publishing of *The Wisconsin Pathogen.* When the big move occurred, the PPCC was determined to meet its stated goals despite the physical stratification there. To this end, the group sponsored a "commons room" featuring coffee and tea, volleyball at noon during the week, and informal sessions at which departmental research was discussed, in addition to the spring picnic and Christmas party. Most of these activities, to a greater or lesser degree, are ongoing today.

Still, with the increasing number of graduate students in the department, small groups were bound to form, and individual socializing tended to overshadow any attempts by the PPCC to structure department-wide events. Because of this, also, social life began to vary quite dramatically. A "common student experience" at Wisconsin became more and more a thing of the past. At one extreme were those who socialized "in what might be termed entertainment of the tired and poor," including haircutting, television watching, and card playing. At one time there existed an informal haircutting club. There were often enough students involved to form a circle, with each cutting the other's hair. In the words of Dickerson, "Some of the barbering was good and other was so-so. When compared to other cuts observed in the classes, they were classics."

At the other extreme were those who "tried to do everything in excess." A favorite haunt for many years was the Hasty Tasty, where parties originating as prelim celebrations "ended up as celebrations for *anything* such as a successful centrifugation run," as Walkinshaw remembers. Ruppel recalls "after-the-game (any game!) parties, birthday parties, ground hogs day parties . . . in the late 1950s and early 1960s." This tradition did not cease once the Hasty Tasty was renamed the Amber Grid and was moved to another location on University Avenue. Originally "legions of frustrated grad students" met there only for special occasions, such as prelims, seminars, "New Year's Eve, Chinese New Year's, Jewish New Year's, etc.," then they met every Tuesday and Friday, then Wednesday and Saturday as well, and eventually Tuesday, Wednesday, Thursday,

Figure 26.2 "Some of the barbering was good and the rest was so-so."

Friday and Saturday, according to Steadman. Such parties, especially if on a Friday or Saturday, would often move to one of the "student houses" and continue until breakfast, frequently to the dismay of roommates or wives! Paisan's was another place for gatherings at that time; more recently, the Copper Grid on Monroe Street has replaced its cousin, the Amber Grid, as the favored watering hole.

Partying has diminished in the last decade perhaps due to the greater percentage of married students within the department. In the early years of the department, the majority of the students were single (and male). This was still the case when Curt Leben arrived in the early 1940s:

> When I arrived in Madison, most of the plant pathology graduate students were male, and all except one or two were unmarried. For some of us who did not study all of the time and who were interested, this left the practical matter of finding a date as often as possible. We soon learned that undergraduate girls had one big limitation—they had to be in the house by 10:00 P.M. most nights. On the other hand, girl graduate students could stay out all night legally (I never knew any that would). The closest grad women were in Ag Hall, the bacteriologists, one of whom I eventually married. These were the prettiest. The home economists, who were also close by and who may have been a little plainer, usually were good cooks and companions. If one liked you, you might receive an invitation to the practice house, where they practiced on you by serving good food, accompanied by the proper napery and manners. In connection with courting activities in the department, there happened to be an emergency glass-fronted case in Moore Hall on the second floor. In this case, there was a fire blanket that would disappear and then appear again. It was said by some plant pathology graduate students that this blanket had started more fires than it had ever put out.

Figure 26.3 After the 'Hasty-Tasty' the parties continued at 'Lebanon House'.
L-R A. Harding, L. Black, G. Nair, D. Kumer, H. Mee, H. Harding, M. Mence, J. Strandberg, B. Webber, J. Klink, A. Saad, E. Thomas, A. Webber, E. Sequeira

However, by the late 1940s, Jack Schafer was "surprised to find that most of my classmates were married. Bill Bruehl, Don Hamilton, and I were among the "lonely" ones. I soon solved that problem as have many other plant pathology graduate students. Numerous times in contact at APS meetings several of us have discovered that our spouses were all from Wisconsin." In the early 1950s, the department "was bulging with the post-WWII graduate crop." Most of the students in the department "had been delayed by the war, were older than normal, a bit cynical and often married with children", and "anxious to get on with their education and life." This distinctly changed the social atmosphere within the department. About half of the graduate students and specialists currently (1985) in the department are married (frequently to each other), with commitments and interests not shared with the single students, leading to less interaction within the student body as a whole.

MORE ACTIVE FORMS OF RECREATION

The close of that first fall semester brings, invariably, a Wisconsin winter, one of the state's more memorable seasons (with tornado season running a close second). Parmeter recalls "the romance and humor of lake flies, black flies, humidity, blizzards, and similar features that lend Madison its charm." He continues, "Those of us who moved to California can remember fondly the wild thunderstorms, the squeak of snow at thirty below zero, and other stimulating environmental factors that contrast so vividly with the incessant sunshine and warmth of our present homes." Some took to the bitter weather, whereas others had difficulty adapting. Roth recalls one student of the latter class:

> Mike Langford (from South Carolina, entering the lab on a cold morning swathed in coat, scarf, ear muffs, etc.) (heavy southern accent): "If it gits any colder than this I'm gonna take ma bed and go right down there in that greenhouse."

> Keitt (years later trying to persuade Langford not to take a job in Central America): "It's very hot and enervating there." Langford: "If it's a toss-up between Wisconsin and Central America, give me Central America."

Others, however, were eager to experience what the clime had to offer, often to the amusement of their more "weathered" colleagues. Ice-skating was a great challenge. Southerners and foreigners alike could not get over there being "a whole lake of the damn stuff." Schieber relates what may be an all-too-familiar tale:

> Snow flakes were coming down . . . and as expected the foreign students were the first to go out to the open and enjoy the experiencc of touching the snow . . . of washing the face . . . of throwing snowballs at each other . . . like we saw it in the movie "Love Story" showing there in Madison. Of course foreign students were the first ones to go on frozen Lake Mendota and try skating. There was a beautiful Caribbean girl from tropical Puerto Rico. She went to the student coop and bought her finest outfit of skating shoes, then took off to Lake Mendota. Five minutes later the Puerto Rican girl was lying on the ice in pain with a broken ankle.

Most fared better, presumably, making use of the supply of ice skates in the departmental "sports library" along with other cast-off, extra, or forgotten sports items. Hockey was an important activity in the late 1950s, when the tennis court on the site where Steenbock Library now stands was flooded. Leben recalls a "glorious and jolting time" with an old ice skate sail which Deane Arny had inherited from Gene Herrling. While others spent their winter lunch hours simply skating on Lake Mendota, Arny and Leben would skate-sail to Governor's Island and back, often on marginally safe ice. Skating parties are still a common occurrence in the department, giving new crops of foreign students a chance to try their hand at the sport.

Webb preferred Madison's popular winter sport of ice fishing on Lake Mendota, while Roth preferred tobaggoning (at least until this incident):

> Then there was the night on the hill at the Blackhawk Country Club with the toboggan. One run. The rush of the wind, the crackling din as the overloaded toboggan broke through the ice-crusted snow, lacerating our hands; then the bunker and silence as we took to the air. I am not sure the toboggan, when extracted from the heap, was worth taking home.

Once the winter finally passed, outdoor endeavors turned from ice and its challenges to water and the numerous forms of recreation it offers. Canoe trips were common by the 1940s, and became annual events by the 1970s. Students often owned sail boats or row boats collectively. Ruppel related the following event:

> Though usually engrossed in my quest for a Ph.D., I did manage to get in some fishing. Three of us living at Eagle Heights even bought a row boat that we tied up on the south end of Lake Mendota's Picnic Point. Being poor graduate students, we had to scrounge what paint we could find for our boat, and we had to use several colors. Well, one day our boat was missing, so I called the University Police. When they asked for a description, I told them that the outside of the boat was gray, the gunwales were white, the inside was green, the oars were red, and the seats were yellow. After a lengthy pause, the police dispatcher asked incredulously, "And your boat is *missing?*"
>
> Just about dark, the diligent police called and said they found our boat abandoned on the east shore about half way out on Picnic Point. Big George, an engineering grad who was a co-owner of the boat—all 6′6″ of him—and I grabbed flashlights and headed out on the Point. Now, we all know what went on at Picnic Point, especially after dark. Thrashing through the brush and trees, we suddenly stumbled over two warm entities. Our flashlights revealed two consenting, almost-adult persons of opposite gender, obviously rehearsing their parts for an Adam and Eve production. Stuttering and stammering, we excused ourselves and uttered something about looking for our stolen boat. That's when the pretty young blond gal stared into our flashlight beam and said, "Honestly, fellas, we don't have it."

Plant pathology students have participated in numerous other sports throughout the years. Early mycological forays with Professor L.R. Jones, often at Blue Mounds State Park, later gave way to more structured intramural and interdepartmental activities, such as volleyball, basketball, badminton, baseball, volleyball, soccer, tennis, and even water-polo. In 1965, a ping-pong table was placed in B38 of Russell Labs for the use of "faculty, students, etc." when inclement weather prevented outdoor recreation. Bicycling remains a common form of transportation and exercise, but with the health craze of the past decade or so, jogging has become the one most popular sport both department- and campus-wide, as evidenced by the motley assortment of human forms which can be seen coursing the Lake Shore path between noon and one o'clock, five days per week, come rain or shine.

FIELD WORK HAS ITS ADVANTAGES (AND RUSSELL LABS ITS DISADVANTAGES)

The close of the spring semester brings, invariably, field season. This usually means a lot of hard work, but good times as well. Walter Theis recalls a season of the "hard work" variety at the Griffith State Nursery at Wisconsin Rapids with the forestry group:

> I remember that summer very well because we poured and counted and washed about 10,000 petri plates. We did the counts . . . scooped the agar out . . . washed them by hand . . . and then set them out on the hood of one of the cars so that the sun could dry them. Then sterilized them, poured the plates that evening and were ready for the next round. On kind of a continuous basis we did an awful, awful lot of plates.

Ruppel can attest to the good times had upon occasion:

> Don Hagedorn and his boys made several field excursions to plant peas, and once we were scheduled to head north into some prime trout fishing areas. The eve before departure, Don called me on the phone and said that he needed help, so I trucked on over to his house where he surreptitiously led me to the basement. He said we had to build a box, which I thought was needed to haul pea seed. But it sure was a damn big box! Finally, Don confided that the box was for fishing rods and hip boots. We were going to take a university fleet vehicle, and he thought that citizens en route might get the wrong idea about using a state car for extracurricular activities, which, of course, we would *never* do. I wonder if Don still has that box?

Students fortunate enough to spend their summers in the orchards of Door County experienced firsthand one of the fringe benefits associated with work in a plant-related field—plants (and their fruit, and other edible parts). The students at Sturgeon Bay were a resourceful bunch. Joe Nusbaum relates:

> I recall a particular event where we capitalized upon a fortuitous circumstance. During cherry harvest we conducted an experiment to determine the effect of certain sprays upon fruit size and weight. After we had finished weighing the samples we had a washtub full of pitted cherries. Not wanting to throw them away we decided to make some jam. We bought fifty pounds of sugar and two cases of Certo. Then we spent all day Sunday making batch after batch of jam. Before long we ran out of glasses and jars so we put it up in milk bottles. Of course, we gave a lot of it away and still had enough left to last all winter. The stuff was delicious.

Apparently cherry wine was also a by-product of Sturgeon Bay experiments, and one student, resourceful in another way, would sell glasses to his fellow students back in Madison for twenty-five cents (along with "a haircut and a philosophical discourse—and an occasional critique of your research").

Autoclave cooking has always been a challenge. According to Thies, "Tom McGrath was . . . the world's best cook in an autoclave. He used to autoclave chickens for dinner, and buttered squash. And he could literally fix his whole meal in an autoclave at the drop of the hat." Others didn't meet the challenge as well. A coeditor of this volume attempted to make juice from a batch of cranberries brought back by Lester Carlson, one of Boone's students, in the autoclave in T–18. Upon letting the pressure down and opening the door, he was met with a "wall of pectinated steam" which poured out onto the floor, blowing cranberries all over the lab.

Jam, corn, and hundreds of baked potatoes, the latter to satisfy hungry plant pathologists at numerous department picnics, have been prepared in autoclaves over the years, but the prize for the most unique use of an autoclave has to go to Deane Arny. While living in an apartment above Brown's Bookstore, Professor Arny found bed bugs in his mattress, and reasoned that a period of time at 121°C would do the trick. The large autoclave in the headhouse of the greenhouse, more traditionally used for soil and pots, was large enough to hold the mattress. The eradication effort, unfortunately, was unsuccessful (a roommate later solved the problem with DDT).

Handouts were free and plentiful, but often the end product was not worth the time and effort put into preparation. Sometimes it was not the cooking which was the problem, as Ruppel can attest to:

> There was the time when Glenn Pound said we could harvest the spinach from his field experiments. Greed and avarice prevailed over us hungry grads, and I took a sizeable box home to Eagle Heights. The volume of spinach precluded cleaning in our tiny kitchenette sink, so I scoured the bathtub and dumped in the greenery. All went well until I tried to change the dirty water and quite a bit of spinach was sucked down plugging the drain. The apartment manager was a little incredulous when I told him my tub drain was plugged with spinach. Fortunately, boiling hot water solved the problem, and the manager left shaking his head and mumbling something about taking early retirement.

And speaking of greens, Williams volunteered the cranberry tale, but neglected to mention this one recounted by Theis:

> I remember one of the 559 field trips where we went up to look at the lettuce fields in the peat bogs. One of the instructors, I think it was Paul Williams, was telling us about the diseases and things, and then he said, "One of the best things about coming up here . . . ," and he reached over and grabbed a head of lettuce, ripped off the outside leaves, reached under his jacket and pulled out a bottle of salad dressing, dumped it on the head of lettuce and proceeded to munch away. Nothing like fresh vegetables.

Williams has also been known to walk into the commons room, approach an unsuspecting student, and offer three or four varieties of flavored sauerkraut for an impromptu taste test. The next time this happens, students might insist that he follow the precedent set by Hagedorn, as revealed by Ruppel:

> We often met for Saturday morning taste panels to evaluate some of Don's new pea varieties. Have you ever eaten cold peas right out of the can? Yuk! But Don always treated us to a UW Dairy Store ice cream after the ordeal.

There is, however, one predictable disadvantage to life in a department where foodstuff abounds right around the corner from the Department of Entomology. Anyone who has walked into the commons room late at night and flipped on the light switch while glancing at the sink will recognize this reference. With due respect, the situation cannot be blamed entirely on entomology. Even in Moore Hall there were cockroaches—the three-inch-long American variety that we run into now in the basement of the Babcock Street greenhouses. The research variety are a mere one-inch long at most, quite domesticated, and entirely harmless, as any entomologist will tell you. Many occupants of Russell Labs would not find this fact comforting, however. A technician of Professor Kelman's was aghast when, while sitting at the microscope, she noticed a large roach on top of the scope staring out at her. The scream she let out was described as "blood-curdling"!

The predictable way for a group of scientists to deal with such a problem is to conduct a scientific investigation and publish findings. The reader is referred to: Reob, E. 1975. Relationship between *Homo sapiens* and *Periplaneta americana* in Russell Laboratories. The Pathogen. pp. 18–19. One of the most significant discoveries was "the mutual fear (or abhorrence) the two species have for each other." The relationship between the two species was concluded to be one of commensalism, and has probably changed little since the study was published.

THE PERPETUAL HOUSING CRUNCH

Summer in Wisconsin always comes to an end much too soon, and a student who has spent the entire season at a field station is faced with a last-minute search for housing. "Housing was generally a good idea, especially in winter," as Parmeter points out. By late summer, then as now, most of the prime housing was gone. "As a rule, we found that basement apartments were too cold, attic apartments were too hot and anything else was too non-existent." Having the proper connections helped. Deane Arny recalls that six to eight students lived with Gene Herrling's mother, who offered room and board for twenty-five dollars per month. Breakfast, supper, and a sack lunch were provided.

Graduate students from the department frequently shared houses or apartments, as far back as 1915, and often passed on the housing from one group of students to the next. Memorable houses included one on the corner of Mills and Johnson Streets, one at 1210 Dayton Street, "Lebanon House", proprietor Adib Saad and friends, and the "Kendall Coffee Shop", hosts John Mildenhall, Theo Staub, and friends, often the sites of those extended prelim parties referred to earlier in the chapter.

The graduate student stipend has grown from $500.00 per year in 1924–25 to $9,836 in 1985–86. Over the years students have continuously complained about lack of funds, but always seem to get by one way or another. Moonlighting was common during the depression, when "real hardship was rare but austerity prevailed." Students became enterprising in their housing arrangements. One student in the early 1950s supplemented his salary by rooming with someone with a skill for making ends meet (who later was to oversee the finances of APS). He "could always rely on him for a handout at the end of the month."

In the late 1940s, John Boyle remembers, "housing was extremely tight with the return of the veterans, and many were forced to commute by bus to campus from Badger village." This was an inexpensive married veteran student housing area at the Baraboo powder plant, some twenty miles north of Madison. Parmeter's recollections of discussions about the facility "lead [him] to believe that it was in Minnesota!" Most students who lived there remember not so much the accommodations themselves as the ride to and from campus. Sill describes it this way:

> Old school buses went back and forth with graduate students. This was fine in summer but wicked in winter because most of the buses had poor heaters or none. Most of us wore old military clothes most of the time. A lot had heavy winter World War II flying clothes and it was a strange sight to watch those buses disgorge a motley crew of assorted old uniforms with everyone bundled to the eyebrows and half frozen.

University married student housing has since been established at Eagle Heights, on the northwest end of campus. Rent is quite cheap, and the distinctly international flavor of the community provides a unique atmosphere for graduate students and their families.

TRIALS AND TRIBULATIONS

An unavoidable part of any graduate student's tenure is exams—and many of them. Two types of exams in particular seem to stick out in students' memories—the foreign language exam and the departmental preliminary exam. Students entering the program after 1974 have been denied the invigorating experience of a language (most often German) exam, as it was dropped as a degree requirement. One of Schafer's sharpest memories is "being pushed out the door [by his wife] to take the German exam, and actually passing." Following are a few examples of what current students are missing, the first recollected by Hazel Shands:

> In August of 1929, three of us took a fungal taxonomy book to use for the oral German [reading comprehension] exam. The book was repetitious and those portions were not difficult. There was a section with long sentences and difficult grammar with a few verbs stacked at the end. I said to Smith, "We better put study time right here." He said, "No, they'll never find it," but the examiner did. Mid afternoon I tried to retrieve the book, but found Smith very flushed in the face and seemingly in big trouble. I was luckier.

A few years later, Pinckard recalls, there was a student who had been unable to pass his German reading test:

> Several of us were taking the exam but it was Albert's (not his real name) last chance. We were each given a card with a room number. There were two adjacent lines of students half in front of each of two doors taking our turn as the doors opened. We soon learned that behind one door was a tough examiner and Albert was next, in front of that door. But the door on our side opened first; someone snatched Albert out of his line and thrust him through our door, holding it shut. Albert's face was florid and I worried if he could recover enough to remember the little German he had to know. He did!

The preliminary exam has apparently always been a traumatic experience in the life of a plant pathology graduate student. Probably the most difficult of the departmental exams to pass, it continues to require enormous amounts of studying. But once you had passed the prelim, you were "well on your way," in the words of J. C. Walker. Schieber remembers all of those "sleepless nights . . . nervous systems cracking down . . . tears." One exam he will never forget is that of a Latin American woman:

> She came out of the room where the professors were going to start her prelim exam, screaming, with tears in her big black eyes. We surrounded Carmen in the hallway, some of us giving advice and some not knowing what to do. She then told us how one of the professors had told her to go out and cry until the last drop was gone before entering the room again. There was Gert Orlob, also finishing up at the time, who with his dry humor told Carmen, "Listen, Carmen, just imagine all those professors sitting there wearing pajamas!"

Some professors do in fact go out of their way to put students at ease during their exams. Take for instance Ruppel's exam:

> The big day finally came for my prelims. I was pretty nervous, but I felt I at least had one push-over on my committee—Earle Hansen had especially asked to be on my committee, and I had been his grad assistant in his field crops course. I was cruising along in high gear when Earle's turn came for questions. He asked me every conceivable question about the commercial use of wheat—like, what type of wheat is used in pasta? Bread? Noodles? I was stumped, and really thought I'd blown

it. Later, when called back into Don Hagedorn's office for congratulations, Earle quietly remarked that "for a guy from Kansas, you sure didn't know much about wheat." I said, "Kansas! Hell, I'm from Milwaukee." He had me confused with Gayle Worf and, in his attempt to go easy on me, almost sealed my doom.

Webb had a similar experience during his final exam:

Dr. James Johnson, professor of horticulture, placed my thesis dissertation on an informal basis (could have been on purpose) early in my presentation to the committee. He let the unbound thesis slide off his lap and scater *all* over the meeting room floor. We all, including Professor Emma Fisk, participated in retrieving and reassembling the thesis for Professor Johnson.

There is a noticeable absence of commentary from former students about the actual preparation of the theses which were defended on such occasions. Perhaps the thesis preparation represents a time in their graduate career which most former students would prefer to forget. Part of the story may be told by the following "unsolicited, uncalled for, spontaneous and unrehearsed cry of anguish" of "a pore psychotic grad student" (TMcG) from the February 1967 issue of *The Wisconsin Pathogen*:

I'm smothered in papers, I'm buried in books,
I feel like I'm going to pieces.
After all of my labors, I tell you it looks
Like I'll never get done with this thesis.

I work night and day, my hair's turning gray,
My eyes are both bloodshot and red.
I think til I'm tight and can't sleep at night,
I'm going right out of my head!

The title's ambiguous, the tables are fuzzy,
The photos are all out of focus,
The conclusions don't jibe with the data—that's funny—
My major prof think it's all "bogus".

My procedures were perfect for inoculations,
My attack on the trees were most stealthy,
But now after four years of close observations
Those doggoned old pines are still healthy.

But in spite of these problems, my conclusion's so bright
(Thanks to a brain that's elastic),
That I'm sure when my thesis is published all right
It'll be the next Phytopath Classic.

My plan is so brilliant the news just can't wait,
I'll tell it to you now, verbatim:
It's easy to save all the pines in the state,
You just have to INOCULATE 'EM!

AN EVER-CHANGING DEPARTMENT BUT A COMMON BOND

The Madison known to Wisconsin graduate students has indeed changed over the years. Since 1929, when Shands arrived in the department, Madison has increased four-fold in size and population. Political party affiliations have changed—an almost about-face. On campus, the physical changes have been no less dramatic. Shands points out that "Babcock Hall was put in the horticulture garden and flower space—over the protests of J. G. Moore. The softball field east of agronomy is now covered with the molecular biology lab and three additions of the biochemistry building. Many new buildings have gone up, including Russell Laboratories, a new veterinary science building, and a $120,000,000 hospital adjacent to the Veteran's Administration Hospital. The stadium of 37,000 capacity has been increased to 78,000. . . . Hill farms have been sliced up for residential housing, with Charmany Farm being developed for 'hi tech' use. Arlington farms are developed and Charmany tenants are moving about three miles west."

No one can dispute the fact that changes have occurred in the department in facilities, personnel, program emphasis, curriculum, and impact. But can a similar conclusion be drawn of student experiences? Individual experiences differ, but has the overall "student experience" at Wisconsin changed over the years? The similarities among recollections of students from very different time periods—very different historical contexts—seem to answer, "No!" Long days working, and occasionally playing, in the fields of Wisconsin; long nights in the library studying for exams; enjoying Madison's lakes in the summer and withstanding its winters at thirty below, all the while pursuing that often elusive degree—these are timeless activities which could have been recounted by students from any of the decades covered in this volume of history. Wisconsin plant pathology students, by virtue of their common experiences within a department which is steeped in continuity and tradition, have been placing their feet firmly in the *same* furrow year after year, and will continue to do so.

CHAPTER 27

The Impact of the Wisconsin Experience on the Professional Lives of the Alumni

John P. Helgeson and Jennifer L. Parke

In March of 1985, we wrote to some alumni representing a cross section of subject areas (not scientifically selected), career activities and eras. We asked these alumni to comment on one or more of the following questions:

a. Why did you choose to come to UW–Madison?
b. What do you remember best about your days in Madison?
c. What faculty members had an impact on your career development?
d. What impact has the UW department had on plant pathology?
e. What did you always want to say to your major professor but didn't?
f. What was most valuable to you about your experience here?
g. What is your personal view of where the department should go?

The response was overwhelming. Of those we asked, almost everyone contributed and we were soon faced with editing out over half of the material before the editors of this book would even consider printing the chapter!

Many of the responses were fond (or not so fond) memories of student days in Madison and anecdotes about professors of past years. Also, a common thread was how external events—World War I, the depression, World War II, etc.—dramatically affected the lives of students and graduates.

We have arranged the responses in chronological order starting with Harold Browning who first came to the Department in 1914. We hope that these pieces will remind you or inform you of what it was like to be at the University, in Madison and in the Department of Plant Pathology during the seventy-five years that have elapsed since our founding.

Harold W. Browning 1920

I went to the University of Wisconsin for the specific purpose of preparing myself for the chairmanship of the Department of Botany at Rhode Island State College, from which I had graduated in 1914. My original schedule called for my doctorate to be received in June, 1918, but World War I came along and military service in the US Navy (1917–19) delayed my degree until 1920.

My major professor at Wisconsin was J. B. Overton, professor of plant physiology. In arranging for my doctorate, a first minor was planned in chemistry and a second minor in plant pathology. My requirements in plant pathology were met with Professor L. R. Jones in the College of Agriculture. While the Departments of Botany and Chemistry were large, relatively old and well-balanced in specialization, I found the Department of Plant Pathology to be but five years old when I first knew it. Professor L. R. Jones, whom I had known of as a former chairman of the Department of Botany of the University of Vermont, had returned to his native state of Wisconsin in 1909 to organize one of the first departments of plant pathology in the nation. George W. Keitt was a graduate of Clemson College in Georgia and had been one of L. R. Jones' first graduate students. Keitt had taken his doctorate in 1914 and been appointed Assistant Professor of Plant Pathology; he was destined to become Jones' successor years later. J. C. Walker had completed his undergraduate work that year and had been designated a graduate assistant. After finishing his doctorate in plant pathology, he was to become a life-long member of the department. Fred Ruel Jones of Maine had just taken his master's degree and was continuing as a doctoral candidate. Max Gardner and Charles Frey, both of Michigan State, had enrolled as doctoral candidates. Haymaker of Kansas was there for his master's degree and was to return for his doctorate later. Wendell Tisdale from Alabama Polytech, the older of two brothers to eventually enroll, had arrived in the department.

One had the feeling in 1914 that there was a burst of growth in the Department of Plant Pathology. Every candidate was working on some disease of an orchard, field or garden crop. For example, the department was supervising the treatment of cucumber seed which Heinz was issuing to contract growers. I remember the work on apple scab that Frey was doing, determining when spores were discharged and filtering air to determine the maximum number of spores in the air. Today some of our modern hospitals, using similar techniques, are issuing "pollen counts" for the benefit of allergic patients.

Graduate students in plant pathology frequently took courses in the Department of Botany, but only occasionally did those in botany take courses in plant pathology. In today's parlance, the Department of Botany suffered a severe trade deficit.

One of the courses in the Department of Botany of especial appeal to graduate students in plant pathology was that given by Dr. J. J. Davis, M.D. That's right—M.D.—a country doctor who became more interested in plants than patients. He was the curator of the herbarium in the Biology Building. His course was a weekly field trip in spring and fall with identification of various plant diseases during the winter. He gave no formal lectures and no final exams. I am not sure if the course earned academic credit. However, it was a rich experience and one not to miss. During the winter laboratory sessions, Dr. Davis would soak up a half-dozen leaves on a bread board and our problem was to identify the diseases evident on them. In most cases, it involved sectioning the leaves and microscopic examination. Dr. Davis had his own exclusive method of sectioning. He would take a smooth piece of white pine, place the portion of leaf to be sectioned on it, hold the leaf in place with a glass slide and then by drawing one of his former surgical scalpels along the edge of the glass slide he would come up with a section thinner than most students could produce with the more conventional pith and straight edged razor.

I remember two courses that I took in fulfillment of my second minor in plant pathology, a course in the diseases of orchard crops offered by Keitt, and a course involving bacterial diseases of plants. In the latter course, we were given a healthy plant and a culture of the bacterial pathogen. Our problem was to inoculate the plant, watch for the development of symptoms and follow progress of the disease. We were required to keep a notebook. I took especial care in preparing mine, hoping to use it later as a teaching aid. Alas, the Department of Plant Pathology kept it as a model for future classes to follow.

In January, 1920, I had a conference with L. R. Jones to see if I had met all the requirements for my minor in plant pathology. At that time, he discovered that I had never had a course in general bacteriology. I reminded him of my success with his course in bacterial diseases. He replied that no one gets a minor in plant pathology without having had a course in general bacteriology. There was finality in his statement. The last course I ever registered for at the University of Wisconsin was Bacteriology I.

L. R. Jones was a very unusual professor. When he looked at you with squinting and piercing eyes, his sight went far below the surface. He saw not only what you were but what you were capable of becoming. Having no children of his own, his students became the objects of his love and affection. He had high hopes for each and every one of them. His departmental newsletter, *The Wisconsin Pathogen,* was a method of keeping 'in touch'. In my particular case, he asked a question that was to haunt me for many, many years. The question: "What does Browning want to go back to Rhode Island for?" He did not ask the question of me, but he made certain that the question got back to me. I got its implications. I had already become an instructor at Wisconsin. I had reason to hope for more than Rhode Island could offer. I had great respect for L. R. Jones' judgement. I realized that I was probably making a professional sacrifice by returning to Rhode Island. But there were other factors that entered into my decision. I am an only child. I have no brothers and sisters with whom to share my responsibility to parents. In 1920, my mother was chronically ill, and the prognosis was not encouraging. At Rhode Island State, I would be only ten miles away and could attend to their needs. Still L. R.'s question haunted me. It haunted me even more when in 1926 I had an opportunity, probably my last, to return to Wisconsin. But it can now be answered.

As I began my second year at Rhode Island State, I discovered in one of my classes, a graduate student, a very lovely girl of Welsh descent, whom I married in 1922 and who became the mother of my four children. I had found my second reason for returning to Rhode Island. We celebrated our sixty-second wedding anniversary last September. She passed away, quite unexpectedly, last January.

In the late 1930s, I discovered a bright young man named Arthur Kelman in one of my classes and invited him to become my undergraduate assistant. His duties were partly academic, but included the more mundane tasks of washing glassware and maintaining laboratory equipment—even to an annual oiling of laboratory floors.

When he graduated and desired to enter graduate school, I assisted him in his acceptance at North Carolina State. The war soon followed—he joined a military unit organized on campus, went overseas and distinguished himself under fire. Returning to Raleigh, he continued his graduate work and received his doctorate. North Carolina State had discovered in the meantime his excellent qualifications and retained him on its faculty. In the mid 1960s when Wisconsin appointed a search committee for a new departmental chairman, they discovered at North Carolina the young man that I had sent there nearly twenty-five years earlier. After serving with distinction at Wisconsin for nearly two decades, and when the prestigious professorship, the L. R. Jones Professorship of Plant Pathology, was established, Arthur Kelman was the first one to occupy that honorary chair. My answer as to why does Browning want to return to Rhode Island is now complete. The question no longer haunts me. My greatest wish would be that L. R. ask me the question today. I think that I could answer the question to his satisfaction, surely to mine. I salute Rhode Island's contribution to Wisconsin.

Frederick L. Wellman 1928

I graduated in 1920 with a B.A. from a college in Wichita, Kansas (later the university there). In college I had talked to the president, dean, and favorite professors in botany, economics, geology and English lit. All spoke highly of the University of Wisconsin. The geologist, an excellent teacher and a graduate of the School of Mines in Platteville, Wisconsin, told me of Professor L. R. Jones (also Welsh) and his Department of Plant Pathology ("best in the U.S."). Realizing I knew very little in biology, I wondered about attending Wisconsin. University courses? I liked botany (had it as a hobby, made sketches for four years and observations on rosette-forming plants for over-wintering in prairie land).

I borrowed $200 from an English teacher, and bought clothes and a railroad ticket to Madison. Through a Kansas girl who had married a young U.W. professor, I learned of possible temporary work on seeds of cabbage. I applied. In plant pathology, Professor L. R. Jones and Dr. J. C. Walker were concluding a long research effort on bringing supplies of superior *Fusarium*-resistant cabbage to the seed trade. Some were for sale, and some were used for breeding work. I counted and bagged for days on end. J. C. Walker was my boss, and he kept me more than busy.

Unsophisticated, I read voluminously, not only about cabbage but also science. I learned that in plant pathology much discovery was necessary, and above all that this was a fairly old science and its purpose was to help growers produce healthy crops and even guard against famine. I made preparations to ask Jones and Walker about graduate work. They helped me to matriculate. Bless 'em.

When I was assigned a desk (six drawers, one with a key) in the "Bull Pen" of twenty-nine students, I felt well started. There were two timid girls who came in only during daylight hours. Study and laboratory rules were strict and work was careful and techniques well studied. There was a good library and equipment, but we were encouraged to try almost anything and even invent things (I made my own colorimetric outfit to study $^{-}$H ion solutions). Besides the regular course work I paid special heed to the diseases and agroecology of cabbage and onions. Through good relations I helped twelve students in routines required for their Ph.D. theses. I learned a lot in this! They appreciated someone counting, washing roots, etc.

There were wonderful chances to hear lectures by world famous archeologists, sociologists, philosophers, poets, historians, writers of fiction, and composers of music, all around. I found it profitable to become acquainted with the dean of the Graduate School, heads of soils, sociology, genetics, geology, botany, chemistry, and economics. I inadvertently had short contacts with presidents of our university. I met a few people outside the university (for example, Aldo Leopold), but I didn't have much extra time.

The University of Wisconsin–Madison provided a broad cultural experience as well as a thorough and intense professional training. At first, I wanted to stay there. Perhaps I could have helped J. C. Walker, this top true scientist in my department. I liked him, and his family was wonderful to me. I talked it over with Professor L. R. Jones. Should I apply to stay? He shook his wise head. "No," he said, "Frederick, I believe I know of your ideals, vigor and ambitions. Don't sink yourself among the professors here. Get out and search for your own challenges. You need to expand in the next few years. Get out and learn more. You have a wide international background. You may be able to make use of it. Help the plant growers of the world."

In the next month I was offered a position in Alaska, but I could not imagine working where crops lived on permafrost! A few months later the United Fruit Company was taking me down in easy stages to work on bananas in the Central American tropics. I stayed a couple of years. Tough as it was, I have never been sorry. I tired of commercial men telling me what to do in science and came back to the USDA for a few years. But I was a marked man, and I returned to Central America for the U.S. Department of Agriculture.

J. A. Pinckard 1934

The department was housed on the second floor of the Horticulture Building. As I started up the stairway, an elderly man with arms full of books and papers was attempting to descend. The steep stairway was an architectural monstrosity of concrete bound in steel and a potential threat to all who encountered it. I took the elderly man's things from him, placing them in his car. Together we moved his belongings from a corner office. In so doing I discovered his name was L. R. Jones.

Professor Jones had built a department with a magificent reputation relating the host, the parasite and the environment. Dr. Keitt was a recognized authority on fungicides. Dr. Riker had become an authority on bacterial diseases of plants and had proposed an hypothesis asserting that pure bacterial cultures could be assumed only if the culture originated from a single cell. Dr. Walker, working on diseases of vegetables, developed a large following as a result of his studies on soil temperature and disease resistance. Dr. Dickson had a similar reputation from his work with barley and small grains. Dr. James Johnson, although of the Department of Horticulture downstairs, took part in our seminars and meetings as though he were one of us. He was an authority on tobacco mosaic and virus diseases of plants. Dr. Johnson could get into the most heated arguments with his critics at the national meetings. As I listened, there were times when I considered stepping between the two. In my opinion, Dr. Johnson could do no wrong. That was the general situation in the department about mid-depression.

For some strange reason University of Wisconsin students were, and still are, an independent lot. There was a young Italian woman, Jenny Justso, whose family were neighborhood bootleggers. The "feds" nailed Jenny and sent her to the slammer. Upon her release the students met Jenny with a brass band, escorting her to her home in "Little Italy". Could that have occurred anywhere but Madison? Several of us enjoyed celebrating special events and especially New Year's Eve at Jenny's basement hangout.

Our group was prone to hold parties, particularly when one of us left for his job and home. Our ranks thinned rapidly as degrees were earned and the men returned to their places of origin. There were no replacements because of the effect of the depression on budgets, and our numbers were reduced to five or six who had no outside sponsors. We, too, were receiving degrees, but with no money being appropriated by the government or the states and almost no industry activity there were no jobs available; we found ourselves in a limbo hard to describe without prejudice. It was not only our department that was affected—it was the entire country.

Dr. Keitt assigned me to another industrial fellowship supplied by a large apple orchard near Gays Mills in western Wisconsin. This project required being away from Madison making most course work impractical. The orchard's problem was scab and fire blight. Drs. Keitt and Riker loosely directed the project although I was on my own, paying my own expenses. I would leave Madison in early spring before bud break, returning for the winter after harvest. I lived in the orchard in a shack called "The Big House" with another graduate student, T. C. Allen, of entomology. Together we did the field research for both departments. We prepared a technical paper for *Phytopathology* relating to the insect transmission of an apple fruit rot, but were not permitted to submit the manuscript without a staff member's name as one of the authors. Under the circumstances, this university regulation destroyed our identities as being capable of independent research—the sole purpose of the Ph.D. degree.

Professors Jones and James Johnson had the greatest influence on my career: Professor Jones because of his sincere and sympathetic philosophy, James Johnson of horticulture for his very practical encouragement. He loaned me expensive equipment useful for my thesis and not otherwise available. Our department never seemed to have funds; if we students needed special equipment, we either made it or went without.

The simultaneous retirement of Professor Jones and the chilling effect of the Great Depression, which lasted from 1930 to 1936, for us at least, had a devastating effect upon the department and upon those concerned. It was the passage of the Bankhead-Jones Act of Congress in 1935 that provided funds for expansion of the agricultural research in those states with the largest rural populations. The effect of the act was to clear the department of all current students including S. S. Ivanoff, E. E. Honey and the remaining departmental "peons" including "Albert". What I wanted to say to my advisors, Drs. Keitt and Riker, but didn't, was . . . "Why did it take an Act of Congress, the Bankhead-Jones Act, to move the last few very capable Ph.D. graduates out of the department and into productive jobs?"

James H. Jensen 1935

In retrospect, it seems that circumstances conspired to set me in the direction of graduate work at the University of Wisconsin. I started to work in the Department of Plant Pathology at the University of Nebraska as a freshman inoculating black stem rust samples on differential hosts and washing dishes in the laboratory. On weekends I had the responsibility of keeping the Wisconsin soil temperature tanks in order. Thus, the department became more or less my campus home. There were two men in the department with degrees from the University of Wisconsin. They were well acquainted with the Wisconsin staff and referred to all of them on a first name basis (except for Dr. L. R. Jones who was always referred to as Professor Jones).

During my junior year in college, alfalfa wilt was discovered to be present in the Platte Valley of Nebraska and I was brought into the survey and research of this disease. Dr. Fred Jones, a USDA pathologist stationed at Madison, was a frequent visitor to the Platte Valley area where I was stationed during the summer months. The newly discovered disease was such a matter of concern to the Wisconsin department that Professor Jones and a recent doctorate, Bill Zaumeyer, arranged to have me meet them in Kearney, Nebraska, as they were passing through on the Union Pacific Railroad. I spent a day driving them around to see alfalfa wilt firsthand.

Harold Foster, Karl Koch, and I were all graduate students and candidates for master's degrees at the same time at Nebraska. The three of us often visited about what we would do later and where we would go if we were to go on for further graduate work. We finally decided to take a few days off and arrange to spend a day or two at Iowa State, St. Paul and Madison, Wisconsin. We started off early one morning in Koch's father's Buick and traveled to Ames, Iowa. In the meantime, a heavy spring downpour set in and we decided that we could visit only one more university because of travel problems on the roads (almost no roads were even gravelled at this time) and so we decided to travel to Madison. The roads were so muddy and difficult that at the end of the first day we got only as far as Grinnell, Iowa.

Driving on to Madison (on somewhat improved roads) we had three interesting days with the Wisconsin staff and all three of us were accepted for graduate work. Dr. Dickson offered me a fellowship in field crop diseases. However, it was not until later, and under different circumstances, that I actually came to Wisconsin. At that time, I was accepted for graduate study at Wisconsin under Dr. B. M. Duggar. Since Dr. Duggar was in the Department of Botany and Plant Pathology as a jointly appointed professor and had his office in the Botany Department, I, too, was assigned an office in the Department of Botany. As I think about it, there likely was no spare space in the graduate student rooms in plant pathology at that time anyway.

The professors I especially remember include Dr. Emma Fisk, Dr. Duggar, Dr. J. C. Walker, Dr. A. J. Riker and Dr. George Keitt. All of these made very special contributions to my education.

In the years following my graduate work at Wisconsin, my assignments seemed to cover ever broader areas and to include more and more administrative responsibility. I shall be forever grateful for the training in scientific discipline that plant pathology provided. And I am very mindful of the unconsciously acquired benefits of contacts with vibrant fellow graduate students and with the staff at the University of Wisconsin.

Armin C. Braun 1938

Matriculation at the University of Wisconsin seemed a most natural thing for me to do because my father graduated from that institution in 1910 and my older brother was a student there when I enrolled as an undergraduate in 1930. Both were enthusiastic about the training that they had received. As a senior in high school my father had, moreover, given me copies of Paul deKruif's then recently published books *Hunger Fighters* and *Microbe Hunters* in which the important researches of Professors Babcock, Hart and Steenbock were described in a somewhat glamorized but easily understood style. It was clear to me that the University of Wisconsin, like other great universities of the world, had a long and distinguished tradition as a center for research. This was the university of choice for me.

As an undergraduate student I majored in microbiology and biochemistry. Because of my interest and training in microbiology, I was offered a graduate fellowship in 1934 by Professor James Johnson to study the wildfire and angular leafspot diseases of tobacco. Although plant pathology was generally considered to be an applied science, my interest in this field was not concerned with practical applications but rather with a desire to gain an understanding of diseases of plants at a fundamental biological level.

During this period, in the mid 1930s, Professor A. J. Riker had established an active center for studies on the crown gall disease. Students and faculty not only from plant pathology but from related disciplines such as microbiology, plant physiology and biochemistry, actively collaborated in this project. I was thus exposed on numerous occasions to discussion of various aspects of the crown gall problem and found this problem intriguing. This exposure to the crown gall problem was to determine the direction that my scientific career was to take.

Because of a chance observation that I had made during a visit to a European laboratory in 1936, I began to have serious reservations as to whether crown gall was, as was then commonly believed, simply a bacterial stimulated hyperplasia, or whether something far more fundamental was involved. I was determined to look into this question. The opportunity arose shortly after I had received my doctorate in the spring of 1938, when I accepted a two-year postdoctoral fellowship at the Rockefeller Institute for Medical Research. Within two years after I had started my work at the Rockefeller Institute, Dr. Philip White and I had unequivocal evidence that we were dealing with a cellular transformation rather than with a bacterial stimulated hyperplasia. This finding opened the crown gall problem to precise analysis and led to an intensive study of the crown gall disease by many individuals in laboratories around the world. Because of this concerted effort, crown gall is now one of the most thoroughly studied and, in all of its aspects, the best understood of any of the neoplastic diseases of plants, animals or humans. The detailed analyses that have now been made of this disease have led to the development of concepts that have contributed importantly not only to an understanding of cancer but have also provided a model for the genetic engineering studies now being so actively and enthusiastically pursued in laboratories around the world. The agricultural potential of the recombinant DNA studies appears so promising that recent estimates suggest that they will lead to the development of a multi-billion dollar industry by the end of the present century. This is, then, a striking example to illustrate how studies in basic research, and without initial thought of practical application, may well ultimately serve to revolutionize certain important aspects of agriculture.

Woodrow W. Hare 1943

My arrival at Wisconsin was by default—in two ways. One, my assistantship applications had been turned down at Cornell, Minnesota, and Wisconsin in 1937. Nor were the results any better at all three on April 1, 1940 (the date all assistantships were awarded then). This, after a year of teaching and coaching in high school and two years for an M.S. in botany with a plant path thesis. Only after one of the lucky ones threw over his assistantship in July, 1940, did a message come from Dr. John C. Walker (hereinafter referred to as "Doc", a term of respect used by all his students).

My days at Wisconsin were extended—three years graduate work and five years instructor and assistant professor in plant pathology and in agronomy, less one and three-fourths years in the USNR. The memories are many and varied. To touch just a few lightly—the beautiful dawns on early-morn field trips, the shock of how week-old snow cover looked and smelled, the pea fields in bloom, the springtime aroma along Wisconsin roads, learning German pronunciation from a field man during a week of pea-disease survey, wondering how anyone could mispronounce Hare and handle names two lines long without a bobble, taking a beer cup in the field behind three "snoozing" fellows, sharing a gallon of orange-lemonade after a hot day in the plots, early breakfasts at "Hank's", going-away parties (graduation and military), pennyante poker sessions, the stillness of a cold winter night, seeing at retirement age Dr. Duggar, my minor Professor, five straight dawns fishing a cove on Mendota, enjoying the "Indian head" country, and having Wally Reiner teach me how to survive a Wisconsin–Minnesota football game at 0°F.

One memory still too vivid to omit was on one of the byways. After cresting a hill there was an enormous load of hay downhill. Don Hagedorn was asleep on my right and Doc was nodding at the wheel. After a sharp rib-jab and Doc's quick reaction, we ended up four feet behind the hay with burned rubber spread 50 feet back up the hill. After we got out and calmed down some, Doc said, "Don, that's a lesson. When riding with Woody, make him drive, and we can sleep off our lunch in peace," as he handed me the keys.

Another strong memory was the standing, roaring ovation from 15,000 in the fieldhouse when Doc presented me for the Ph.D. degree in June, 1943, "Woodrow Wilson—". While the president, Doc, and I waited for the tumult to die down I grinned, realizing that very few had heard the "Hare".

Many people at Wisconsin had an impact on my career development. From Al Steinmetz and Wally Reiner, graduate students from all over, up through the fine faculty to Dr. Keitt, from the path unit in horticulture, from those in botany, those in agronomy, and many more, I learned—or at least tried my best to absorb and use.

The two with the most impact were Doc and Jim Jolivette (one of the greats—as a pathologist and as a person). Doc had extended the fine Wisconsin system a step and assigned newcomers to work for advanced students. My good fortune was to be assigned to Jim. They told me why later. Doc was a rock-ribbed Republican and Jim a liberal Democrat. They were going through applications after that resignation in July. Doc spotted mine and said, "Look, *Woodrow Wilson* Hare, you ought to get along with him!"

Jim was a good teacher. Listening to the general talk of the older students they said Doc frequently cussed out his students, and they seemed to have a fearful attitude toward him. Jim told me he had not been cussed in his three years there. He explained further that when Doc talked plant pathology, take off your hat, stand at attention, and listen. But when Doc got onto any other subject you were just as good as he was and, though he might argue long and loud about it, he respected your right to your opinions.

Doc was my major professor. That covers the plant pathology. There was a lot more. In all the long trips (plots, surveys, disease calls, and just visits to canneries), the Walker-student parties each month, and other contacts, I got a liberal education from Doc in the general history, the geology, the beer history, the canning history, and the politics of Wisconsin. He loved that state. And there are a lot of fascinating things to learn about Wisconsin and its people. Then there were national and international politics (World War II time), sports, and topics in general. We debated at length about some of those.

Doc's example was marvelous. Through the student and staff years he frequently came up with, "Can I go with you tomorrow? And throw in an extra hoe." He didn't go to boss, he went to work, and asked you what to do and where to start. Imagine a world-famous man out there in the hot sun grubbing with a hoe, or whatever the chores were, and mostly keeping up with you. If you listened, every now and then a gem would fall. He once straightened up, wiped the sweat, and said, "You can take a notebook to the field all you want, but your best observations most often come hoeing up and down the rows."

The impact of the department on plant pathology has been large in many ways. However, to me the overriding impact has been, simply, the training of plant pathologists. Most of the resources were directed toward graduate students and supplying them with materials, equipment, methods, and direction. It was a two-way street. The students got the training and Wisconsin got an awful lot of research from their efforts while training. No better system has ever been devised. Go to almost any department in the U.S. and you will find one or more Wisconsin graduates.

When we left Wisconsin, Doc and Mrs. Walker came and drove us to the train very early on a very snowy morning March 31, 1948. They brought presents for our three and three quarters-year-old Margie and three quarters-year-old Judy. Doc insisted on carrying Margie from the car into the train with me protesting—he had had a serious operation a short time earlier.

These are very personal insights. I have mentioned them only twice before when under provocation. In rap sessions where his students were telling how hard-hearted he was, I had to speak up. It is time to go on record that, tough-guy image or not, Doc really had as big and soft a heart as you could find.

Where should the Wisconsin department go in the future? To me, plant pathology is an agricultural science and the primary objective should be to help growers produce food, fiber, and other plant products more efficiently. "Basic" and "applied" research are generally useless terms flavored highly by the user. Plant pathology should dig into the most intricate corners of science to solve problems but should carry those solutions all the way to the growing field to make sure they work.

Shu-Huang Ou 1945

I came to Wisconsin in 1941, in the midst of World War II, and I returned to China in 1945, six months before the war ended. It was an unusual time and under unusual circumstances. There were many unforgettable memories. Even the trips to Madison and back were memorable. All the Chinese seaports were occupied by the Japanese army when I was scheduled to leave. I had to fly to Hong Kong in order to get to the S.S. President Coolidge which sailed to San Francisco. On the return trip to China, I took a Liberty Ship with a navy crew in a forty ship convoy from Galveston to Calcutta. I crossed the Atlantic, the Mediterranean, the Red Sea, and the Indian Ocean in sixty-five days and flew over the "hump", the Himalayas, to the war capital, Chungkung.

Opportunities to study abroad during that time in China were very scarce. Those who had the opportunity tried to find the best school and worked hard. There was not much information on American universities available to students. I came to Wisconsin because of the good reputation of the department and the name of J. C. Walker, and on the advice of my professor, S. C. Teng, even though he was from Cornell. I never regretted that I chose Wisconsin.

Soon after my arrival, people found my name difficult to say. My landlady Mrs. Wood, never could pronounce any part of my name. Finally she said, "I'll call you 'Joe'." After that, everybody called me Joe, till this day.

Six months later, Japanese war planes bombed Pearl Harbor. My monthly allowance from the China Foundation Scholarship was cut off. At this difficult time, the department gave me an assistantship working for Dr. Riker's class on "Methods". I knew it was somewhat unusual, as it was normally given to a senior graduate student. The department's help and care for a foreign student moved me deeply. In another six months, my contact with the foundation resumed and the assistantship was given to another student.

I had the good fortune of studying under all of the "Big Four"—Keitt, Walker, Riker, and Dickson of the department, and Duggar and Backus of botany. Each was characteristically different from the others, but there was a lot to learn from all of them. The solid training in the fundamentals of plant pathology in those years enabled me to tackle different problems encountered later. This perhaps is most important in the training of foreign students, as they may not know what problems lie ahead of them back home.

I helped Doc plant beans on the university farm one summer, so that he could give me a little money to live on. Al Steinmetz, doubting my ability as a farmer, asked me if I had planted the bean seeds upside down! Most of the summers, I joined Glenn Pound, Woody Hare, Bob Foster, Don Hagedorn, Jim Kuntz and others working in Doc's tomato-cabbage plots in Racine-Kenosha, pea plots in Waupun, cutting beets for boron deficiency tests in central Wisconsin, and other field work. In 1944, I surveyed pea root rot for the Central Wisconsin Cannery alone when many of the boys had gone to war. These associations have developed into deep friendships and affection for each other for the rest of our lives.

Life with fellow students was fun, though six of us on the third floor of the old Horticulture Building did not have as many jokes and tricks as the rest crowded in the second floor. I used to go out with Curt Leben to find a good, cheap place to eat dinner on Regent Street. I had also been on the serving line for the navy boys in the dormitory dining room; about one hour's work in exchange for a good meal. The war was on, and several times I accompanied others to the Madison railway station to see one of the boys off to join the service. It was always a bit sad.

Wisconsin graduates have had great impact on plant pathology in China. I visited China in 1980 and found the leaders in plant pathology in three of the most important agricultural universities are all from Wisconsin: Dr. Chiu in Beijing, Dr. Fong in Nanjing, and Dr. Faan in Guangdong. All are well respected and their influences in the development of plant pathology are great. I am proud of it.

In 1964 I had an opportunity to come to Madison for a brief visit for the first time in nearly 20 years. It was Doc's retirement reception. In 1967–68, I had my sabbatical year in the department. I found many of my contemporaries on the staff: Arny, Berbee, Boone, Darling, Fulton, Hagedorn, Hildebrandt, Kuntz, Mitchell, Moore, Patton, Pound as the Dean, Smalley, Worf, etc. It was like a reunion to me. During the year, I wrote most of *Rice Diseases*. In 1978–80, I returned to the department again with the title of Adjunct Professor and revised *Rice Diseases*. My relationship with the department was special.

The University of Wisconsin has become more and more involved in training of foreign students. Continuing effort toward this direction will greatly help in developing plant pathology in many needy nations.

George W. Bruehl 1948

It is with pleasure and pride that I remember studying at the University of Wisconsin. Why did I attend this institution? There was almost no alternative. The Department of Plant Pathology at the University of Arkansas sent Ralph Shay, Glenn Pound, me and Mannon Gallegly in that order to Wisconsin. Drs. V. H. Young and E. M. Cralley sent their products to Badger Land!

Upon arriving in Madison, Ralph Shay met me, introduced me to the faculty and students, and he arranged a room for me. Many of us ate, family style, at Mrs. Herrling's house (Gene Herrling's mother). This courtesy and consideration will always be appreciated.

My original appointment was with Dr. Keitt in orchard pathology. However, after a summer in Door County spraying cherries and apples with Dewey Moore, it became clear to me that my heart was in grass pathology, and I asked Dr. Keitt if I could switch my subject. This gentleman accepted my preference with no unpleasantness whatsoever, and my field of study was changed immediately, first with Dr. Allison and then with Dr. Dickson. This flexibility within the department amazes me in retrospect. It was my good fortune to have had Drs. Backus, Dickson, Walker, Keitt and Riker for teachers. Better fortune than that is hard to imagine.

The impact of the University of Wisconsin on plant pathology? My visits to the department have been few since Dr. Dickson's death, but on one occasion I walked along a hall and saw pictures of former students, class by class. It was humbling and inspiring to pause and think of the contributions of these former students. All that is needed to evaluate the department is to take that walk slowly. Friends made in graduate school, fellow students, have been a source of help, encouragement, and support through all succeeding years.

The Department of Plant Pathology has a great responsibility. It teaches students from all around the world. My greatest concern is that the department have balance, that it not be specialized in just facets of the field. It is big enough and strong enough to have leadership in each important subject matter and skill area.

Universities also have the problem of encouraging and supporting individuals truly dedicated to teaching. This is difficult to balance with the need to obtain financial support of research. The big money now is in "basic" science. It is my hope that the University of Wisconsin will stay close to its heritage, emphasizing both basic and applied research. One foot in the furrow sounds like you are doing well. One foot in the furrow and one in the laboratory is as good as you can be.

Arthur L. Hooker 1951

I was part of the group of students who returned from overseas military assignment following World War II. We felt we were behind in our personal lives and attacked college work with vigor. At that time, the University of Wisconsin was on a three semester per year schedule. I remember going to school year round with only a few days off. I also worked by the hour for the agronomy department and delivered the university newspaper, the *Daily Cardinal,* each morning. My work assignment in the Babcock House, a cooperative where I lived, was making breakfast. By taking extra credits each semester I finished the four-year B.S. degree program and the M.S. degree program in two and one-half calendar years. The doctorate program took thirty-three months more. I had a joint major in plant pathology and plant breeding with a minor in genetics.

Dr. J. G. Dickson was probably the major factor drawing me into plant pathology. He was a great salesman for biology. It was said that Jim Dickson could sell a refrigerator to an Eskimo! My respect for Dr. Dickson was tremendous. He invited students into his home where he and Mrs. Dickson were warm and generous hosts. We saw his home study where he worked prior to leaving for the office. Dr. Dickson was a wonderful thesis advisor. I consulted with him regularly on my research. He had a genuine interest in what was found out. After reporting my recent results he would ask the question, "Art, what do you plan to do next?" I was prepared, and outlined what I thought was the next best approach. His reply invariably was, "Let's proceed on that basis!" While he would occasionally suggest a new idea, he never discouraged me from following my own.

My research assistantship was on the corn breeding program. We had regular duties full-time in the summer and part-time during the winter. This was an excellent experience as one learned how to organize experiments, lay out field plots, keep pedigrees in nursery books, pollinate and select corn. This was before herbicides were used so we also became familiar with the hoe and the value of this tool in weed control. All of our data were summarized on hand operated desk calculators. Many hours were required from the research assistants. My father, at home, was the first farmer to learn about the new hybrids.

I was the departmental fellow for one year. The intent, I believe, was to obtain relief from assistantship duties and to allow more time for research. However, I was not completely free as I made media and performed other assignments for Plant Pathology 102 (methods class) and assisted in Dr. Keitt's fruit crop and Dr. Walker's vegetable crop disease courses.

There were many wonderful people on campus and it was a thrill to learn new things. Dickson, Walker, Keitt, Riker, and Pound were the key people in plant pathology. Plant Pathology 101 gave me deep appreciation for reading original research papers. We wrote long reports on selected diseases. Deane Arny, Earle Hanson, and Don Hagedorn were young staff members at the time, and my friendship with them has grown in subsequent years. Of course, Al Steinmetz and Wally Reiner were a continuous source of consultation for those who worked in or passed through the greenhouses. D. C. Smith, who taught me plant breeding theory, James Torrie, who gave me an appreciation of experimental design and statistical analyses, and especially N. P. Neal, who instilled in me the art of practical corn breeding, were my main contacts in agronomy and plant breeding. R. A. Brink, a highly respected fundamental geneticist, was my advisor for the genetics minor.

My most valuable experience at Madison was the research and service atmosphere that prevailed. There was a dedication to solving problems of the people and of agriculture in the state. The motto was "The boundaries of the university are the boundaries of the state." People had a great respect for the university and it did a lot for them.

Teaching was excellent. Most of the professors had their own mimeographed text-books and taught authoritatively. Seminars in plant pathology were memorable. I still have these outlines. Subjects like the history of plant pathology, physiology of parasitism, chemical control of diseases, and other topics not included in regular courses were covered. These topics were given the first semester with the second semester reserved for research reports. My class notes in Dickson's diseases of field crops were particularly useful to me as I subsequently taught a similar course at Illinois for many years. Dickson provided specimens of diseased tissue which were sampled and mounted on cards by the students in class. My collection is still in good condition.

It is difficult to define the impact the University of Wisconsin department has had on the science of plant pathology. Certainly, the great numbers of graduates who subsequently have had outstanding careers must be mentioned. The many facets of research accomplished are too numerous to mention. The text books, *Introduction to Plant Pathology* and *Diseases of Vegetable Crops* by Walker and *Diseases of Field Crops* by Dickson have been of great use around the world.

Where should the department go in the future? My view is that it should be in continual contact with reality. Talk to nature and the people who grow and use plants, not only to other pathologists. Do the kind of research that results in the most feasible means of controlling the plant diseases of Wisconsin. Structure the teaching program so that graduates will develop the same philosophy. Be the connecting link between basic biology and the growers of plants. Work in concert with other departments on campus and with industry and government. Do the basic biology when there is a void or a need for something to be done. Always ask the question, "In the real world does it make a difference?"

Robert P. Scheffer 1952

There is no doubt in my mind that graduate student days at Wisconsin were something special. There were, of course, the obvious things; at the time, I considered Madison to be the most livable and desirable of places, in spite of the long, hard winters. There were excellent opportunities for social and personal as well as academic interactions. After all, I first met my wife at a square dance arranged by the graduate student club.

There was an additional and very important factor at Madison that is much more difficult to define and express. We all (students and faculty alike) had a pervasive feeling that we could and must accomplish something of scientific or practical significance: that we could accomplish anything, academically speaking. Such ambience was more evident at Madison than at almost any other place. I have noticed that it is missing in many institutions of research and higher learning, both in the United States and abroad. It is a fragile condition, but a precious one that must be preserved. I am confident that the university still carries the vapors and inspires students to make a difference in their chosen area. The attitude has been important to me, for whatever I may have achieved.

When I was a student (some thirty years ago) the Department of Plant Pathology at Wisconsin was generally conceded to be the leading department of its kind. The names of the "Big Four" of the faculty at that time will still be recognized by plant pathology students for many years to come. My professor, J. C. Walker, certainly had a dominant influence on my career, and on that of many other students as well. I suspect that "Doc" turned out more Ph.D.'s in plant pathology than has anyone else, and for good reason.

As students, we had a steady diet of hard work; it was a standard grad student joke. Perhaps this sounds like drudgery, but it was not; instead, it was all part of the spirit mentioned above. Nevertheless, there were many diversions and light moments. I particularly remember many activities with other students: hikes in the Baraboo Hills; swimming, sailing and fishing in Lake Mendota; drinking beer in the Union; strolling on Picnic Point; celebrating prelims and finals; and intense discussions of politics, religion, the state of the world, and (yes) plant pathology (especially with Real Pelletier, philosophe extraordinaire). It was a truly stimulating time. In retrospect, I learned as much from student colleagues as from classes.

Finally, there is every indication that the Department of Plant Pathology at Madison holds its dominant position to this day. Only us "old timers" will say that life cannot possibly be as stimulating as it was then.

Carl Beckman 1953

I was among the immediate post World War II crop of graduate students. I chose UW–Madison for graduate studies because it was one of the leading universities in the country in terms of plant pathology. There were other institutions that may have been stronger in specific areas, but Wisconsin was acknowledged as probably the leading all-around institution. Why Wisconsin chose me is a mystery that has long since passed from the memory of anyone still living.

I remember especially well the stimulation I received from the seminars that first fall of 1947. The topic was a history of plant pathology and it included bench mark discoveries and the people and circumstances surrounding them. I remember that my assignment was Hartig. I was expected during the course of my preparation to read Hartig's major papers—in German. No one ever asked me if I could read German. I was just expected to do it, which I did.

An incident I remember from the seminar series was the day I was assigned to prepare the coffee. I had not anticipated how long it took for a sixty cup pot of coffee to brew. I frantically applied extra Bunsen burners as the fatal hour approached—and who should walk in early and head directly for the pot but J. C. Walker! He poured himself a cup, looked into the contents and growled, "What is this, *tea?*"

I also remember the midnight hours in the library preparing the weekly papers on the etiology of 4,973 diseases. And I remember J. C.'s lectures at 1:00 P.M. (right after lunch) when he would growl in a monotone, out of one side of his mouth, for forty-seven minutes in complete darkness (except for a dim, mesmerizing podium lamp)—and then show one slide. But somehow we got a real insight into the physiological aspects of plant pathology.

Then, of course there was my major professor, A. J. Riker, who believed whole-heartedly and unswervingly in providing opportunities—but not one damn word of advice or council. A. J. spent most of his time conning various agencies into providing us with vehicles on permanent loan, surplus trailers for field camps and any loose dollars that were not thoroughly nailed down. What amazed me is that all of these agencies seemed to feel A. J. had done them a big favor. They would even ask him, year after year, if he wouldn't do them additional favors of the same kind. But even more than learning the methods of a con-artist, I learned from Riker how to write, write, write—and even come to enjoy it.

Then there was Dickson, a man of great knowledge, understanding and helpfulness, who taught a course that dealt with root rots of wheat and oats and barley and timothy and rice and brome grass, and culm rots of wheat and oats and barley and timothy and rice and brome grass—and sudan grass, and leaf blights of wheat and oats and barley and timothy and rice and brome grass. . . . .

Then there was George W. Keitt, that thoroughly southern gentleman and head of the department, whom you would see smiling and nodding quietly to anyone who happened to pass him in the hall, who gave us real insight into plant pathology as an ecological science in his course on diseases of fruit trees—and whom you could see in his inner sanctum—*if you could get past Audrey!*

The "Big Four" were an amazing collection of characters who were all highly respected for their accomplishments and who by one thoroughly nonpedagogic method or another cajoled, intimidated, inspired and bored us into a vigorous pursuit of plant pathology.

I wouldn't have missed it for the world! Congratulations to us!

Katie Helms 1954

After working for several years in the plant pathology section of the CSIRO Division of Plant Industry in Canberra and submitting some of the work to the University of Tasmania for an M.S. degree, I decided to see something of the world and looked forward to an extended holiday. In response to suggestions of some of my colleagues, I decided to modify these plans and explore the possibility of gaining some research experience while overseas and so further my career at the same time.

It was Dr. H. R. Angell, then head of the Plant Pathology Section in which I was working, who suggested that I apply for a research assistantship in the Department of Plant Pathology at the University of Wisconsin. He had studied at Madison under Dr. J. C. Walker from 1925 to 1928 and was sure that I would not only benefit from research experience, but also enjoy spending time in the United States. I will digress here to say that Dr. Angell, who is now 92, is still a great admirer of Dr. Walker and the Department of Plant Pathology at the University of Wisconsin. In Madison, he will be remembered for his work with Dr. Walker and Dr. Link, which provided the first authentic record that a plant pathogen could be chemically excluded from a plant part by showing that protocatechuic acid in coloured onion scales could inhibit growth of onion smut.

Following Dr. Angell's advice, I applied to work in virology in the Department of Plant Pathology in Madison under Dr. James Johnson. The application was successful, and I obtained one year's leave of absence from CSIRO and was making plans for my departure when a letter arrived stating that Dr. Johnson had died. If I still wished to come, I would be assigned to another member of the staff. I arrived in Madison in September, 1952, and Dr. Glenn Pound became my supervisor. One of the first comments that he made was that if I wanted to make the most of my opportunity in coming to Madison, I should certainly enroll as a candidate for a Ph.D; if all went well, he would support me in obtaining an additional year's leave of absence from CSIRO. Within a few days I felt I was in a race track with a succession of hurdles ahead. I have never regretted taking Glenn Pound's advice, even though at that time several Australian colleagues considered that my time in Madison would be better spent if it were devoted entirely to research rather than partly to course work. I should perhaps indicate here that in the early 1950s there was no established tradition in Australia for scientists to obtain a Ph.D. degree, even though most universities had gazetted regulations enabling them to confer Ph.D. degrees within a few years of the end of the second world war. D.Sc. degrees could be obtained by a mature scientist following his successful submission of a collection of published papers. Nevertheless, within a few years of my return to Australia, a Ph.D. degree became a minimum qualification for a research position in Australia.

My stay in Madison was a valuable and enjoyable experience both scientifically and personally. The broadly based course work in plant pathology and plant physiology (my minor subject) has stood me in good stead in CSIRO where different areas of research are promoted at different times. Not having done any course work for some years and having attended the University of Tasmania, then the smallest university in Australia, I was initially somewhat apprehensive as to how I would measure up among students from a wide range of countries who had chosen the Department of Plant Pathology in Madison for their graduate studies. These anxieties were forgotten in the stimulating, friendly and generous atmosphere which pervaded the department. As I look back on the two years I spent qualifying for a Ph.D. degree and the further nine months working in the department, I recall some advice given me by Glenn Pound: to be a successful scientist, he said, one needs to be a bit of a salesman. I think this is even more true today than it was in the early 1950s. An amusing incident also comes to mind. Perhaps Glenn remembers how very proud he was of the first Spinco high speed ultra centrifuge that the department obtained for work on viruses? Not long after it arrived a dreadful crashing and grinding noise was heard coming from the room in which it was installed. We dashed along the corridor to find out what had happened. Glenn had been giving a demonstration of his pet equipment in action to a visitor and had forgotten to screw the lid onto the rotor! I can assure you that we sympathized greatly with Glenn, but we were very glad that it had been a professor and not a student who had made the mistake.

I found Madison a charming town, quite different from any I had known in Australia. I loved the winter snow on the trees and the roof tops and the gay decorations on the streets at Christmas time. I was fascinated to see the ice sail boats and ice fishing and had a lot of fun trying to skate. In the early 1950s Australia had not yet become a "multicultural society" as a consequence of post-war migration and I was intrigued by the regional customs, wide range of religions, accents and the many clearly defined nationalities within the United States. Your country also proved to be much more heterogeneous scenically than I had expected and I was fortunate enough to see quite a lot during my stay. I went south to New Orleans, east to New York, Pennsylvania and Vermont, north through to the lake districts of Ontario and made a memorable car trip west with Don Hagedorn, Deane Arny, Eddie Echandie and his wife to attend the Estes Park meeting of the American Phytopathological Society.

I often recall the friendship and hospitality of the staff, students and their families and I was delighted when Mike Woodward, a more recent graduate from the department, came to work in Canberra from 1976 to 1979. Over the years, I have had much pleasure, and also much scientific stimulus from again meeting up with those of the department who have visited Canberra or attended the same scientific meetings as myself. Also, I revisited many friends briefly in Madison in 1968. These reunions, as well as scientific publications, newsletters and successive editions of *The Wisconsin Pathogen* have enriched my career and given me much personal pleasure. I congratulate the Department of Plant Pathology on its seventy-fifth anniversary and wish it the same success in the future as it has certainly enjoyed in the past.

Kenneth R. Barker 1961

The decision to enroll in a Ph.D. degree program at Wisconsin came easily for me. The Department of Plant Pathology at the University of Wisconsin–Madison was recommended by the faculty at N.C. State as the best in the country. The opportunity to work with Professors J. C. Walker and Gerald Thorne was a rare privilege.

Many warm memories of my almost eight years in Madison remain with me. I was amazed at how large numbers of plant pathology students (fifteen to twenty per year) were able to complete excellent theses with the extremely restricted facilities and financial support that were available in the late 1950s and early 1960s. One highlight of my student days involved frequent educational trips evaluating the disease situation on vegetable crops in the state with Dr. Walker. I learned much about the geology and history of Wisconsin as well as plant pathology via this mobile classroom. These interactions also brought challenges to isolate and identify rare pathogenic fungi such as *Itersonilia*.

Being housed in "T-18", a temporary building located where Russell Labs are today, was a unique educational experience. We had numerous two- to three-inch floods quickly moving under our feet after heavy rains. Fortunately, Professor Thorne, with a vast experience in irrigation of western crops, finally succeeded in convincing the maintenance and ground supervisors that water runs downhill—even in correctly constructed ditches. An equally memorable encounter was having my bag lunch replaced with a living chicken—courtesy of Paul Williams. The noon student bridge groups in T-18 also were exciting, especially when a "Dr. Walker is coming!" alert was sounded. The greatest benefit for incoming students to T-18 resulted from the senior students serving as unofficial mentors. I continue to be indebted to Joe Peterson and Gayle Worf for patient guidance, including suggested techniques for preventing frostbite during those first exposures to −32°F.

My greatest surprise came one Saturday morning after receiving the Ph.D. degree in 1961. Dr. Glenn Pound, department chairman at that time, called and suggested that I consider assuming Emeritus Professor Thorne's position in nematology. Working on the faculty at Wisconsin was truly an invaluable experience. Initially, I had a desk and laboratory space in T-18. Paul Williams and I later shared a small laboratory in the Horticulture Building. The historic event of our moving into Russell Labs was an exhilarating day for all members of the department. Some of us could not wait for the movers. Instead, we carried microscopes, chairs and other equipment and commenced work in the beautiful new facility.

Many members of the department had a significant impact on the development of my career. I continue to profit from the exposure to Dr. Walker with his uncanny mind, knowledge, and philosophy. The enthusiasm and unending energy of Professor Thorne served as a key source of motivation as I changed from the study of soilborne diseases to nematology. Dr. Henry Darling always provided support, counsel, and encouragement. Miss Audrey Dunlap, departmental secretary, after terrifying me initially as an incoming student, became a dear friend and added much to my career. Fellow students and eventually faculty colleagues, Drs. Gayle Worf and Paul Williams, truly enriched my years in Madison. Finally, I am indebted most to Dr. Arthur Kelman who introduced me to plant pathology in his exciting undergraduate class at N.C. State.

The Department of Plant Pathology at the University of Wisconsin has made innumerable contributions to the characterization, understanding and management of plant diseases during the last seventy-five years. Nevertheless, the department's most important role has been that of the premier educational center for our discipline. Wisconsin plant pathology graduates are teaching and doing research in universities and other institutions over much of the world. The department must continue to maintain a balance between fundamental and practical plant pathology, or this heritage could be forfeited. Following Dr. Walker's philosophy of closely linking these components of research should ensure a bright future for plant pathology at UW–Madison.

Solke H. DeBoer 1976

I look back on my years at the University of Wisconsin with a great deal of nostalgia and appreciation. In many ways the experiences during that time as a graduate student in the Department of Plant Pathology had an important impact on my future and my career. I came to Wisconsin, not only because I was able to obtain an assistantship, but very much as a result of the urging of my first teacher of plant pathology, Dr. R. J. (Bob) Copeman. A graduate of Wisconsin, himself, he spoke so very highly of the department and was insistent that I go. For this I remain grateful.

My move to Madison in 1972 was almost blocked by a dedicated but somewhat overzealous customs officer at the United States–Canada border crossing. However, any apprehensions about moving to Wisconsin were soon allayed by the warm reception from the department students and staff. I'll never forget my first evening in Madison at the Brat 'n Brau, celebrating someone's—I think Dave Coplins—successful completion of his final exam. The sociable and congenial interaction with fellow students certainly made life as a graduate student not only bearable but also enjoyable and memorable.

The bacteriology lab on the eighth floor was my "home"—and how beautiful was the view over Lake Mendota. One appreciates such pleasant surroundings complete with scenic view when another hundred potatoes need to be injected, six times each.

I feel fortunate to have been able to do my graduate work at Wisconsin and even more so to have had Dr. Kelman as my major professor (affectionately known as Dr. "K" when he wasn't around). I think back with a certain degree of amusement at the intimidation I felt during those first months under his careful supervision and questioning eyes. I even had to skip Friday evening pub sessions to earn adequate grades in the Saturday morning plant biochemistry course to meet his demands. It seemed at first that my best experiments were but child's play in his eyes. But I learned. I learned to ask myself, "What questions will Dr. "K" ask me this time? How will he criticize this experiment?" In other words, he forced me to think critically about my own endeavors. Although the learning may at times have been difficult, frustrating, and even humiliating, it was important. Today I am still thankful for his guiding questions and careful explanations.

The learning of plant pathology in the various courses was sometimes enjoyable, sometimes painful. I especially enjoyed the Plant Path 601 course taught mainly by Dr. Sequeira at that time. His lectures were always logical (which really helped), lucid, and well presented. Also Dr. Arny's field course is remembered as a fine introduction as to what plant pathology is really all about.

During the years I was there, the scope of plant pathology at Wisconsin was wide. It must continue to be so in the future. The rapid advancements in computer technology and molecular engineering have not bypassed the field of plant pathology. The department is challenged to exploit these developments to the fullest. At the same time consideration of practical plant pathology must not be forgotten. There is a continuing need for extension and field specialists to face the real plant disease problems as they confront the grower. It is my hope that the Department of Plant Pathology at the University of Wisconsin will continue as a leader in both the fundamental and practical side of the science involving plant health and plant disease.

Finally I would like to express the hope that graduates will continue to leave the department with a sense of responsibility. A responsibility not only to the pursuit of knowledge, not only to the agricultural community, but to all creation. Protection of the environment is everyone's responsibility, but especially the responsibility of those who must selectively control pests and pathogens so that men and women and children may live. There must be a sense of responsibility, also, to those for whom a successful crop is not a difference between a profit large or small, but is a matter of life and death.

Margo Daub 1978

I originally decided to go into the field of plant pathology because I had always been fascinated by diseases, but clearly did not have the stomach to tolerate research in animal or human sciences. During my undergraduate days at a small liberal arts college, my advisor (a mycologist) introduced me to the book *Famine on the Wind* which spoke to both my scientific interests and my concern with global humanitarian issues, and cemented my decision to study plant pathology. I came to Madison because I was familiar with the campus (my father being on the engineering faculty) and because I knew of the department's reputation overall and in the area of breeding for disease resistance, which was my major area of interest at the time. Through my training at Wisconsin, my interests moved toward the more basic aspects of our science, but I still remain fascinated with the applied and social aspects of plant disease.

I think what my years at Wisconsin did for me was give me the broad training that I needed to become a good plant pathologist in addition to being a good scientist. In a field as diverse as plant pathology it is often very difficult to give students a good exposure to and appreciation for all aspects of the discipline, and still give them the focused training that is necessary to become a good scientist. This is something I think Madison does very well, and it comes out of having a diverse department with strengths in a number of different areas and excellent faculty who respect the knowledge and skills of their colleagues. I was fortunate at Wisconsin to work under the direction of three world-class plant pathologists, Dr. Hagedorn, my major professor, and Drs. Kelman and Sequeira. I credit them collectively with teaching me to be a plant pathologist, forcing me to think and to be critical about my work, and strengthening my respect and concern for the effects of plant diseases on society as a whole. These are skills that will always be with me.

What are my fondest memories of my graduate work? My main one, I guess, is the camaraderie among graduate students, especially for me among the female graduate students (of which there weren't too many at the time!). I formed close friendships during that time that have and will stay with me for years to come. I also remember the prelim and final exam parties at the Brat and Brau and intramural softball and inner tube water polo. In a more academic vein I think back on long, hot days at the Hancock Experimental Station and on Dr. Arny's field course with its field trips and introduction to Wisconsin agriculture and natural flora in addition to the study of diseases. I remember the dreaded literature review seminars where we attempted to choose topics in the areas of expertise of the "gentle" members of the department, and my first day in PP300 lab where I looked from Doug Maxwell's smiling face to the many disease specimens scattered across the room, and thought that I could never learn it all. I now teach the equivalent course at North Carolina State University, which is a constant reminder of how much I've learned since my first semester at the University of Wisconsin. I value the experience of participating in our student disease diagnostic clinic, and look back with gratitude to members of the technical staff, particularly Bob Rand, Gary Gaard, and Steve Vicen, who, in addition to my committee members, taught me much of what I learned during my graduate work. All in all, my years at Wisconsin were very positive ones socially, academically, and professionally.

It is difficult to evaluate where the department should go in the future, for it has already changed a great deal even in the six years since I left. If I were to make suggestions, however, I think the department should strive to continue to give students a basic understanding of all the varied disciplines within plant pathology and at the same time train them to be experts in their own particular field. This is not easy to do, but, in my opinion, successful plant pathologists are those who have respect for the science as a whole and who are also trained to perform excellent, sophisticated research in their own subdiscipline. I think the department at Wisconsin has done an excellent job of this in the past, and should continue to strive for this in the future.

Jan E. Leach 1981

It is not frequent that a scientist is asked to write from a nostalgic point of view; hence, I found it a more difficult task than I first imagined. Initially, my mind raced with pleasant memories from my days as a graduate student in plant pathology at the University of Wisconsin. The clouds of nostalgia were quickly blown away with the realization that many of my memories were of personal interest, and any potential readers would be quickly yawning with boredom. Then, I reasoned that a common link between myself and other graduates of the department would be the memories we carry of friendships cultivated while students in the department. These friends played an integral role in our overall graduate training. We shared with them many different kinds of experiences, from softball games on Sunday afternoons and TGIFs by the lake at Memorial Union to the traumas of research proposal seminars and preliminary exams. The transient nature of our tenure at Wisconsin and the hours required for completion of our degrees tended to restrict many relationships to colleagues within the department. These friendships were enhanced by the primary focus of our interests at that time (i.e., plant pathology) and, in the case of students, the similarity of our short term goals. Because these friends had such influence on our graduate training, in the next few paragraphs I would like to invoke memories of them.

Interactions with friends benefited our graduate studies in many ways. It was these friends that set their own research projects aside to help fellow students plant trees, harvest peas, or spend hours wielding a syringe to infiltrate tobacco leaves with bacteria. They would stop to teach a new technique or listen to brainstorms (however bizarre) over pizza and beer late at night. We struggled together with the concepts of parasexuality and gene-for-gene, and shared the elation when we finally grasped them.

We not only worked hard, but we also played very hard. Remember volleyball games (and sprained thumbs), canoe trips, cow chip chucking contests, prelim parties, Mad-City's amazing Halloween celebrations, or the innumerable TGIFs? What fun would outings to Kemp Station or field trips to the potato seed certification farm have been without friends to share the mosquitos with? To what avail would the carefully plotted late night pranks in the lab have been, had there not been friends to play them on?

Faculty and staff members continually offered their friendships as well. Remember the secretary or photographer who helped you rush forms or illustrations through? Or the technician who knew just the right moments to shepherd you out of the lab for an "attitude adjustment?" Not only was their time offered, but they shared their experience and hobbies with us as well. For example, interest in the "Diseases of Economic Crops" class field trips was enhanced by lessons on the recognition of many Wisconsin wild flowers (not to mention the lemonade and cookies Mrs. Arny had packed for us). They gave us their concern and interest. Professors' doors were always open for students who needed advice, had questions, or who merely wanted to chat. Major professors patiently listened to our disasters, encouraged us to continue (to make more disasters?), relentlessly edited our papers, boosted our self-confidence, and gently guided our programs. It is impossible to forget the busy major professor who left his desk laden with manuscripts to spend a Saturday morning peeling potatoes to help with an experiment, and how he managed to suppress laughter when confronted with my "latest theory".

I am certain that, at least in part, the success of plant pathology as a department hinges on the amicable environment which it provides for working. This environment, in turn, is fostered by the friends who work within it.

Conclusion

These, then, are the comments of a number of your friends and colleagues from throughout the years. To those who feel that we were a bit rough on their contributions, we apologize. We hope that we retained the essence of what you wrote for us. To all who contributed, we express our sincere appreciation and the hope that in twenty-five years, when the 100th anniversary party comes around, we shall all meet again.

CHAPTER 28

My Memories of L. R. Jones

Edith Seymour Jones 1896–1984[1]

These are my day to day recollections of L. R. Jones. Much has been written of him. His achievements in scientific research, in administration, and in the broad educational field have all been told. He was given many awards and much recognition, both nationally and internationally.

Personal touches of men's lives are apt to be omitted in the records of their achievements. That these incidences may give a little intensified appreciation of a great man I write them.

No human being can go through life without encountering some differences between his thinking and that of others around him. Perhaps these differences need never be recorded, but, on the other hand, they do reveal the human side of a man's character. His weaknesses seem to us to be few and have dropped into the unrecorded distance.

The term "politician" was sometimes applied to him. I am sure that was incorrect, for "politician" connotes the use of flattery, craftiness, or artificiality. Instead, the best definition I can

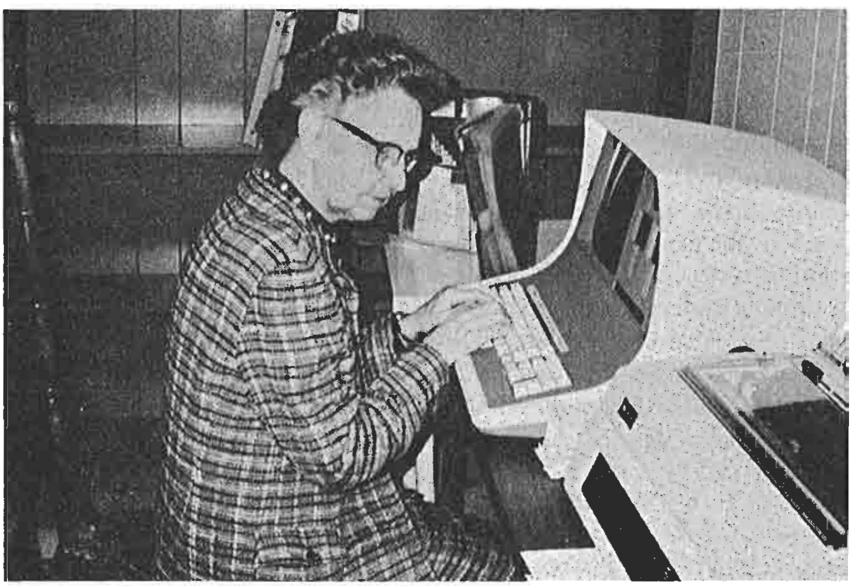


Figure 28.1 Edith Seymour Jones in 1984.

[1]Edith K. Seymour, daughter of Arthur B. Seymour (assistant curator of the Farlow Herbarium at Harvard University), came to Wisconsin in 1918 as a graduate student and earned a master's degree under L. R. Jones. In 1921 she married Fred R. Jones, adjunct professor of plant pathology. In her later years she returned to the department and remained active, contributing her time and talents to assist a number of faculty. She wrote "My memories of L. R. Jones" a few years before her death.

apply to Prof was that of a person who has an understanding of people and the facility of language to make a point of view clear to people dealing with the different sides of a question.

Should this account of my experiences with Professor Jones reflect too much of myself, it must be pointed out that he was equally kind to everyone. My impressions of him are retained very vividly in my mind.

To start at the beginning, as a child, I used to hear my father speak of "L. R." with deep affection. So when I was looking for a position as I was graduating from Miami University, Oxford, Ohio, under the famous lichenologist, Dr. Bruce Fink, I wrote L. R. applying for a position. It was during World War I. I must have asked for a fairly good salary. Professor Jones' reply was immediate. In his tactful way, he said: "Our staff has $85 a month." I did not hesitate, but took the next train after graduation for Madison.

It was the 30th of May when I first went to the laboratory forgetting it was a holiday. Everything was quiet. Doors were closed except those of the big laboratory which were partly open. Hearing whistling inside I pushed a door open. There was Dimitr Atanasoff working over his fusaria. That very day Prof invited me and Frieda Bachman (the bacteriologist) to dinner at the University Club with him and Mrs. Jones. Frieda had graduated from Miami a few years before me and I had found a room with her.

Fred, too, used to tell of his favorable experience when he first reached Madison some approximately six years before me. He graduated from the University of Maine, visited several midwestern laboratories and then came to Madison. On talking with Professor Jones he knew immediately he was a man with whom he could work.

The stories I tell show the great human qualities of one of our most prominent men, the scientist, the administrator, and the educator. He had genius for organization and national cooperation. He could convince people of his point of view, at the same time never antagonizing but working cooperatively.

In the first weeks at the laboratory I was assigned to the pressing of rusted barberry leaves and making other class specimens in the big laboratory on the third floor of the Horticulture Building. It seemed a rather menial task to me, for I had pressed Father's plants all my life and there I was after graduating from college still pressing. There was, however, a dignity Prof gave to the work as he described how I was making good specimens for students.

Other plant pathological problems soon followed and I was assigned a desk in the big east laboratory with other graduate students. Every late afternoon Prof would make the rounds of the laboratory stopping at each person's desk. It was not for detailed discussion. Serious work was taken up in the office during the day. I can visualize his kindly smile as he spoke to each of us. "I'm just taking a turn around the laboratory," he would say.

It was that fall of 1918 when the Plant Pathology War Emergency Board met. First they gathered around the big table in the library. I remember many of the enthusiastic group: Stakman, Whetzel, Coon, etc. Whetzel would sit on the edge of the table shaking his long gray locks in convulsive laughter. Stakman had very positive ideas which did not always agree with those of L. R. After working over the problems here in Madison, the party went the next day to Minnesota. The story was told to me afterward by Dr. E. M. Gilbert who was with them. There were two automobile groups, in L. R.'s car the right decisions were made. Halfway to St. Paul, he changed cars joining Stakman in the other car. Stakman had taken a different point of view. By the time they all reached St. Paul everyone agreed. It was Prof.'s persuasiveness. That was characteristic of his ability to keep harmony.

Another illustration of his tactfulness comes to mind. One late afternoon I was walking along Linden Drive toward the Biology Building when L. R. and someone else, maybe E. J. Kraus, passed me. They were deeply engaged in conversation. I overheard a bit. L. R.: "Now if it takes one more trip to the Biology Building we will make it."

I remember Professor Jones telling of his work with E. F. Smith. Prof did not stay with Smith very long. He looked embarrassed as he spoke of having thrown away a tube of bacteria to Smith's great displeasure. It was generally accepted that only women could work with Smith. He had some excellent people with him: Charlotte Elliott, Florence Hedges, Lucia McChulloch etc. However, L. R. and Smith kept a close friendship through the years.

The first summer when I reached Wisconsin was the War year. I remember Florence Coerper's great concern for L. R. who had been working very hard. She said Prof had worked so hard that he had broken down the summer before. The L. R. Joneses went regularly to their cottage in Ellison Bay so that Prof could rest after his strenuous year's work.

I must recount that winter of 1918–19 when we were suffering through the War. Prof himself taught the methods course. There were only six or seven of us in the class: Addie Pea who later married Otto Reinking, Ruth Tillotson, a man who was old enough to have escaped the draft, perhaps one or two others, and myself. The class was a real inspiration. We enjoyed every minute. Most specifically I remember how Prof, himself, took us to the University Library. The library was dear to his heart. There, the charming librarian, Dudley, gave us a splendid glimpse of the functioning of a library. I am sure that the significance of the library for research which Prof pointed out made a fundamental and long lasting impression on my mind.

It was some time probably in that winter of 1918–19 that a new student came to study in the department. It was Miss Rose, quite a little older than I. Prof asked me to help her find a place to live. It was in the depth of winter. A slushy snow had fallen. I, being a husky person, never thought of getting taxis to go from possible living quarters to another, and so dragged Miss Rose quite long distances around the university area to find housing. The next morning she must have telephoned the laboratory that she was not able to go to work. So I rushed up to the Park Hotel to see what I could do for her. When I reached her room I found a Christian Science Practitioner before me. I was thoroughly horrified and hurried back to the laboratory to tell Professor Jones. How could a scientific research worker turn to a Christian Scientist? I felt quite remiss that I had dragged poor Miss Rose around Madison in wet, snowy weather and was very embarrassed. Prof looked at me with his benign smile. (Mrs. L. R. was a Christian Scientist.) He said: "Whether we call it common sense or Christian Science. . . ." I was duly reprimanded, but never again offered to help Miss Rose.

During the flu epidemic that winter of 1918–19, Eugene Roark, one of the favorite students of the department died of the flu. The sadness in the department was deeply felt by everyone. Prof left no stone unturned in thinking of Roark's mother. I remember that he asked Fred, who did much of the photography for the department to go to the cemetery to take a picture for Roark's mother of the flowers on the grave.

Being a good Republican he looked with disdain on me when he discovered that I voted for Cox instead of Harding. He did not quite understand how I could have acquired such ideas.

Prof was always concerned about his students. He did not like to have the women working at night or on holidays. One night I wanted to take care of some cultures or something. As I was coming out of the building, there was Prof looking at me with great disapproval. Not a word was said, but I knew what he thought.

The great care he took of all his students may be illustrated by his and Mrs. Jones' care when I had an appendix operation. I think it was September 1919. Since I was over 21, the University Clinic could operate without parental consent, but they took the pains, not only to telegraph my family, but also to inform Professor Jones, who, with Mrs. Jones stayed at the hospital until my operation was over. I always felt the Joneses showed unusual kindness.

Not too long after the war was over, the big west laboratory which had been used by the Department of Horticulture was turned over to the Department of Plant Pathology. This gave space to those of us who were employed by the Federal Government. At an enormous table were Charles Drechsler, Helen Johann, Grace Wineland, Ben Koehler, Luciel Bartholomew, and myself.

There was the occasion when someone was consulting Prof about E. T. Bartholomew as a candidate for a position. Prof thought it would be good for this person to meet Mrs. Bartholomew. In his tactful way he thought it best not to call Lucile into the office, but said to her: "This gentleman will be leaving about such and such a time. You just be going by my office about that time and I'll introduce you." I was in the laboratory at that time and watched Lucile trying to guess the right moment to be passing.

Prof loving to go hiking. Mrs. Jones did not hike so he would ask his students to go with him. There was one beautiful trip when we walked around Lake Monona on a Sunday afternoon and caught the street car to Madison from Fair Oaks.

One of the best trips we made in the winter of 1919–20. Rose Bracher, the English girl, Harold Rickett, Fred, Prof and myself took the train to Blue Mounds. It was a remarkably beautiful day. As we climbed the Mound, hoar frost was on the trees. We hiked over the Mound down into Walnut Valley carrying our lunch on our backs. When we finally found a beautiful spot near the stream we built a fire. What should Prof discover but that his loaf of bread had somehow fallen out of his pack. He was quite chagrined, but we had plenty to eat. From there we hiked to Barneveld and caught the afternoon train home.

Another noteworthy trip was in the spring of 1921, I think. Professor Jones belonged to some outing organization. (I cannot remember just what.) This group took hiking trips. Prof felt free to invite students. So Fred, Clifford Leonard, Edna Feltges, and I were invited. In the group were Judge and Mrs. Rosenberry, Professor Cole of the Genetics Department, Dean Russell, and a naturalist from Baraboo. We took the morning train to Devil's Lake, climbed the east bluff, walked along the top to Parfrey's Glen and ate our lunch in the upper part of Parfrey's Glen. I remember that it was at that spot Dean Russell taught us to cook John Burroughs' Brigand Steak. In the afternoon we found our way to Merrimac where we caught the afternoon train to Madison.

The first Mrs. Jones' death came without warning at night. It was said that Prof recognized it some time in the night, but sat quietly with complete self control not to disturb anyone until morning.

I think he was so lonesome after her death that he invited students to his house Sunday evenings, each person participating in getting the supper. After eating we read poetry aloud. I remember especially reading Robert Frost with him.

I've looked back at the time when he showed us some beautiful old furniture. I was too young to appreciate furniture. All I thought of was the extra work of dusting. I said so and he reprimanded me very firmly.

To show Prof's tactfulness, there was the incident of his brief visit to Harvard. When he returned to Madison, he explained to me why he had not seen my father. He said: "Were I leading the party, I would have gone to the Agassiz Museum to see your father."

He was Fred's and my advisor when we were considering marrying. For a third person to take such infinite pains to advise us is somehow inconceivable now. I remember he had me go into his office three days in succession to report how I felt on the matter. He said that men, like Fred, took marriage very seriously. Whereas in his youth the question was just who was he to take to the next dance. After Fred and I were married, Prof was heard to say that the "important thing now is for my students to marry." He advised them all: the Doolittles, the Walkers, the Rikers. So the department gained quite a reputation in Washington for being a place conducive to marriage. It was as if, since he did not have children of his own, that he, not only devoted himself to their professional welfare, but also to their personal interests as if they were his own.

Professor Jones' attitude toward women's taking the Ph.D. was rather significant. He encouraged them to take the master's degree, but said that the Ph.D. was instituted for the masculine mind and not suited to the feminine mind. I sometimes wondered whether his first wife's intellectual position affected this attitude toward women. (The first Mrs. L. R. was very sweet and worked without question for her husband's interests. When she was not able to entertain, they took friends out to dinner. She was always very cordial.) So far as I know Charlotte Elliott was the first woman to take the Ph.D. Audrey Richards and Eloise Gerry followed, but they were employed at the Forest Products Laboratory. I remember that Prof explained to me the reason he allowed himself to encourage Charlotte, but his exact words I cannot remember. There was an occasional bitter feeling among the women. Nevada Evans, who married David Schmidt, wanted to take her degree and always held a little resentment that Prof. did not approve. I remember at least one other case.

Prof used to say to me that I should continue always to study. There was no mistake about that, but I should not work for the Ph.D. He said it was better I should operate the cook stove than the autoclave. Most of us fell into the pattern of accepting his recommendations. (I suffered many years for lack of a Ph.D.)

One incident might be recorded. The year has gone from my mind. It was a time when the AAAS was electing a president with the mantle falling on the biologists. L. R. was the logical person and the most popular. There was, however, a little jealousy on the part of Dr. E. J. Kraus. L. R. was nominated. Kraus asserted himself and nominated Dr. C. E. Allen. That divided the vote so that the biology group lost the presidency. It was very disappointing to those of us devoted to Dr. L. R.

So many times his concern for the other fellow was evident. I think it may have been while they still lived in the house on Regent Street that Prof arrived early one morning at our door with vegetables from his garden. I can picture that very kindly face giving us vegetables early in the morning. He used to have a garden when they lived on Regent Street. Later there came a time when he decided it did not really pay financially to keep a garden.

Years later, after he had retired and he and Mrs. Anna Jones were spending their summers in Vermont, we visited them. We were on our way back to Madison after a visit with our families and stopped at the Jones' house. Our party consisted of our three children and my nephew who was to enter the University of Wisconsin. The L. R. Joneses had everything beautifully planned for us. "What would have the best educational value for the children?" Prof asked. I think it was to the slate mines he took us for a lesson in geology.

CHAPTER 29

With One Foot in the Furrow—A Perspective for the Future

Christen D. Upper

At the time this department was founded, most plows were pulled by a team of horses. The plowman followed the plow, walking in the furrow. Both of his hands grasped the handles of the heavy implement to guide it. The mechanization of agriculture has changed this practice. By the time that J. C. Walker suggested to Paul Williams that he keep "one foot in the furrow" (Preface) most plows were pulled by tractors. Walking in the furrow was an anachronistic means of locomotion. The plowman no longer walked in the furrow; instead he drove the tractor. Most of those who still followed a plow, at least in Wisconsin, did so because their religion prohibited use of a tractor. In this context, was Walker really suggesting that we focus our attention on outmoded agricultural practice? I think not. The statement does illustrate how heavily our idioms of agriculture are influenced by memory and history. Even a man who had made a practice of being thoroughly informed of contemporary agricultural practice throughout his entire career chose this outmoded term to symbolize modern agriculture. By using this backward-looking symbol, Walker provided us with a sound warning for how not to cope with the future. The view of the department's future that comes most readily to most peoples minds is a view of the past department. Perhaps new (younger) faces are substituted for some (older) individuals. Of course all of those old problems that have plagued us for years will miraculously yield to all of the powerful new techniques. But, by and large, we still will be working on the same crops, same sorts of responsibilities, the same organization for business and teaching the same classes from (miraculously lucid new editions of) the same texts. An object in motion tends to stay in motion unless acted upon by an external force. . . .

There are, however, external forces sufficient to cause us to change. First, our society, our university, and the agriculture of our state change. The plowman drives a tractor today, he does not walk in the furrow behind the plow. Nor can we expect him to. If we don't assure that our organization and personnel are able to serve these changing institutions, the social, educational and economic interests of the state may (rightfully) inquire about the justification for our existence. Secondly, our science changes. (An optimist might say it progresses.) And knowledge developed in other disciplines becomes available for application to plant pathology. How can we perceive of ourselves as leaders if others are the first to endorse each fad? Thus, changes—perceived or real—in and around the field of plant pathology provide substantial force toward reshaping our view of where we should be and what we should become.

Our challenge is to balance the need to respond to changes in our world with the requirements of our day-to-day existence. If we are really authorities on plant pathology and its relationship to society, we ought to be better able to shape a plant pathology department for the future than other individuals and institutions. At least, if we err, either on the side of resisting change too vigorously or of accepting too much or the wrong change without adequate thought, it will be an error of our own professional judgement; not a mistake forced upon us from without. For the past fifteen years we have developed and continuously updated a departmental long range plan, and used the plan as a functional contingency plan for faculty hiring. By use of this mechanism we have maintained balance and strength in the department while modernizing. We have retained rational control of the process. Our response has been made after careful consideration of our science, our state and its agriculture, and our university. In this way, we try to be ready to meet needs and capitalize on opportunities as they arise—not to hire faculty only in response to external pressures. A reasoned approach to the future of this department (we hope) continues each time we hire a new faculty member. In the past two years, we have added eight of our current faculty of twenty-five. There have been five retirements. The impact these changes and additions will have on the programs and directions of the department is currently an unknown, which will only gradually reveal itself over the next several years. It will undoubtedly be an important part of the history of the department on its 100th anniversary. However, Walker's advice can be used to anticipate the effectiveness of our preparation for the future.

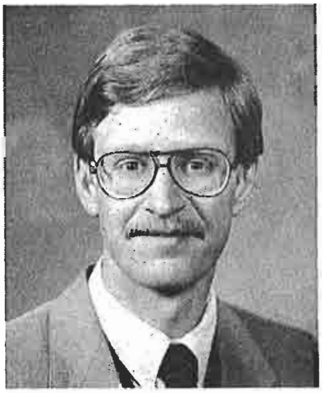
To walk with "one foot in the furrow" is a strange means of locomotion—not the act of a serious plowman, but the sort of thing a child might do in play. Might Walker have meant that field research should be regarded as child's play—something not to be taken too seriously? Of course not. But might an attitude that tends to regard field research as applied research and as something of less interest—perhaps as something not to be taken too seriously—have crept into our collective thinking? Has this led to a "pecking order" in our science in which field research is equated with "child's play" and relegated to a lower level of importance than research at the "molecular level", which is equated to basic research, and is therefore of the utmost importance and difficulty (regardless of how mundane or applied it might be)? Might this order of importance have influenced the direction in which the better students are directed? In planning for the future, how can we achieve balance—quality in all areas of plant pathology—if our perception of quality is more dependent on the direction in which we look than upon what we see there? As we move forward, however, the need is ever apparent for breadth, balance, and most of all, quality in all aspects of plant pathology. Departmental progress must include some with feet in the field, and others with their buckles to the bench.

Does walking "with one foot in the furrow" imply license to skip every other step, to bound ahead on assumption alone, omitting tedious and time-consuming experimental confirmation of one step before progressing to the next? I hope not! Such a means of locomotion is more appropriate to building a house of cards than a sound science. Any proper plowman knows to keep both feet in the furrow and both hands on the plow to get the job done right! With the ease of recognition afforded those on the faculty at Wisconsin, it is quite possible to achieve leadership among plant pathologists by talking to the right people, volunteering for the right committees, soliciting the right invitations, and doing enough in the laboratory to be recognized as "being very active" in a particular field. Leadership of this sort, although very supportive of the fraternity of plant pathologists, does little to advance plant pathology as a science.

If we are to provide the sort of leadership our field needs, we must lead in the science of plant pathology, not merely lead among plant pathologists. Progress in science, after all, depends upon development of concepts that withstand the tests of experimentation and time. Development of these concepts requires creative individuals who are able to sift the important questions from the chaff of popular dogma and fad and to find experimental approaches appropriate to test them rigorously.

The final message from keeping "one foot in the furrow" is the reminder that plant pathology has its roots and its reality in agriculture and the real world. We can expect our efforts to be divided among a number of activities. There will be the inevitable committees here, there and everywhere on which to spend our time and leave our mark. We must teach—in the classroom and in the growers' meetings, for discovery is meaningless if it is not shared with society. But most important of all, there must be real discovery. Although we may place great importance in instruction, administration, extension, academic politics, leadership and all of the related professional activities, what plant pathology really has to offer science and agriculture alike is Plant Pathology. All of these other activities, particularly instruction, are hollow if they are not supported by a sound science. If we are to lead in this field, we must continue to lead in plant pathology. The cricital challenge for the future of this department is, very simply, how well we select and foster scientists whose research achieves true discovery in the science of plant pathology.

APPENDIX 1
Faculty, Department of Plant Pathology University of Wisconsin, 1910–1985

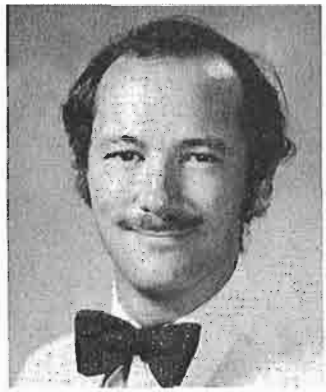


Paul G. Ahlquist, Assistant Professor

B.S., 1976, Iowa State; Ph.D., 1981, Wisconsin, Biophysics (Kaesburg)

Wisconsin, Plant Pathology and Biophysics, 1984–present

Molecular plant virology; structure, evolution and expression of plant virus genomes.

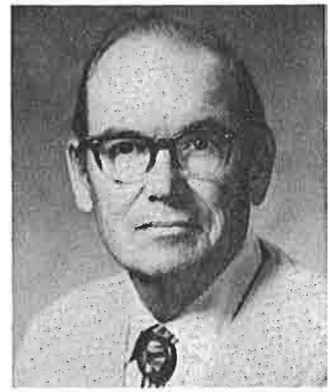


John H. Andrews, Associate Professor

B.S., 1967, McGill; M.S., 1969, Maine; Ph.D., California-Davis, Plant Pathology (Shalla)

Wisconsin, Plant Pathology, 1976–present

Theory and practice of disease control by integrated application of cultural, genetic and chemical means.



Deane C. Arny, Professor Emeritus

B.S., 1939, Minnesota; Ph.D., 1943, Wisconsin, Agronomy and Plant Pathology (Dickson)

Wisconsin, Plant Pathology, 1943–84

Epidemiology of diseases of small grains, alfalfa and corn; breeding for resistance.

John G. Berbee, Professor

B.S., 1949, Toronto; M.S., Yale; Ph.D., 1954, Wisconsin, Plant Pathology (Riker)

Canada Science Service, 1954–57; Wisconsin, Plant Pathology, 1957–present

Forest pathology; nursery diseases; mycorrhizae; intensive poplar culture.

Donald M. Boone, Professor Emeritus

B.S., A.B., 1940, Marion College; Ph.D., 1950, Wisconsin, Plant Pathology (Keitt)

Wisconsin, Plant Pathology, 1956–84

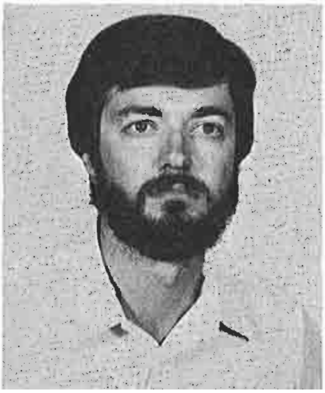
Genetics of pathogenicity of apple scab fungus; diseases of cranberries, strawberries, apples and cherries.

John W. Brann, Assistant Professor Emeritus (D)

B.S.A., 1913, Wisconsin; M.S., 1914, Wisconsin, Plant Pathology (L. R. Jones)

Wisconsin, Plant Pathology, 1916–47

Potato seed certification program.



Murray K. Clayton, Assistant Professor

B. Math., 1979, Waterloo; Ph.D., 1983, Minnesota, Statistics (Berry)

Guelph, 1983–84; Wisconsin, Plant Pathology and Statistics, 1984–present

Sequential decision theory; foundations of statistical inference; curvature problems; biometry

Henry M. Darling, Professor Emeritus

Ph.B., 1931, Ripon College; M.S., 1935, Minnesota; Ph.D., 1942, Minnesota, Plant Pathology (Eide, Stakman)

Wisconsin, Plant Pathology, 1941–76

Viral and fungal diseases of potatoes; potato seed certification program; nematology.

Gustaaf A. de Zoeten, Professor

Cand., 1957, Wageningen; In., 1960, Wageningen; Ph.D., 1965, California-Davis, Plant Pathology (Shalla)

Wisconsin, Plant Pathology, 1967–present

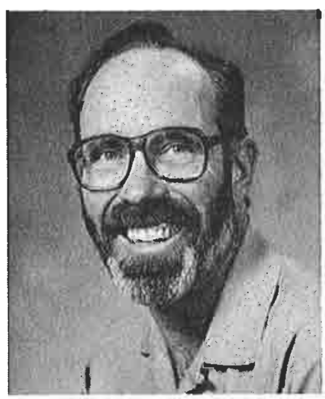
Viral multiplication and translocation; mechanism of cross protection.

James G. Dickson, Professor Emeritus (D)

B.S., 1915, Washington State; M.S., 1917, Wisconsin; Ph.D., Wisconsin, Botany (Overton)

Wisconsin, Plant Pathology, USDA, 1916–61

Cereal diseases, nature of disease resistance, influence of environment on disease development, international agriculture.

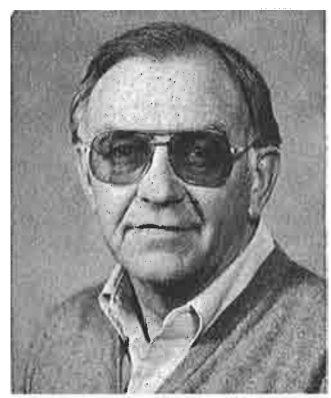


Richard D. Durbin, Professor

B.S., 1952, California-Berkeley; Ph.D., 1957, California-Berkeley, Plant Pathology (Baker)

University of Minnesota, 1958–62; Wisconsin, USDA, Plant Pathology, 1962–present

Structure and mode of action of phytotoxins.



Albert H. Ellingboe, Professor

B.S., 1953, Minnesota; M.S., 1955, Minnesota; Ph.D., 1957, Minnesota, Plant Pathology (Kernkamp)

Michigan State, 1960–80; International Plant Research Inst., 1980–83; Wisconsin, Plant Pathology and Genetics, 1983–present

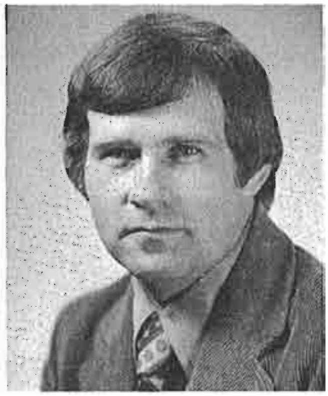
Diseases of field crops; genetics of host-parasite interactions; cloning of genes controlling disease resistance.

Robert W. Fulton, Professor Emeritus

A.B., 1935, Wabash College; Ph.D., Wisconsin, Plant Pathology (J. Johnson)

Wisconsin, Horticulture, USDA, 1946–1955; Wisconsin, Plant Pathology, 1955–84

Characterization of viruses of deciduous fruit trees; genetics of multiparticulate viruses; breeding for disease resistance in tobacco.



Craig R. Grau, Associate Professor

B.S., 1969, Iowa State; M.S., 1971, Iowa State; Ph.D., 1975, Minnesota, Plant Pathology (Kommedahl)

Wisconsin, Plant Pathology, 1976–present

Extension; diseases of corn, soybeans, forages and small grains.

Donald J. Hagedorn, Professor

B.S., 1941, Idaho; M.S., 1943, Wisconsin; Ph.D., 1948, Wisconsin, Plant Pathology (Walker)

Wisconsin, Plant Pathology, 1948–present

Epidemiology and control of bean and pea diseases; breeding for resistance.

Jo Handelsman, Assistant Professor

B.S., 1979, Cornell; Ph.D., 1983, Wisconsin, Molecular Biology (Brill)

Wisconsin, Plant Pathology, 1985–present

Genetics and biochemistry of specificity and antagonism of bacterial pathogens.

Earle W. Hanson, Professor Emeritus

B.S., 1933, Minnesota; M.S., 1939, Minnesota; Ph.D., 1942, Minnesota, Plant Pathology (Stakman)

University of Minnesota, USDA, 1937–46; Wisconsin, Plant Pathology, USDA, 1946–76

Etiology, epidemology, and resistance in cereal and forage crops.

John P. Helgeson, Professor

A.B., 1957, Oberlin; Ph.D., 1964, Wisconsin, Botany (Skoog)

Wisconsin, USDA, Plant Pathology, 1966–present

Development of tissue culture model systems for studying disease resistance; somatic hybridization of crop plants.

Eugene H. Herrling, Special Staff Person

B.S., 1925, Wisconsin

Wisconsin, Plant Pathology, 1927–69

Photographer, draftsman.

Albert C. Hildebrandt, Professor Emeritus

B.S., 1939, Penn State; M.S., 1941, Penn State; Ph.D., 1945, Wisconsin, Plant Pathology (Riker)

Wisconsin, Plant Pathology, 1950–78.

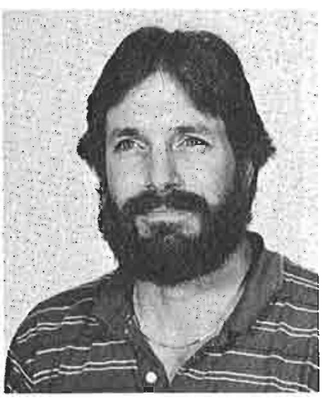
Cell and tissue culture; somatic hybridization; diseases of ornamental plants.

Paul E. Hoppe, USDA (D)

B.S., 1921, Wisconsin; 1924–28, Wisconsin, Plant Pathology (Dickson)

Wisconsin, USDA, Plant Pathology, 1929–1966

Corn diseases with emphasis on seed decays and seedling diseases; breeding for disease resistance.

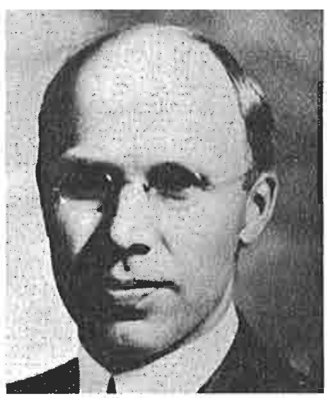


Steven N. Jeffers, Assistant Professor

B.S., 1976, California-Davis; M.S., 1980, Cornell; Ph.D., 1985, Cornell, Plant Pathology (Aldwinckle)

Wisconsin, Plant Pathology, 1985–present

Control strategies for diseases of fruit crops.



Aaron G. Johnson, USDA (D)

B.S., 1907, South Dakota; M.S., 1911, Purdue; Ph.D., 1914, Wisconsin, Plant Pathology (L. R. Jones)

Wisconsin, USDA, 1912–1919.

Diseases of cereal crops.

James Johnson, Professor Emeritus (D)

B.S.A., 1909, Wisconsin; M.S., 1911, Wisconsin; Ph.D., 1918, Wisconsin, Plant Pathology (L. R. Jones)

Wisconsin, Horticulture and Plant Pathology, 1911–1952

Virology; diseases of tobacco.

Fred R. Jones, USDA (D)
B.S., 1912, Maine; M.S., 1914, Wisconsin; Ph.D., 1917, Wisconsin, Plant Pathology (L. R. Jones)
Wisconsin, USDA, Plant Pathology, 1917–1950
Diseases of canning peas; bacterial wilt of alfalfa.

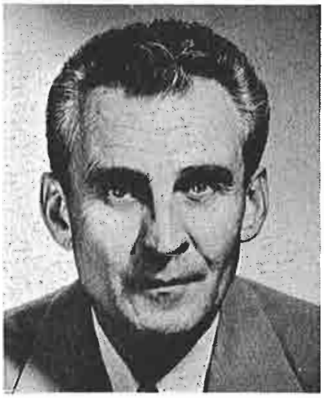
L. Ralph Jones, Professor Emeritus (D)
Ph.B., 1889, Michigan; Ph.D., 1904, Michigan, Botany (Spalding)
University of Vermont, 1889–1909; Wisconsin, Plant Pathology, 1910–1935
Influence of environmental factors on disease development; breeding for disease resistance; founder of the department.

George W. Keitt, Professor Emeritus (D)
B.S., 1909, Clemson; M.S., 1911, Wisconsin; Ph.D., 1914, Wisconsin, Plant Pathology (L. R. Jones)
Wisconsin, Plant Pathology, 1914–1957
Epidemiology and control of fruit crop diseases; genetics of the apple scab fungus.

Arthur Kelman, Professor
B.S., 1941, Rhode Island; M.S., 1946, North Carolina State; Ph.D., 1949, North Carolina State, Plant Pathology (Jensen)
North Carolina State, 1948–65; Wisconsin, Plant Pathology and Bacteriology, 1965–present
Ecology, epidemiology and physiology of soft rot bacteria; mechanisms of pathogenesis by bacterial pathogens; mechanisms of disease resistance.

John D. Kemp, Professor
B.S., 1962, California-Los Angeles; Ph.D., 1965, California-Los Angeles, Biochemistry (Atkinson)
Wisconsin, USDA, Plant Pathology, 1968–85
Molecular biology of crown gall disease.

James E. Kuntz, Professor Emeritus
B.A., 1941, Ohio Wesleyan; M.S., 1942, Wisconsin; Ph.D., 1945, Wisconsin, Plant Pathology (Walker)
Wisconsin, Plant Pathology and Forestry, 1947–84
Control of oak wilt; black walnut and butternut diseases.



Russell H. Larson, Professor (D)

Ph.B., 1928, Ripon; M.S., 1930, Wisconsin; Ph.D., 1934, Wisconsin, Plant Pathology (Walker)

Wisconsin, Plant Pathology, 1935–61

Diseases of potatoes, onions and crucifers; virus diseases; breeding for disease resistance.

Sally A. Leong, Assistant Professor

B.A., 1976, California-Berkeley; Ph.D., 1980, California-Berkeley, Comparative Biochemistry (Neilands)

Wisconsin, USDA, Plant Pathology, 1983–present

Molecular genetics of host-parasite interactions; role of siderophores in pathogenesis.

Ann E. MacGuidwin, Assistant Professor

B.S., 1972, Michigan State; M.S., 1979, Florida; Ph.D., 1983, Michigan State, Entomology-Nematology (Bird)

Wisconsin, Plant Pathology, 1984–present

Ecology and population dynamics of plant parasitic nematodes.

Douglas P. Maxwell, Professor

B.A., 1963, Nebraska Wesleyan; Ph.D., 1968, Cornell, Plant Pathology (Bateman)

Fungal physiology; breeding for disease resistance in forage legumes.

John E. Mitchell, Professor Emeritus

B.S., 1939, Minnesota; Ph.D., 1948, Wisconsin, Biochemistry (Burris)

US Army Biological Branch, 1948–56; Wisconsin, Plant Pathology, 1956–84

Physiology and cytology of the pea root rot pathogen; etiology of potato early dying; diseases of ginseng.

J. Duain Moore, Professor Emeritus and Director Emeritus Expt. Farms

B.S., 1939, Penn State; Ph.D., 1945, Wisconsin, Plant Pathology (Keitt)

Wisconsin, Plant Pathology, 1945–80

Epidemiology and control of fungal, bacterial and viral diseases of stone and pome fruits; effects of fungicides on fruit quality.

Jennifer L. Parke, Assistant Professor

B.A., 1975, California-Santa Cruz; Ph.D., 1982, Oregon State, Botany and Plant Pathology (Linderman, Trappe)

Wisconsin, Plant Pathology, 1984–present

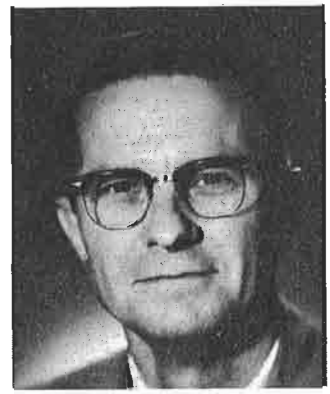
Ecology and biocontrol of soil-borne pathogens.

Robert F. Patton, Professor

B.S.F., 1940, Michigan State; M.S., 1942, Idaho; Ph.D., 1952, Wisconsin, Plant Pathology (Riker)

Wisconsin, Plant Pathology and Forestry, 1951–present

Epidemiology, cytology and control of white pine blister rust; *Scleroderris* pine canker; *Armillaria* root rot.



Glenn S. Pound, Professor Emeritus and Dean Emeritus of CALS

B.A., 1940, Arkansas; Ph.D., 1943, Wisconsin, Plant Pathology (Walker)

USDA, Mount Vernon, Washington, 1943–46; Wisconsin, Plant Pathology, 1946–79

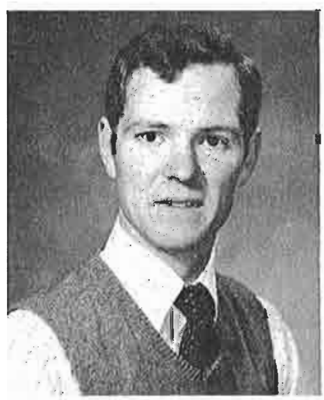
Diseases of crucifers, radish, tomato and spinach; viral diseases of vegetables; mineral nutrition of plants in relation to disease.

A. Joyce Riker, Professor Emeritus (D)

B.S., 1919, Oberlin; M.A., 1920, Cincinnati; Ph.D., 1922, Wisconsin, Plant Pathology (Keitt)

Wisconsin, Plant Pathology, Bacteriology and Forestry, 1922–64.

Chemical and physical factors affecting tumor development in the crown gall disease; plant tissue culture; diseases of forest trees.

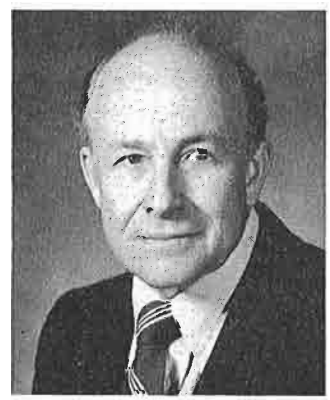


Douglas I. Rouse, Associate Professor

B.S., 1974, Ottawa, Kansas; M.S., 1976, Colorado State; Ph.D., 1979, Penn State, Plant Pathology (Nelson, MacKenzie)

Wisconsin, Plant Pathology, 1979–present

Mathematical characterization of pathogen variation and plant epidemics.



Luis Sequeira, Professor

A.B., 1949, Harvard; A.M., 1950, Harvard; Ph.D., 1952, Harvard, Biology (Weston)

United Fruit Company, 1953–61; Wisconsin, Plant Pathology and Bacteriology, 1961–present

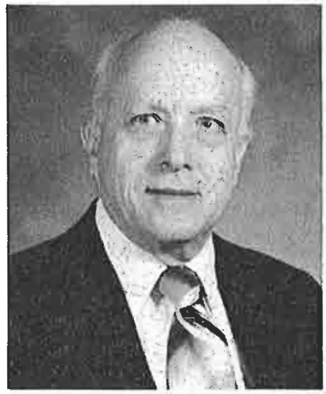
Mechanisms of induced resistance; phytobacteriology; southern bacterial wilt; diseases of lettuce.

Steven A. Slack, Professor

B.S.A., 1969, Arkansas; M.S., 1971, Arkansas; Ph.D., 1974, California-Davis, Plant Pathology (Shepherd)

Wisconsin, Plant Pathology, 1975–present

Director of Potato Seed Certification Program; viruses of potatoes; bacterial ring rot of potatoes.

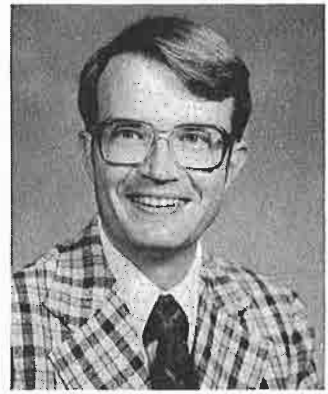


Eugene B. Smalley, Professor

B.S., 1949, California-Los Angeles; M.S., 1953, California-Berkeley; Ph.D., 1957, California-Berkeley, Plant Pathology (Hansen)

Wisconsin, Plant Pathology, 1957–present

Control of Dutch elm disease; mycotoxins in grain and hay.



Walter R. Stevenson, Professor

B.S., 1968, Cornell; Ph.D., 1972, Wisconsin, Plant Pathology (Hagedorn)

Purdue, 1973–79; Wisconsin, Plant Pathology, 1979–present

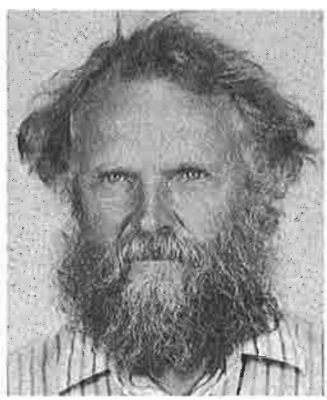
Vegetable extension specialist; diseases of potato and mint.

Gerald G. Thorne, Professor Emeritus (D)

B.S., 1918, Utah State; M.S., 1925, Utah State

USDA, Salt Lake City, 1918–56; Wisconsin, Plant Pathology, 1956–61

Taxonomy and identification of plant parasitic nematodes; biology and control of sugar beet nematode.



Christen D. Upper, Professor

B.S., 1958, Washington State; Ph.D., 1964, Illinois, Biochemistry (Gunsalus)

Wisconsin, USDA, Plant Pathology, 1966–present

Epidemiology of bacterial diseases; role of epiphytic bacteria in frost injury to plants.

Richard E. Vaughan, Professor (D)

B.S., 1907, Vermont; M.S., 1912, Wisconsin, Plant Pathology (L. R. Jones)

Wisconsin, Plant Pathology, 1914–49

Extension plant pathologist.

Earl K. Wade, Professor Emeritus

B.S., 1938, Wisconsin; M.S., 1949, Wisconsin, Plant Pathology (Keitt)

Wisconsin, Plant Pathology, 1946–79

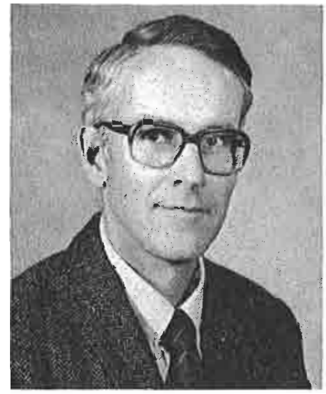
Extension; fruit and vegetable diseases.

John C. Walker, Professor Emeritus

B.S., 1914, Wisconsin; M.S., 1915, Wisconsin; Ph.D., 1918, Wisconsin, Plant Pathology (L. R. Jones)

Wisconsin, USDA, Plant Pathology, 1919–64

Diseases of vegetables; breeding for disease resistance; chemical basis for disease resistance.

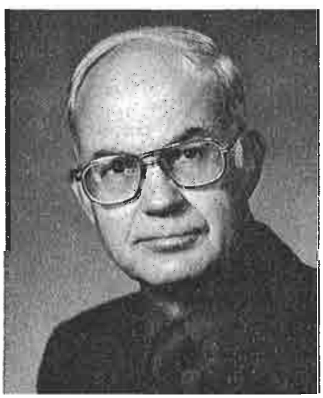


Paul H. Williams, Professor

B.S.A., 1959, British Columbia; Ph.D., 1962, Wisconsin, Plant Pathology (Pound)

Wisconsin, Plant Pathology, 1962–present

Breeding for disease resistance in cabbage, cucumber and radish; methodologies for detection of resistance; crucifer genetics.



Gayle L. Worf, Professor

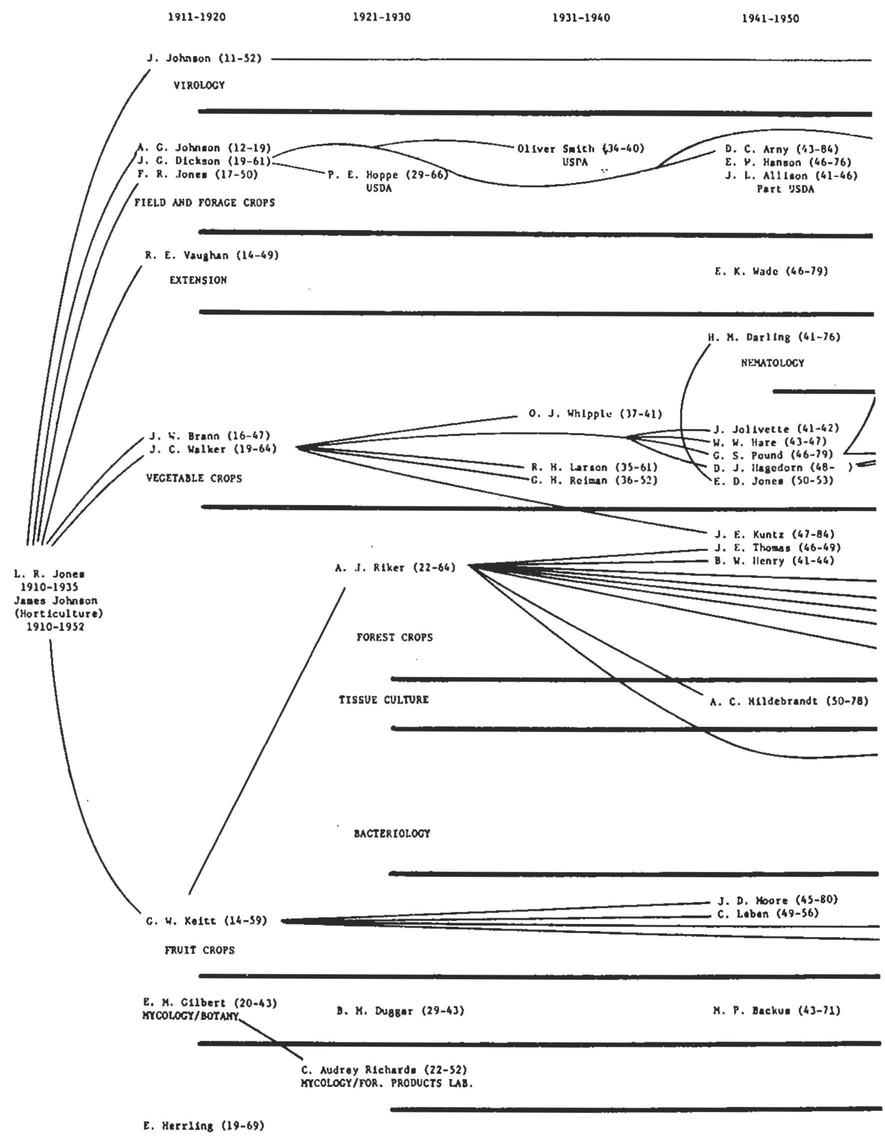
B.S., 1951, Kansas State; M.S., 1953, Kansas State; Ph.D., 1961, Wisconsin, Plant Pathology (Hagedorn)

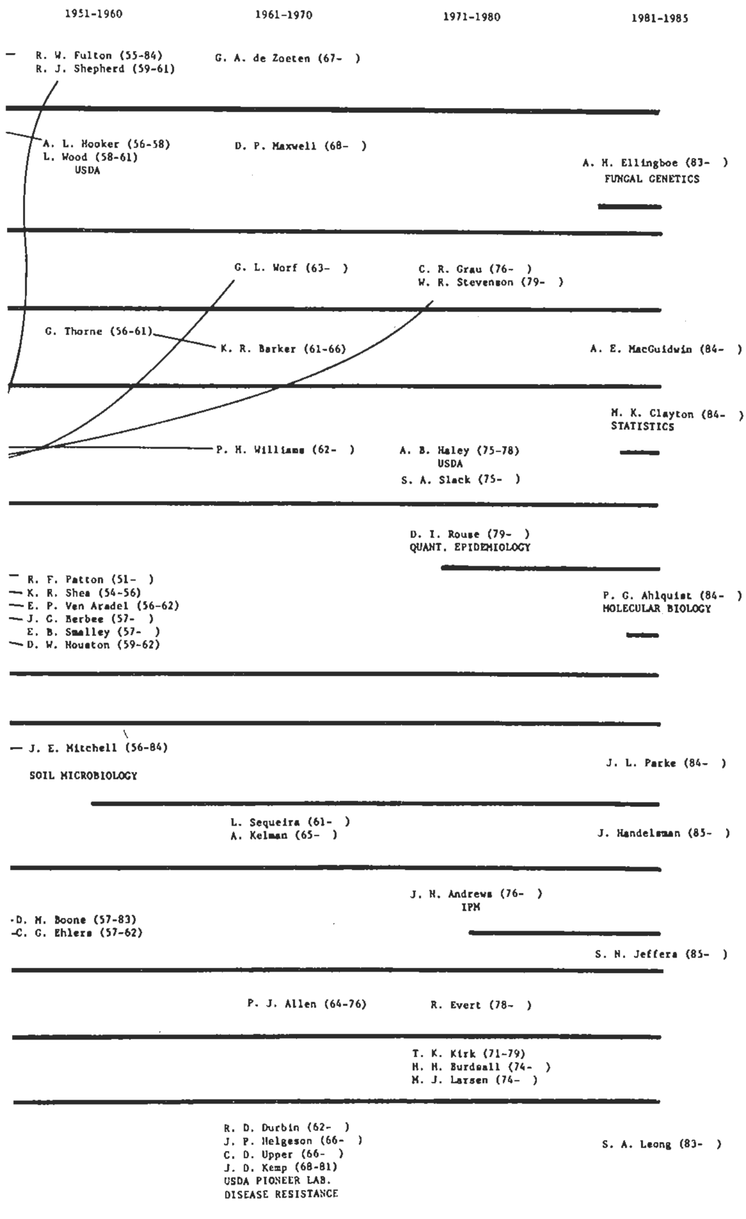
Iowa State, Plant Pathology, 1961–64; Wisconsin, Plant Pathology, 1964–present

Extension; etiology and control of diseases affecting turf, ornamentals and shade trees.

APPENDIX 2

Staffing Patterns, Department of Plant Pathology University of Wisconsin, 1910–1985


1911-1920
1921-1930
1931-1940
1941-1950
J. Johnson (11-52)
VIROLOGY
A. G. Johnson (12-19)
J. G. Dickson (19-61)
F. R. Jones (17-50)
FIELD AND FORAGE CROPS
P. E. Hoppe (29-66)
USDA
Oliver Smith (34-40)
USDA
D. C. Arny (43-84)
E. W. Hanson (46-76)
J. L. Allison (41-46)
Part USDA
R. E. Vaughan (14-49)
EXTENSION
E. K. Wade (46-79)
H. M. Darling (41-76)
NEMATOLOGY
O. J. Whipple (37-41)
J. W. Brann (16-47)
J. C. Walker (19-64)
VEGETABLE CROPS
R. H. Larson (35-61)
C. H. Reiman (36-52)
J. Jolivette (41-42)
W. W. Hare (43-47)
G. S. Pound (46-79)
D. J. Hagedorn (48-)
E. D. Jones (50-53)
J. E. Kuntz (47-84)
J. E. Thomas (46-49)
B. W. Henry (41-44)
L. R. Jones
1910-1935
James Johnson
(Horticulture)
1910-1952
A. J. Riker (22-64)
FOREST CROPS
TISSUE CULTURE
A. C. Hildebrandt (50-78)
BACTERIOLOGY
G. W. Keitt (14-59)
J. D. Moore (45-80)
C. Leben (49-56)
FRUIT CROPS
E. M. Gilbert (20-43)
MYCOLOGY/BOTANY
B. M. Duggar (29-43)
M. P. Backus (43-71)
C. Audrey Richards (22-52)
MYCOLOGY/FOR. PRODUCTS LAB.
E. Herrling (19-69)


1951-1960
1961-1970
1971-1980
1981-1985
R. W. Fulton (55-84)
R. J. Shepherd (59-61)
G. A. de Zoeten (67-)
A. L. Hooker (56-58)
L. Wood (58-61)
USDA
D. P. Maxwell (68-)
A. H. Ellingboe (83-)
FUNGAL GENETICS
G. L. Worf (63-)
C. R. Grau (76-)
W. R. Stevenson (79-)
G. Thorne (56-61)
K. R. Barker (61-66)
A. E. MacGuidwin (84-)
M. K. Clayton (84-)
STATISTICS
P. H. Williams (62-)
A. B. Haley (75-78)
USDA
S. A. Slack (75-)
D. I. Rouse (79-)
QUANT. EPIDEMIOLOGY
R. F. Patton (51-)
K. R. Shea (54-56)
E. P. Van Arsdel (56-62)
J. G. Berbee (57-)
E. B. Smalley (57-)
D. W. Houston (59-62)
P. G. Ahlquist (84-)
MOLECULAR BIOLOGY
J. E. Mitchell (56-84)
SOIL MICROBIOLOGY
J. L. Parke (84-)
L. Sequeira (61-)
A. Kelman (65-)
J. Handelsman (85-)
J. H. Andrews (76-)
IPM
D. M. Boone (57-83)
C. G. Ehlers (57-62)
S. N. Jeffers (85-)
P. J. Allen (64-76)
R. Evert (78-)
T. K. Kirk (71-79)
H. H. Burdsall (74-)
M. J. Larsen (74-)
R. D. Durbin (62-)
J. P. Helgeson (66-)
C. D. Upper (66-)
J. D. Kemp (68-81)
USDA PIONEER LAB.
DISEASE RESISTANCE
S. A. Leong (83-)

APPENDIX 3
Staffing Pattern of Plant Pathology 1910–1985

Persons holding Professorial Positions

Name	Degree Granting University	Year of Appointment	Year of Budget Exit	Remarks
L. R. Jones	Michigan	1910	1935	Founder of department
A. G. Johnson	Wisconsin	1912	1919	Left to go to USDA/ Washington, D.C.
G. W. Keitt	Wisconsin	1914	1959	Chairman, 1930–55; fruit crop diseases
R. E. Vaughan	Wisconsin	1914	1949	Extension plant pathologist
J. W. Brann	Wisconsin	1916	1947	Potato seed certification program
J. G. Dickson	Wisconsin	1919	1961	Field crop diseases
J. C. Walker	Wisconsin	1919	1964	Vegetable crop diseases
E. M. Gilbert	Wisconsin	1920	1943	Left budget due to shifts between departments; primary app't was in botany
A. J. Riker	Wisconsin	1922	1964	Crown gall disease; forest pathology
E. H. Herrling	Wisconsin	1928	1969	Not a professor, but a special staff person with professional skills
B. M. Duggar	Cornell	1929	1943	Primary app't was in Botany; plant physiology
R. H. Larson	Wisconsin	1935	1961	Viruses of potatoes, died in 1961
G. H. Rieman	Wisconsin	1936	1952	Left due to budget shifts between departments
H. M. Darling	Minnesota	1941	1976	Potato seed certification program; nematology
M. P. Backus	Wisconsin	1943	1971	Taught lab portion of 101 but did not show on budget due to Gilbert's being on budget; mycology
J. Johnson	Wisconsin	1943	1952	Functioned as a plant pathologist years before appearing in budget; virology

Name	Degree Granting University	Year of Appointment	Year of Budget Exit	Remarks
D. C. Arny	Wisconsin	1944	1984	Field crop diseases
W. W. Hare	Wisconsin	1944	1947	Went to Miss. State Univ.
J. D. Moore	Wisconsin	1945	1980	Fruit crop pathology; Director of Exp. Farms, 1974–80
J. E. Thomas	Wisconsin	1946	1949	Went to Okla. State Univ.
G. S. Pound	Wisconsin	1946	1979	Chairman 1954–64; dean of CALS 1964–79; acting chancellor 1977; vegetable crop diseases
E. K. Wade	Wisconsin	1946	1979	Extension; fruit and vegetable crop diseases
J. E. Kuntz	Wisconsin	1947	1984	Forest pathology
D. J. Hagedorn	Wisconsin	1948		Vice W. W. Hare
C. C. Leben	Wisconsin	1949	1956	Went to Eli Lilly Co.; then Ohio State University
A. C. Hildebrandt	Wisconsin	1950	1978	Tissue culture, ornamental plant diseases
E. W. Hanson	Minnesota	1946	1976	Vice Allison in 1946 but did not appear on state budget until 1951
R. F. Patton	Wisconsin	1951		Forest pathology
K. P. Shea	Wisconsin	1954	1956	Went to Weyerhaeuser Lumber Co.–Centralia, WN
R. W. Fulton	Wisconsin	1955	1984	Functioned as a plant pathologist years before entering budget; virology; tobacco diseases
G. Thorne	Utah	1956	1961	Nematology
J. E. Mitchell	Wisconsin	1956	1984	Chairman 1975–80; soil-borne pathogens
A. L. Hooker	Wisconsin	1956	1958	USDA; went to University of Illinois; field crop pathology
J. G. Berbee	Wisconsin	1957		Forest pathology
D. M. Boone	Wisconsin	1957	1984	Cranberry diseases; fungal genetics
C. G. Ehlers	Wisconsin	1957	1962	Became a County Extension agent
E. B. Smalley	California–Berkeley	1957		Dutch elm disease; mycotoxins
R. J. Shepherd	Wisconsin	1959	1961	Went to Univ. California–Davis; virology
D. R. Houston	Wisconsin	1959	1962	Forest pathology, went to Northeast Forest Exp. Sta., New Haven, CT

Name	Degree Granting University	Year of Appointment	Year of Budget Exit	Remarks
K. R. Barker	Wisconsin	1961	1966	Went to N.C. State Univ.; nematology
L. Sequeira	Harvard	1961		Disease physiology; phytobacteriology
R. D. Durbin	Minnesota	1962		USDA; disease physiology
P. H. Williams	Wisconsin	1962		Vegetable crop diseases; disease resistance
G. L. Worf	Wisconsin	1963		Extension; turf, ornamental and shade tree diseases
P. J. Allen	California–Berkeley	1964	1976	Primary app't was in botany; died in 1976; fungal physiology
A. Kelman	N.C. State Univ.	1965		Chairman 1965–75
J. P. Helgeson	Wisconsin	1966		USDA; tissue culture
C. D. Upper	Illinois	1966		USDA; epidemiology of bacterial diseases
G. A. de Zoeten	California–Davis	1967		virology
D. P. Maxwell	Cornell	1968		Chairman 1980–present; forage crop diseases
J. D. Kemp	California–Los Angeles	1968	1981	USDA; Left to go to Agrigenetics; became adjunct
A. B. Haley	California	1975	1978	USDA; vegetable pathology
S. A. Slack	California–Davis	1975		Potato seed certification program; potato diseases
J. H. Andrews	California–Davis	1976		Integrated control
C. R. Grau	Minnesota	1976		Extension, field crop diseases
R. F. Evert	California–Davis	1978		Primary app't in botany; plant anatomy
D. I. Rouse	Pennsylvania	1979		Quantitative epidemiology
W. R. Stevenson	Wisconsin	1979		Extension; vegetable crop diseases
S. A. Leong	California–Berkely	1983		USDA; molecular biology
P. G. Ahlquist	Wisconsin	1984		Virology; joint app't with biophysics
A. H. Ellingboe	Minnesota	1984		Field crop diseases; genetics
M. K. Clayton	Minnesota	1984		Biometry; joint app't with statistics
A. E. MacGuidwin	Michigan	1984		Nematology
J. L. Parke	Oregon	1984		Soil-borne plant pathogens
J. Handelsman	Wisconsin	1985		Phytobacteriology
S. N. Jeffers	Cornell	1985		Fruit crop diseases

Persons Who Were Primarily in Adjunct Positions

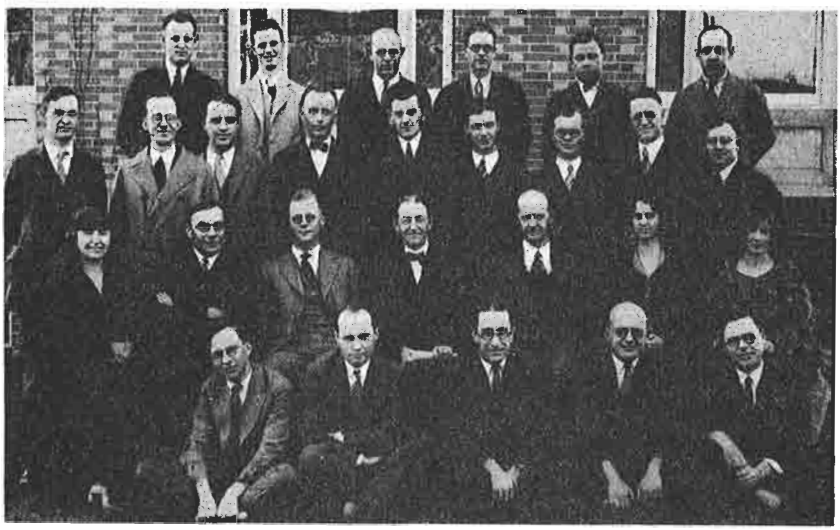
Name	Degree Granting University	Year of Appointment	Year of Budget Exit	Remarks
F. R. Jones	Wisconsin	1917	1950	USDA, legume crop diseases
P. E. Hoppe	Wisconsin	1929	1966	USDA, corn diseases
O. F. Smith	Wisconsin	1934	1940	USDA—transferred to Nevada
E. P. Van Arsdel	Wisconsin	1956	1962	USDA Forest Service; transferred to Great Lakes Regional Laboratory
A. D. Dickson	Wisconsin	1933	1973	USDA, Malt and Barley Lab. director
J. L. Allison	Minnesota	1941	1946	USDA; left to go to USDA/ Washington, Beltsville
L. S. Wood	Minnesota	1958	1961	USDA, returned to S.D. State University
M. J. Kaufmann	Illinois	1957	1958	Grass pathologist left to become Agr. Missionary
V. G. Perry	Wisconsin	1955	1958	USDA, went to Univ. Florida
C. A. Richards	Wisconsin	1922	1952	Lecturer from Forest Products Lab.
T. C. Scheffer	Wisconsin	1935	1968	Forest Products Lab
R. M. Lindgren	Minnesota	1946	1963	Lecturer from Forest Products Lab.
T. K. Kirk	North Carolina	1971	1979	Forest Products Lab.; transferred to bacteriology
H. H. Burdsall	Cornell State Univ.	1974		Forest Products Lab.
M. J. Larsen	New York–Syracuse	1974		Forest Products Lab.
J. D. Kemp	California–Los Angeles	1981	1985	Left to go to New Mexico State University

APPENDIX 4

Students Through the Decades

1914

Front row, L to R: O. A. Reinking, J. W. Brann, J. C. Walker, M. W. Gardner, E. W. Roark
Back row, L to R: H. G. MacMillan, A. G. Johnson, C. E. Allen, R. H. Denniston, Mrs. P. M. Smith, J. B. Overton, G. W. Keitt, Mina Willis, Otto Appel (visitor), Johanna Westerdijk (visitor), C. N. Frey, L. R. Jones, J. J. Davis



1926

Front row, L to R: F. L. Wellman, R. M. Caldwell, G. H. Conant, R. E. Nolan, J. C. Walker
2nd row, seated, L to R: Regina Rker, James Johnson, G. W. Keitt, L. R. Jones, E. M. Gilbert, Florence Markin, Isme Hoggan
3rd row, standing, L to R: R. E. Vaughan, A. J. Riker, E. E. Wilson, P. E. Hoppe, J. M. Hamilton, J. C. McKee, W. M. Banfield, J. G. Dickson, N. Mogendorff
Back row, L to R: W. J. Zaumeyer, A. Weed, P. W. Miller, R. Sprague, T. G. Fajardo, H. R. Angell

1935

Front row, L to R: B. M. Duggar, N. J. Giddings, J. C. Walker, L. R. Jones, G. H. Rieman, O. F. Smith
2nd row, L to R: F. R. Jones, C. T. Wei, V. A. Wright, D. E. Pryor, D. R. Ozanne, J. P. Jolivette, O. C. Whipple, M. W. Felton
3rd row, L to R: S. S. Ivanoff, R. D. Wilson, S. B. Locke, J. G. McLean, W. B. Allington, J. A. Torrie, J. G. Dickson
Back row, L to R: C. Chiao, A. J. Riker, L. M. Josephson, E. M. Gilbert, L. F. Roth, B. J. Sallans, James Johnson

1945

Front row, L to R: W. J. Reiner, J. D. Moore, G. R. Grimm, R. H. Gruenhagen, G. Farr, J. L. Allison, C. T. Fang, F. R. Jones, C. Wang, J. C. Walker, J. F. Schafer, R. E. Vaughan, W. F. Chiu, A. C. Hildebrandt, M. E. Gallegly, K. S. Thind, G. W. Bruehl, D. C. Arny
Back row, L to R: R. H. Larson, W. C. Hatfield, C. W. Schaller, P. E. Hoppe, H. M. Darling, J. S. Boyle, D. M. Hamilton, R. Hodgson, H. E. Heggestad, A. M. Gorenz, E. L. Moore, O. H. Calvert, R. E. Foster, R. G. Grogran, T. N. Theis, J. E. Thomas, Helen Johann, C. C. Leben, Nedra Utech, Irene Hodgson, J. G. Dickson

1956

Front row, L to R: G. P. Singh, C. Garces, P. Chen, M. M. Thaung, E. K. Wade, A. L. Hooker, R. H. Larson, K. R. Shea, V. G. Perry, D. M. Boone, R. Syamananda, P. Tsao

2nd row, L to R: C. R. Drake, T. Susaki, D. Srivastava, L. V. Edgington, J. M. Kuntz, A. J. Riker, R. W. Scott, R. F. Patton, H. M. Darling, E. W. Hanson, D. J. Hagedorn, B. C. Knight, G. W. Welkie, J. E. Nighswander

Back row, standing, L to R: W. S. Kim, D. M. Kline, R. T. Sherwood, W. J. Reiner, W. R. Phelps, R. H. Kurtzman, M. R. Nelson, K. L. Callahan, J. C. Horton, S. D. VanGundy, G. D. Easton, A. H. Steinmetz, D. R. Houston, L. R. Faulkner, L. V. White, A. J. Hansen, A. L. Flangas, A. C. Troemner, F. B. Diez

1966

Front row, L to R: E. Megahed, P. A. Arneson, H. A. Hoitink, W. G. Theis, R. D. Pinney

2nd row, L to R: K. Yoshii, J. C. Watterson, L.-H. Huang, D. Bagga, M. Kalil, S. Schenck, W. S. Gazaway, H. C. Newton, W. T. McGrath

3rd row, L to R: W. F. Marasas, A. Campos, D. W. Johnson, (below) H. T. Bone, R. J. Friend, (above) O. W. Barnett, J. M. Duniway, R. J. Copeman, D. T. Myren

Back row, L to R: J. P. Crill, N. T. Keen, S. M. Saad, C. G. Iverson, J. W. Klink, R. H. Phelps, J. A. Bartz, M. Soto

1975

Front row, L to R: C. D'Arcy, E. Fernandez-Northcote, M. Daub, J. Victoria, J. Omuemu, W. F. Fett
2nd row, L to R: C. A. Lopes, B. Holroyd, D. Cuppels, E. Halk, M. Woodward, S. Lindow
3rd row, L to R: M. Riberio, R. Riberio, A. Gkinis, S. H. DeBoer, O. Tortolero, R. R. Martin
Back row, L to R: J. Pronos, R. D. Reeleder, L. Ciampi, D. Webster, A. Eimanis

1985

Front row, L to R: A. A. Al-Heeti, M. A. Boudreau, G. R. Stanosz, C. S. Young
2nd row, L to R: R. J. McLaughlin, J. W. Pscheidt, D. A. Samac, N. H. Rhodehamel, L. L. Kinkel
3rd row, L to R: K. C. Tzeng, K. K. Knoche, J. B. Mullen, C. A. Jasalavich, E. B. Holub, J. A. Souza Dias, A. L. Bishop, P. W. Bosland, A. W. May
Back row, L to R: W. P. C. Stemmer, S. C. Ingels, B. B. Morris, S. A. Demler, R. H. Proctor, D. E. Mathews

APPENDIX 5

Degrees Conferred by the Department of Plant Pathology at the University of Wisconsin 1911–1985

	Ph.D. degrees		Professor	M.S. degrees		Professor
1911:	None			George W. Keitt		Jones
1912:	Melhus, I. E.		Jones	Bailey, Floyd D.		Jones
	Morse, W. J.		Jones	Vaughan, Richard E.		Jones
1913:	Edson, Howard A.		Jones	Byars, Luther P.	(Mar)	Jones
	Smith, G. M.		Jones	Gilbert, Alfred H.		Jones
				Jagger, I. C.	(Apr)	Jones
				MacMillan, Howard G.		Jones
				Wilcox, R. B.		Jones
1914:	Bartholomew, E. T.		Jones	Brann, John W.		Jones
	Gilbert, E. M.		Jones	Carsner, Eubanks		Jones
	Henderson, M. P.		Jones	Drechsler, Charles F.		Jones
	Johnson, Aaron G.		Jones	Gilman, James C.		Jones
	Keitt, George W.		Jones	Jones, Fred R.		Jones
				McClintock, J. A.		Jones
				Willis, Mina A.		Jones
1915:	None			Gardner, Max W.		Jones
				Hungerford, Charles W.		Jones
				McKay, M. B.		Jones
				Rands, Robert D.		Jones
				Reinking, Otto A.		Jones
				Roark, Eugene W.		Keitt
				Schultz, E. S.		Jones
				Tisdale, Wendell H.		Jones
				Walker, J. Charles		Jones
1916:	None			Coerper, Florence M.		Jones
				Davis, W. J. (M.A.)		Johnson, A. G.
1917:	Carsner, Eubanks		Jones			
	Jones, Fred R.		Jones	Abbott, Roy L.		Jones
	Rands, Robert D.		Jones	Haymaker, Herbert H.	(Mar)	Jones
	Tisdale, Wendell H.		Jones	Tisdale, William B.		Jones
1918:	Doolittle, Sears P.		Jones	Atanasoff, Dimitr		Jones
	Elliott, Charlotte		Jones	Binney, Morgan T.		Jones
	Gardner, Max W.	(Mar)	Jones	Ninman, H. J. (minor)	(Mar)	Jones
	Giddings, N. J.		Jones			
	Johnson, James		Jones			
	Roark, Eugene W.		Keitt			
	Walker, J. Charles					
1919:	Byars, Luther P.		Jones	Slagg, Charles M.		Johnson (J.)
	MacMillan, Howard G.		Jones			

	Ph.D. degrees	Professor	M.S. degrees	Professor
1920:	Atanasoff, Dimitr	Johnson (A. G.)	Foster, Arthur C.	Jones
	Baird, E. A. (minor)	Gilbert	Gray, John	Jones
	Clayton, Edward E.	Jones	Jorstad, Ivar	Jones
	Frey, C. N.	Gilbert	Koehler, Benjamin	Jones
	Richards, Bert L.	Jones	McKinney, Harold H.	Jones
	Snell, Walter H.	Jones	Seymour, Edith	Jones
	Tisdale, William B.	Jones	Sherwood, E. C.	Jones
	Crowning, Harold (minor)		Teodoro, Nicanor G.	Jones
			Weber, George F.	Johnson (A. G.)
			Welles, Colin G. (minor)	Jones
1921:	Dickson, James G. (minor) (Jan)	Jones	Bitterman, Ruth	Jones
	Gerry, Eloise (minor)	Jones	Bailey, Ernest	Jones
	McFarland, F. T.	Jones	Bracher, Rose	Jones
	Stover, Wilmer G.	Johnson (J.)	Fellows, Hurley	Jones
			Jones, Leon K. (Jan.)	Keitt
			Leukel, Robert W.	Johnson (A. G.)
1922:	Davis, William H.	Jones	Bahadur, Mohindra	Jones
	Humphrey, Clarence J. (minor)	Jones	Boyle, Connell (M. A.)	Jones
	Jones, Leon K.	Keitt	Rawlins, Thomas E.	Johnson (J.)
	Reinking, Otto	Jones	Sands, David R.	Jones
	Richards, C. Audrey (minor)	Gilbert	Streets, Rubert B.	Keitt
	Riker, A. Joyce	Keitt		
	Weber, George F.	Johnson (A. G.)		
1923:	Fellows, Hurley	Jones	Berg, Anthony	Jones
	Godfrey, George H.	Jones	Evans, William G.	Jones
	Goss, Robert W.	Jones	Lindegren, Carl C.	Walker
	Hubert, Ernest E.	Jones	Walker, Marion N. (Feb.)	Jones
	Monteith, John	Jones		
	Ocfemia, Gerardo O.	Dickson		
	Reddy, Charles S.	Johnson		
	Teodoro, Nicanor G.	Walker		
1924:	Davis, Ray J.	Dickson	Gates, Percival T.	Jones
	Streets, Rubert B.	Jones	Gilchrist, Grace	Jones
	Tims, Eugene C.	Walker	Marshall, Rush P.	Walker
	Walker, Marion N.	Jones	Wellman, Frederick, L.	Walker
1925:	Dungan, George (Jt w/Botany)	Dickson	Dahl, Arnold	Jones
	Hungerford, Charles W.	Jones	Dykstra, Theodore P.	Jones
	Janssen, George (Jt w/Botany & Agronomy)	Dickson	Hoggan, Isme	Johnson
	Koehler, Benjamin	Dickson	Robertson, L. A. (Jt w/Agronomy)	Dickson
	Mulvania, Maurice (minor)	Johnson (J.)	Simmonds, P. M.	Dickson
	Tompkins, C. M.	Johnson (J.)	Wilson, E. E.	Keitt
1926:	Albertz, H. W. (Jt w/Agronomy)	Dickson	Lewcock, H. K. (Jt w/Agronomy)	Jones
	Bennett, C. W.	Keitt	Markin, Florence	Jones
	Brooks, A. N.	Keitt	Walker, William	Dickson
	Conant, George H.	Jones		
	Smith, Rose (minor)	Dickson		
1927:	Haymaker, H. H.	Dickson	Blank, Lester M.	Walker
	Hoggan, Isme	Johnson	Magee, C. J.	Jones
	Linford, M. B.	Jones	Taylor, T. M.	Keitt
	Wilson, E. E.	Keitt	Zaumeyer, William J.	Jones
1928:	Angell, Herbert R.	Walker	Alexander, Leonard J.	Walker
	Simmonds, P. M.	Dickson		
	Wellman, Frederick L.	Walker		

Year	Ph.D. degrees	Professor	M.S. degrees	Professor
1929:	Caldwell, Ralph M. (Jt w/Botany)	Dickson	Hildebrand, Earl M.	Riker
	Hamilton, James M.	Keitt	Ivanoff, Spas S.	Riker
	Miller, Paul W.	Keitt	Palmiter, DeForest H.	Keitt
	Mogendorff, Nico	Johnson	Sumner, Charles B.	Walker
	Shands, Ruebush G. (Jt w/ Agronomy)	Dickson		
	Zaumeyer, William J.	Jones		
1930:	Banfield, Walter M.	Keitt	Gibson, Earle A.	Riker
	Blank, Lester M.	Walker	Larson, Russell H.	Walker
	Blood, H. Loran	Walker	Magie, Robert O.	Keitt
	Fajardo, Tranquilino G.	Dickson	Ogden, William B.	Jones
	Kohl, Edwin J. (Mar)	Keitt		
1931:	Backus, Myron		Grant, Theodore J.	Keitt & Johnson
	Dahl, Arnold S.	Jones	Ludbrook, Wallis V.	Walker
	Hildebrand, E. M.	Riker	Nusbaum, Chalres J.	Keitt
	Sumner, Charles B.	Walker	Pinckard, Joseph A.	Riker
1932:	Anderson, Melvin E.	Walker	Murphy, Albert	Walker
	Boyle, Lytton W.	Dickson	Smith, Oliver F.	Dickson
	Dippenaar, Borend J.		Ullstrup, Arnold J.	Dickson
	Gordon, W. L.	Dickson		
	Harris, Marion R.	Dickson		
	Ivanoff, Spas S.	Riker		
	Koch, Karl L. (Jt w/Econ. Ent.)	Johnson		
	Ludbrook, Wallis V.	Walker		
	Palmiter, DeForest H.	Keitt		
	Shands, Hazel L. (Jt w/Agronomy)	Dickson		
	Shaw, Luther	Keitt		
	Smith, Albert L.	Dickson		
	Snyder, William C.	Walker		
	Tharp, William H. (Jt w/Botany)	Dickson		
	Dippenaar, Borend J.			
1933:	Grant, Theodore J.	Keitt & Johnson	Fuelleman, Robert F. (Jt w/Agronomy)	Dickson
	Pierce, Walter H.	Walker	Meuli, Lloyd J.	Riker
			Sammet, Anita	Walker
1934:	Alexander, Leonard J.	Walker	Wilson, Alasdair R.	Riker
	Blodgett, Earle C.	Keitt		
	Larson, Russell H.	Walker		
	Magie, Robert O. (Jt w/Botany)	Keitt		
	Nusbaum, Charles J.	Keitt		
	Owens, Charles E. (Oct)	Jones		
	Pinckard, Joseph A.	Riker		
	Ryker, Truman C.	Walker		
	Scheffer, Theodore C. (Oct)	Keitt & Duggar		
	Smith, Oliver F. (Jt w/Agronomy)	Dickson		
	Ullstrup, Arnold J.	Dickson		
	Yarwood, Cecil E.	Dickson		
1935:	Conner, H. A. (minor)	Riker	Adams, John F.	Walker
	Foster, Harold H.	Keitt	Berge, T. O. (minor)	Walker
	Jensen, James M.		Haberkorn, Theodore L.	Dickson
	Stubbs, Merl W.	Walker	Locke, Seth B. (Mar)	Riker
1936:	Bayles, Burton B.	Dickson	None	
1937:	Locke, Seth B. (joint with Bot.)	Riker	Ozanne, Dalton, R.	Walker
	Ross, A. Frank (Biochem.)	Tottingham	Wilson, Ralph D.	Riker
	Wei, Ching-tsao	Walker		

	Ph.D. degrees		Professor	M.S. degrees		Professor
1938:	Allington, William B.		Johnson (J.)	None		
	Braun, Armin C.		Johnson (J.)			
	Whipple, Ottis C.		Walker			
	Torrie, Jim					
1939:	Bowman, Donald H. (Jt w/		Dickson	Alvarez-Garcia, Luis A.		Riker
	Agronomy)			Gruenhagen, Richard H.		Riker
	Dimond, A. E. (Botany)		Duggar	Ko, Siang-Yin	(Mar)	Dickson
	Edwards, Eric T.		Dickson			
	Pryor, Dean E.		Walker			
	Sallans, Bryce J.		Dickson			
1940:	Bever, Wayne (Jt w/Agronomy)		Dickson	Hamilton, Donald G.		Dickson
	Clayton, Carlyle N. (Jt w/Botany)		Keitt	Kellett, Orme S.		Dickson
	Fulton, Robert W.		Johnson (J.)	(Agronomy)		
	Langford, Michael H.		Keitt			
	Ko, Siang-Yin	(Oct)	Dickson			
	(Jt w/Agronomy)					
	McLean, John G.		Walker			
	Meuli, Lloyd J.		Riker			
	Roth, Lewis F.		Riker			
	Spiegelberg, Carl H.	(Oct)	Riker			
	(Jt w/Ag. Bact.)					
	Stevens, R. B. (Botany)		Gilbert			
	Van Lanen, James (minor)		Riker			
	Virgin, Walter J.	(Mar)	Walker			
1941:	Carpenter, John B. (Jt w/Botany)		Keitt	Shay, Junior Ralph		Keitt
	Henry, Berch W. (Jt w/Botany)		Riker			
	Jolivette, James P.		Walker			
	Josephson, Leonard M.		Dickson			
	(Jt w/Agronomy)					
	Schroeder, Wilbur T.		Walker			
	Smith, Paul G.	(Mar)	Walker			
	(Jt w/Agronomy)					
1942:	Felton, Mathias W.	(Mar)	Walker	Gorenz, August M.		Walker
	Hooker, William J.		Walker			
	LeBeau, Francis J.		Walker			
	Stevenson, Elmer C.		Dickson			
1943:	Arny, Deane C.	(Feb)	Dickson	Hagedorn, Donald J.	(Feb)	Walker
	(Jt w/Agronomy)					
	Chamberlain, Donald W.	(Feb)	Dickson			
	Gries, George (minor)					
	Hare, Woodrow W.		Walker			
	Pound, Glenn S.		Walker			
	Shay, J. Ralph		Keitt			
1944:	Gruenhagen, Richard H.	(Feb)	Riker			
	Heggestad, Howard E. (Jt w/		Johnson (J.)			
	Genetics)					
1945:	Calavan, Edmond C.		Keitt			
	Foster,Robert E.		Walker			
	Hildebrandt, Albert C.	(Jan)	Riker			
	(Jt w/Botany)					
	Kuntz, James E.		Walker			
	Moore, J. Duain	(Jan)	Keitt			
	Ou, Shu-Huang	(Jan)	Walker			

Year	Ph.D. degrees		Professor	M.S. degrees		Professor
1946:	Leben, Curt C.		Keitt	Gallegly, Mannon E.	(Sept)	Walker
	Schaller, Charles W. (Jt w/ Agronomy)		Dickson			
1947:	Andes, James O.		Keitt	Grimm, Gordon R.		Dickson
	Hatfield, William C.		Walker			
	Kendrick, James B. Jr.					
	Moore, Emmeline L.		Dickson			
	Thomas, John E.		Riker			
	Wang, Chuang	(Jan)	Dickson			
	Shaw, Charles G. (minor)		Keitt			
1948:	Bruehl, George W.		Dickson	Gilmer, Robert M.		Keitt
	Calvert, Oscar H.		Pound	Stessel, George J.	(Sept)	Keitt
	Chiu, Wei-Fan		Walker			
	Gorenz, August M.		Walker & Larson			
	Grogan, Raymond G.		Walker			
	Hagedorn, Donald J.		Walker			
	Mitchell, John E. (minor)		Riker			
	Thind, Kartar S.	(Sept)	Keitt			
	Thirumalachar, M. J.		Dickson			
	Utech, Nedra M.	(Sept)	Johnson (J.)			
1949:	Boone, Donald M.	(Nov)	Keitt	Futrell, Maurice E.	(May)	Dickson
	Boyle, John S.	(June)	Keitt & Moore	Wade, Earl K.	(May)	Keitt
	Fang, Chang T.	(Feb)	Riker			
	Gallegly, Mannon E.	(May)	Walker			
	Grant, Marshall N. (Jt w/Agronomy)	(June)	Shands & Dickson			
	Ladeburg, Richard C.	(Apr)	Larson			
	Owen, John H.	(June)	Walker			
	Self, Raymond L.	(Mar)	Walker			
	Struble, F. Ben	(Jan)	Keitt			
	Theis, Thomas N.	(Apr)	Riker			
	Weber, Paul V. V.	(Aug)	Keitt			
	Whitehead, Marvin D.	(May)	Dickson			
	Wolls, D. G.					
1950:	Bridgmon, George H.	(Dec)	Walker	Cook, Allyn A.	(Jan)	Walker
	Carter, Jack F.	(Apr)	Dickson	Fowler, Dorsey L.	(Aug)	Pound
	Earhart, Robert W. (Jt w/ Agronomy)		Shands & Dickson	Green, Gordon J.	(May)	Dickson
				Porter, William A.	(May)	Riker
	Faan, Wei Chung	(Aug)	Keitt			
	Gilmer, Robert M.	(Nov)	Keitt & Moore			
	Schafer, John F.	(May)	Dickson			
1951:	Cheo, Pen Ching	(May)	Pound	Halpin, James E.	(May)	Hanson
	Cook, Allyn A.	(May)	Walker	LeBeau, Jack	(May)	Dickson
	Darby, John	(May)	Larson	McDonald, William C.	(May)	Dickson
	Gasiorkiewicz, Eugene C.	(Aug)	Larson	Thomason, Ivan J.	(June)	Dickson
	Hooker, Arthur L.	(Dec)	Dickson			
	Kilpatrick, R. A	(June)	Dickson & Hanson			
	Mohajer, Abdur-Rasheed (Jt w/Agronomy)		Dickson			
	Raabe, Robert D.	(May)				
	Sill, Webster H.	(May)	Walker			
	Wiles, Alfred B.	(Jan)				

	Ph.D. degrees		Professor	M.S. degrees		Professor
1952:	Futrell, Maurice C.	(May)	Dickson	Madinger, Francis L.	(Oct)	Johnson & Keitt
	Guthrie, James W.	(Oct)	Keitt & J. Johnson	McMahon, Irwin L.	(Jan)	Keitt & Moore
	Kiesling, Richard	(June)	Dickson			
	Patton, Robert F.	(Jan)	Riker			
	Scheffer, Robert P.	(Jan)	Walker			
	Scott, Ralph W. (Biochem.)		Riker			
	Slack, Derald A.	(Oct)	Keitt & Moore			
	Smith, Harlan E.	(Jan)	Keitt & Moore			
	Stessel, George J.	(June)	Keitt			
	Varney, Eugene H.	(Dec)	Keitt & Moore			
	Webb, Raymon E.	(Apr)	Larson			
1953:	Beckman, Carl H.	(Feb)	Riker	MacKinnon, John P.	(May)	Larson
	Bloom, James R.	(Aug)	Walker			
	Drolsom, Paul N. (Jt w/Agronomy)	(Jan)	Dickson			
	Green, Gordon J.	(May)	Dickson			
	Grimm, Gordon R.	(June)	Dickson			
	Jones, Edward D.	(May)	Darling			
	Kendrick, Edgar L.	(Oct)	Dickson			
	LeBeau, Jack B.	(June)	Dickson			
	Lockwood, John L	(Oct)	Keitt			
	MacLachlan, Donald S.	(May)	Larson			
	Pelletier, Real L.	(May)	Keitt			
	Pierson, Charles F.	(July)	Walker			
	Skotland, Calvin B.	(Aug)	Hagedorn			
	Warnock, Stephen J. (Jt w/agronomy)	(Jan)	Hagedorn			
	Weathers, Lewis G.	(May)	Pound			
	Winstead, Nash N.	(Aug)	Walker			
1954:	Berbee, John G.	(June)	Riker	Brown, Lily R.	(Jan)	Larson
	Fulton, Neil D.	(Mar)	Hanson	Campbell, Ruth	(May)	Riker
	Graves, Clinton H.	(Jan)	Hagedorn	Wenham, Hugh	(May)	Hagedorn
	Helms, Katie	(Oct)	Pound			
	Klemmer, Howard W. (minor)	(June)	Riker			
	Lamey, H. Arthur	(Aug)	Keitt			
	LeRoux, P. Meier	(Aug)	Dickson			
	McDonald, William C.	(May)	Dickson			
	Paulus, Albert O.	(June)	Pound			
	Shea, Keith R.	(May)	Riker			
	Thomason, Ivan J.	(Feb)	Dickson			
	Tinline, Robert D.	(June)	Dickson			
	Van Arsdel, Eugene P.	(June)	Riker			
1955:	Armolik, Neeme	(June)	Dickson	Flangas, Arthur J.	(June)	Dickson
	Bancroft, John B.	(May)	Pound	Kenworthy, Francis T.	(Aug)	Dickson
	Cameron, H. Ronald	(Jan)	Keitt & Moore	Syamananda, Riksh	(June)	Dickson
	Duffus, James E.	(June)	Keitt & Moore			
	Echandi, Eddie Z.	(Oct)	Walker			
	Hall, Dennis H.	(Aug)	Walker			
	Halpin, James E.	(May)	Hanson			
	Lindberg, G. Donald	(May)	Walker			
	Muir, William H.	(May)	Riker			
	Parmeter, John R.	(June)	Kuntz			
	Sinclair, James B.	(Jan)	Walker			
	Skoropad, William P.	(June)	Arny			

	Ph.D. degrees		Professor	M.S. degrees		Professor
1956:	Bagnall, Richard H.	(May)	Larson	Hansen, Anton J.	(Nov)	Larson
	Busch, Lloyd V.	(May)	Walker	Kim, Woon Soo	(June)	Hagedorn
	Cardona, Canuto	(June)	Walker	Knight, Brian C.	(Aug)	Walker
	Clark, Robert V.	(May)	Dickson	Pelet, Francis	(May)	Hildebrandt
	Drake, Charles R.	(May)	Kuntz	Singh, Ganga	(Nov)	Pound
	Edgington, Lloyd V.	(June)	Walker	Srivastava, Daya N.	(Nov)	Walker
	Garces, Carlos	(May)	Pound			
	Horton, James C.	(May)	Pound			
	Kline, David M.	(Jan)	Keitt			
	Thaung, Maung M.	(Aug)	Walker			
	Tsao, Peter	(Aug)	Keitt			
1957:	Callahan, Kemper L.	(June)	Moore & Keitt	Chantarasrikul, Anong	(Feb)	Dickson
	Easton, Gene D.	(June)	Larson	Chen, Peter	(Aug)	Hildebrandt
	Ehlers, Clifford G.	(June)	Keitt & Moore	Orlob, Gert B.	(Oct)	Arny
	Robinson, Dean B.	(Apr)	Larson	Pizarro, Antonio C.	(Jan)	Arny
	Sherwood, Robert T.	(Nov)	Hagedorn	Schieber, Eugenio	(July)	Dickson
	Troutman, Joseph L.	(Jan)	Fulton	Schofield, Elizabeth	(Aug)	Walker
	Van Gundy, Seymour D.	(Feb)	Walker			
	Welkie, George W.	(June)	Pound			
1958:	Edmunds, Leon K.	(May)	Hanson	Calabresa, James V.	(Mar)	Dickson
	Flangas, Arthur L.	(Jan)	Dickson	Knox-Davies, Peter	(Sept)	Dickson
	Hansen, Anton Juergen	(July)	Larson	Kollmer, German F.	(Sept)	Larson
	Kim, Woon Soo	(Jan)	Hagedorn	Kurtzman, Ralph H.	(Aug)	Hildebrandt
	Nelson, Merritt R.	(June)	Pound	Qazi, Abdul	(Jan)	Larson
	Perry, Vernon G.	(Aug)	Darling	Rabie, Christian J.	(Aug)	Dickson
	Phelps, William R.	(Oct)	Kuntz			
	Shepherd, Robert J.	(Oct)	Pound			
	Singh, Ganga P.	(Jan)	Pound			
	Srivastava, Daya N.	(July)	Walker			
	Syamananda, Riksh	(Jan)	Dickson			
	Templeton, George E.	(Aug)	Dickson			
1959:	Chi, Chien Chen	(May)	Hanson	Caglevic, Milan	(Nov)	Arny
	Cowling, Ellis B.	(May)	Riker	Lee, Bae Ham	(May)	Dickson
	Faulkner, Lindsey R.	(May)	Darling	Lii, Shing-lin	(Aug)	Arny
	Knox-Davies, Peter	(May)	Dickson	Norman, Theresa	(Aug)	Walker
	Kurtzman, Ralph H.	(Mar)	Hildebrandt	Patel, Prabodh	(May)	Walker
	Martin, James P.	(May)	Hanson			
	Nayudu, Malepati V.	(Apr)	Walker			
	Nighswander, James E.	(Feb)	Patton			
	Orlob, Gert B.	(July)	Arny			
	Pelet, Francis J.	(Feb)	Hildebrandt			
	Peterson, Joseph L.	(Aug)	Pound			
	Sasaki, Toshio	(May)	Kuntz			
	Schieber, Eugenio	(Aug)	Dickson			
	Shaw, John G.	(Aug)	Larson			
	White, Lyle Vernon	(April)	Darling			
1960:	Cervantes, Javier	(Dec)	Larson	DeGroot, Rodney C.	(June)	Kuntz
	Grover, Rajendra K.	(Aug)	Moore	Prichakas, Phanthavee	(Jan)	Dickson
	Hampton, Raymond E.	(May)	Fulton	Kankam, Joseph S.	(May)	Arny
	Klisiewicz, John M.	(May)	Pound			
	Kollmer, German F.	(Sept)	Larson			
	Latch, Garrick C. M.	(May)	Hanson			
	Pavgi, Madhav S.	(May)	Dickson			
	Pirone, Thomas P.	(May)	Pound			
	Seaman, W. Lloyd	(Aug)	Larson			
	Smart, Grover C.	(June)	Darling			

Year	Ph.D. degrees		Professor	M.S. degrees		Professor
1960 cont.						
	Tamaoki, Taiki	(Mar)	Hildelbrandt			
	Walkinshaw, Charles H.	(June)	Larson			
	Wasuwat, Slearm L.	(Aug)	Walker			
	Williams, Barbara J.	(Aug)	Boone			
1961:	Anderson, J. LaMar	(May)	Walker	Kais, Albert G.	(May)	Smalley
	Barker, Kenneth R.	(May)	Walker	Marks, Geoffrey	(Aug)	Riker
	Coyier, Duane L.	(June)	Hildebrandt	Pupipat, Udom	(Mar)	Arny
	Cunningham, John L.	(June)	Hagedorn	Sloey, William	(Aug)	Dickson-Arny
	Dickerson, Ottie J.	(May)	Thorne	Yang, Charles	(May)	Mitchell
	Heyns, Juan	(Sept)	Thorne			
	Houston, David R.	(May)	Kuntz			
	Lee, Bae Ham	(Mar)	Dickson			
	Reyes, Andres A.	(May)	Mitchell			
	Rosenkranz, Eugen E.	(Mar)	Hagedorn			
	Rossouw, Daniel J.	(Aug)	Fulton			
	San Juan, Mario O.	(July)	Pound			
	Sehgal, Om Parkish	(May)	Boone			
	Spurr, Harvey	(June)	Hildebrandt			
	Starzyk, Marvin	(Sept)	Mitchell			
	Tsao, Pamela	(Sept)	Hagedorn			
	Worf, Gayle L.	(June)	Hagedorn			
1962:	Anderson, Roger V.	(May)	Darling	Campos, Armando	(Sept)	Darling
	Berger, Richard D.	(May)	Hanson	Humphries, Susan	(Dec)	Moore
	Chen, Peter	(Jan)	Hildebrandt	Maduewesi, Johnson	(May)	Hagedorn
	Geary, Thomas	(June)	Kuntz	Prey, Allen J.	(Mar)	Kuntz
	Gonzalez, Luis	(July)	Pound	Ross, Arnold	(Jan)	Kuntz
	Griffin, Gerald	(Dec)	Darling	Shrivastava, Keshava	(Oct)	Walker
	Krebill, Richard	(July)	Patton	Wilcox, W. Wayne	(Mar)	Kuntz
	Lortie, Marcel	(May)	Kuntz			
	Martinez, Eugenio	(Nov)	Hanson			
	Patel, Prabodh N.	(Mar)	Walker			
	Reinert, Richard E.	(May)	Hildebrandt			
	Riffle, Jerry	(June)	Kuntz			
	Rivera, Carmen	(July)	Pound			
	Ruppel, Earl	(Aug)	Hagedorn			
	Wall, Ronald	(June)	Kuntz			
	Waterworth, Howard E.	(May)	Fulton			
	Williams, Paul H.	(Apr)	Pound			
	Willis, Carl B.	(May)	Fulton			
1963:	Berry, Robert W.	(Jan)	Arny-Dickson	Nichols, Courtland	(Jan)	Gabelman-Walker
	Blair, Gaston P.	(Jan)	Darling			
	Carlson, Lester	(May)	Boone	Stavely, J. Rennie	(Jan)	Hanson
	Chand, Jnanendra N.	(Feb)	Walder	Torrealba, Pedro A.	(June)	Pound
	Kumar, Sushil	(Mar)	Hildebrandt	Wilmar, Johanna C.	(Aug)	Hildebrandt
	Marks, Geoffrey C.	(May)	Berbee			
	Nichols, Courtland (Jt w/Horticulture)	(July)	Gabelman-Walker			
	Rogers, Jack D.	(Jan)	Berbee			
	Sievert, Richard C.	(Jan)	Hildebrandt			
1964:	Laferriere, Lucien (Jt w/Horticulture)	(Dec)	Gabelman	Boettcher, Allen D.	(May)	Hildebrandt
				Mee, Ming-Ling	(Jan)	Moore
	Ling, Keh Chi	(May)	Pound	Nicholls, Thomas H.	(May)	Patton
	Maduewesi, Johnson	(Aug)	Hagedorn	Ravenscroft, Alvin V.	(Jan)	Mitchell
	Main, Charles E.	(May)	Walker	Webber, Arthur J.	(Dec)	Barker
	Nair, Gengadharan V. M	(May)	Kuntz			

	Ph.D. degrees		Professor	M.S. degrees		Professor
	Rickard, Samuel F.	(Apr)	Walker			
	Rodrigues, Carlos	(Dec)	Arny			
	Saad, Adib T.	(Oct)	Boone			
	Stuteville, Donald	(May)	Hanson			
	Wilcox, Webster Wayne	(Sept)	Kuntz			
	Yang, Charles Y. D.	(May)	Mitchell			
1965:	Angell, Frederick F.	(Jan)	Gabelman-	DeLeon, Carlos	(Jan)	Pound-Williams
	(Jt w/Horticulture)		Pound	Huang, Liang-Hsuing	(Aug)	Hagedorn
	Amin, Kantilal S.	(July)	Sequeira	Klink, Johannes W.	(May)	Barker
	Black, Lowell L.	(July)	Pound-Williams			
	Holcomb, Gordon	(Sept)	Hildebrandt			
	Huisingh, Donald	(May)	Durbin			
	Martens, John W.	(May)	Arny			
	Pizarro, Antonio C.	(Nov)	Arny			
	Rabie, Christian J.	(Jan)	Smalley			
	Stavely, J. Rennie	(May)	Hanson			
	Teliz-Ortiz, Moises	(Oct)	Mitchell			
	Temp, Marvin	(Aug)	Hagedorn			
	Yang, Shaw-Ming	(Aug)	Hagedorn			
1966:	Alconero, Rodrigo	(Oct)	Hagedorn	Darunday, Zenaida	(May)	Hanson
	Bagga, Harmahinder	(Mar)	Boone	Bartz, Jerry A.	(May)	Mitchell
	De Leon, Carlos	(May)	Pound-Williams	Hsu, Grace	(May)	Mitchell
	Gordon, Donald T.	(Jan)	Arny			
	Lachance, Denis	(May)	Kuntz			
	Maheshwari, Ramesh	(Apr)	Hildebrandt			
	Paulsen, Avelina Q.	(Nov)	Fulton			
	Saettler, Alfred	(May)	Pound-Williams			
	Thomas, Peter E.	(July)	Fulton			
1967:	Arneson, Phil A.	(July)	Durbin	Gettens, Rebecca	(Aug)	Kelman
	Campos, Armando	(July)	Darling	Soto, Marco	(May)	Darling
	Harding, Howard		Williams	Wang, Tung-Chia	(May)	Hagedorn
	Hoitink, Henricus A.	(May)	Hagedorn			
	Iverson, Carl G.	(June)	Kuntz			
	Kalil, Millicent L.	(Jan)	Hildebrandt			
	Leu, Lii-Sin	(Aug)	Boone			
	McGrath, William T.	(Apr)	Patton			
	Phelps, Ralph H.	(Feb)	Sequeira			
	Singh, Dilbagh	(Sept)	Smalley			
	Strandberg, James O.	(Sept)	Williams			
	Torrealba, Pedro	(May)	Darling			
1968:	Adegbola, Michael O.	(May)	Hagedorn	Krupasagar, Venka-		
	Bagga, Davinder Jit	(Apr)	Smalley	taraman	(Apr)	Sequeira
	Barnett, Ortus W.	(Aug)	Fulton	Steadman, James R.	(May)	Sequeira
	Bartz, Jerry A.	(Oct)	Mitchell			
	Biris, Dimitrios A.	(Mar)	Moore			
	Crill, Jerry P.	(Dec)	Hanson-			
	Friend, Robert J.	(Jan)	Hagedorn			
	Keen, Noel T.	(May)	Boone			
	Klink, Johannes W.	(Oct)	Williams			
			Mitchell			

	Ph.D. degrees		Professor	M.S. degrees		Professor
1969:	Bone, Horace T.	(Aug)	Kuntz	Fribourg-Solis, Cesar	(Nov)	de Zoeten
	Copeman, Robert J.	(Oct)	Sequeira	Ladipo, Jacob L.	(Oct)	de Zoeten
	Duniway, John M.	(July)	Durbin	Lozano, Carlos	(July)	Sequeira
	Marasas, Walter F.	(Mar)	Smalley	Mildenhall, John P.	(Sept)	Williams
	Megahed, El Sayed	(Mar)	Moore	Oyekan, Peter O.	(Oct)	Mitchell
	Myren, Donald T.	(May)	Patton	Ribeiro, Raul	(Oct)	Mitchell
	Pinney, Robert D.	(Oct)	Hildebrandt	Staub, Theodor	(Oct)	Williams
	Saad, Sami M.	(Jan)	Hagedorn			
	Steadman, James R.	(Sept)	Sequeira			
	Sutton, John C.	(July)	Williams			
	Thies, Walter G.	(May)	Patton			
1970:	Woodbury, William (Jt w/Biochem)	(Feb)	Stahmann-Williams	Hansen, Everett M.	(Oct)	Patton
				Hartman, John R.	(Jan)	Kelman
1971:	Aist, James R.	(May)	Williams	Jacobsen, Barry J.	(May)	Williams
	Hartman, John R.	(Aug)	Kelman	Shanmugasundaram, S.	(Jan)	Williams
	Johnson, David W.	(May)	Kuntz	Still, Paul E.	(Oct)	Smalley
	Kliejunas, John T.	(June)	Kuntz	TeBeest, David O.	(Aug)	Kuntz
	Ladipo, Jacob L.	(Mar)	de Zoeten	Watterson, Jon C.	(May)	Williams
	Mildenhall, John P.	(July)	Williams			
	Newton H. Calvin	(Sept)	Sequeira			
	Oyekan, Peter O.	(July)	Mitchell			
	Staub, Theodor	(May)	Williams			
	Taylor, Paul A.	(Jun)	Durbin			
1972:	Coplin, David L.	(Aug)	Sequeira	Gotlieb, Alan R.	(June)	Berbee
	Hansen, Everett	(June)	Patton	Heimann, Mary F.	(May)	Hildebrandt
	Hoch, Harvey C.	(May)	Mitchell	Kahn, Mushtaq A.	(Nov)	Maxwell
	Lozano, Carlos	(June)	Sequeira	Lim, Wa Lee	(Aug)	Hagedorn
	Stevenson, Walter R.	(Aug)	Hagedorn	Wacek, Thomas	(June)	Sequeira
	Yoshii, Kazuhiro	(June)	Hagedorn	Wahab, Abdel	(Dec)	Arny
				Zalewshi, James W.	(July)	Sequeira
1973:	Bhalla, Hari S.	(May)	Mitchell	Morales-Bance, Fernando	(Aug)	Moore
	Bonn, Gordon W.	(Mar)	Sequeira			
	Onesirosan, Peter T.	(Sept)	Arny			
	Still, Paul E.	(May)	Smalley			
1974:	Abo El-Nil, Mostafa	(Nov)	Hildebrandt	Abul-Hayja, Zaydan	(July)	Williams
	Corcuera, Luis J.	(Nov)	Upper	Granada, Gustavo	(July)	Sequeira
	German, Thomas	(Aug)	de Zoeten	Hepp, Ruperto F.	(Feb)	de Zoeten
	Gotlieb, Alan R.	(June)	Berbee	Kifle, Lemma	(Sept)	Arny
	Hadi, Soetrisno	(Feb)	Berbee	Murray, Gordon	(May)	Maxwell
	Humaydan, Hasib	(Aug)	Williams	Pinnow, David L.	(May)	Hagedorn
	Loesch, Loretta Sue	(Nov)	Fulton			
	Porto, Miguel D.	(Apr)	Hagedorn			
	Pratt, Robert G.	(Oct)	Mitchell			
	TeBeest, David	(July)	Kuntz			
	Tontyaporn, Sanchai	(July)	Boone			
	Wacek, Thomas J.	(Feb)	Sequeira			
	Zalewski, James C.	(Aug)	Sequeira			
1975:	Fenn, Patrick	(Jan)	Kuntz	Ehr, Robert J.	(Jan)	Williams
	Merlo, Donald J.	(Apr)	Kemp	Fries, Robert E.	(Jan)	Hanson
	Howard, Ronald	(Apr)	Williams	McCabe, Phyllis	(June)	Hildebrandt
	Murray, Gordon	(June)	Maxwell	D'Arcy, Cleora J.	(Dec)	de Zoeten
	Sushak, Ronald	(June)	Hildebrandt	Webster, David	(Dec)	Sequeira
	Omuemu, John	(Sept)	Berbee			
	Woodward, Michael	(Nov)	Helgeson			
	Abul-Hayja, Zaydan	(Nov)	Williams			

	Ph.D. degrees		Professor	M.S. degrees		Professor
1976:	DeBoer, Solke H.	(Feb)	Kelman	Willis, David	(July)	Mitchell
	Hepp, Ruperto F.	(Mar)	de Zoeten	Delwiche, Patricia	(Aug)	Williams
	Khan, Mushtaq	(May)	Maxwell	Otoide, Vincent O.	(Aug)	Patton
	Armentrout, Vivienne	(May)	Maxwell	Albers, Michael A.	(Oct)	Berbee
	Lim, Wa-Lee	(July)	Hagedorn	Holroyd, Barbara	(Dec)	Kemp
	Pronos, John	(Aug)	Patton			
	Gross, Henry L.	(Oct)	Patton			
	Cuppels, Diane	(Nov)	Kelman			
1977:	Nishijima, Wayne T.	(Mar)	Smalley	Fett, William F.	(Feb)	Sequeira
	Gkinis, Asimina	(June)	Smalley	Tortolero, Omar	(Apr)	Sequeira
	Victoria, Jorge	(July)	Kelman	Cardosa, Jose	(Aug)	Hildebrandt
	Lindow, Steven	(July)	Arny	Lopes, Carlos A.	(Dec)	Hagedorn
	Halk, Edward	(Aug)	Fulton	Cours, Barbara	(Dec)	Williams
				Phillips, Jane A.	(Dec)	Kelman
				Ribeiro, Maria I.	(Dec)	de Zoeten
1978:	Webster, David	(May)	Sequeira	de Assis, Marcio	(Jan)	Hildebrandt
	Fernandez-Northcote,			Nadolny, Lois	(Jan)	Sequeira
	Enrique	(May)	Fulton	Mueller, James	(July)	Mitchell
	Ribeiro, Raul	(July)	Hagedorn	Modjo, Hakam	(July)	Mitchell
	D'Arcy, Cleora	(July)	de Zoeten	James, R. Vaughan	(July)	Williams
	Castello, John	(Nov)	Berbee	Perry, Joy B.	(Dec)	Andrews
				Okeke, Godson	(Dec)	Mitchell
1979:	Daub, Margaret E.	(May)	Hagedorn	Basset, Steven R.	(May)	Kunt
	Reeleder, Richard	(July)	Hagedorn	Campbell, Jana	(June)	Helgeson
	Martin, Robert	(July)	Berbee	Miller, Sally	(July)	Maxwell
	Walgenbach, Paul	(Aug)	Williams &	Stough, Michael	(Aug)	Mitchell
	(Jt w/Entomology)		Chapman	Suleman, Patrice	(Dec)	Arny
	Ciampi, Luigi	(Aug)	Sequeira			
	Fett, William	(Nov)	Sequeira			
	Reifschneider, Francisco	(Nov)	Arny			
1980:	Hack, Ethan	(Jan)	Kemp	O'Laughlin, Jane	(May)	Andrews
	Irwin, John	(Feb)	Maxwell	Hahm, Young-IL	(May)	Slack
	Delwiche, Patricia	(Mar)	Williams	Bowman, John	(June)	Sequeira
	Pfannesteil, Mary Ann	(Feb)	Slack	Tanaka, Hiroshi	(July)	Sequeira
	Mmbaga, Margaret	(Feb)	Arny	Hansen, John	(Oct)	Sequeira
	Weidemann, Gregory	(May)	Boone	Blenis, Peter	(Oct)	Patton
	Pastalka, Tomas	(May)	Berbee			
1981:	Pfender, William	(Feb)	Hagedorn	Simmons, Scott	(May)	Berbee
	Lindemann, Julianne	(June)	Arny	Khonga, Elinimu	(June)	Andrews
	Lum, Keng-yeang	(June)	Kelman	Avenius, Robert	(July)	Andrews
	Granada, Gustavo	(July)	Sequeira	Grasmick, Michael	(July)	Slack
	Sherwood, John	(July)	Fulton	Radke, Vicki	(Aug)	Grau
	Leach, Jan	(Sept)	Sequeira	Leung, Hei	(Sept)	Williams
	Schwarz, Michael	(Sept)	Boone			
	Cullen, Daniel	(Nov)	Smalley			
1982:	Styer, Donald	(May)	Durbin	Reeser, Paul	(Jan)	Rouse
	Miller, Sally	(June)	Maxwell	Yuran, Gene	(May)	Williams
	Duvick, Jon	(July)	Sequeira	Monkman, Carol	(May)	de Zoeten
	McGranahan, Gale	(July)	Smalley	Kempe, Jennifer	(May)	de Zoeten
	Heye, Christian	(July)	Andrews	Bishop, Andrew	(July)	Slack
	Tooley, Paul	(Aug)	Grau	Brown, Kristen	(Sept)	Boone
	Blenis, Peter	(Aug)	Patton	Fox, David	(Dec)	Williams
	Rahemian, Mohammad	(Oct)	Mitchell			
	Kobriger, Kim	(Nov)	Hagedorn			
	Tisserat, Ned	(Nov)	Kuntz			
	Faria, Josias	(Nov)	Hagedorn			
	Antonius, Steven	(Dec)	Hagedorn			

	Ph.D. degrees		Professor	M.S. degrees		Professor
1983:	Lukens, Jean	(Feb)	Durbin	Zarnstorff, Jane	(Jan)	Berbee
	Hendrick, Carol	(Feb)	Sequeira	Pscheidt, Jay	(Feb)	Stevenson
	Kotcon, James	(Aug)	Rouse	Havey, Michael	(Apr)	Maxwell
	McGuire, Raymond	(Aug)	Kelman	Sah, Dip	(May)	Grau
	Miller, Christopher	(Sept)	Williams	Kovacevich, Peter	(May)	Andrews
	Gabriel, Clifford	(Nov)	deZoeten	Birrenkott, Gary	(Aug)	Andrews
	Orchard, Lewis	(Dec)	Kuntz	Stanosz, Glen	(Dec)	Patton
1984:	Grasmick, Michael	(Mar)	Slack	Sanderson, Peter	(May)	Andrews
	Wyszogrodzka, Anna	(Apr)	Williams	Putnam, Melodie	(June)	Grau
	Havey, Michael	(Aug)	Maxwell	Clark, Eleanor	(July)	Smalley
	Leung, Hei	(Oct)	Williams	Fjellstrom, Robert	(Aug)	Williams
				Hansen, Mary Ann	(Oct)	Grau
1985:	Nicot, Philippe	(Mar)	Rouse	Gottlieb, Deborah	(May)	Andrews
	Zinnen, Thomas	(Mar)	Fulton			
	Mengistu, Alemu	(May)	Grau			
	Pscheidt, Jay	(May)	Stevenson			
	Morris, Cindy	(Apr)	Rouse			
	Bishop, Andrew	(July)	Slack			

APPENDIX 6

Graduates of the Department of Plant Pathology University of Wisconsin, 1911–1985

(Students arranged alphabetically by year.)

I. E. Melhus
Ph.D. 1912
L. R. Jones

W. J. Morse
Ph.D. 1912
L. R. Jones

R. E. Vaughan
M.S. 1912
L. R. Jones

H.A. Edson
Ph.D. 1913
L. R. Jones

A. H. Gilbert
M.S. 1913
L. R. Jones

G. M. Smith
Ph.D. 1913
L. R. Jones

E. T. Bartholomew
Ph.D. 1914
L. R. Jones

J. W. Brann
M.S. 1914
L. R. Jones

C. F. Drechsler
M.S. 1914
L. R. Jones

E. M. Gilbert
Ph.D. 1914
L. R. Jones

J. C. Gilman
M.S. 1914
L. R. Jones

M. P. Henderson
Ph.D. 1914
L. R. Jones

A. G. Johnson
Ph.D. 1914
L. R. Jones

Keitt
Ph.D. 1914
L. R. Jones

E. S. Schultz
M.S. 1915
L. R. Jones

E. Carsner
Ph.D. 1917
L. R. Jones

F. R. Jones
Ph.D. 1917
L. R. Jones

R. D. Rands
Ph.D. 1917
L. R. Jones

W. H. Tisdale
Ph.D. 1917
L. R. Jones

S. P. Doolittle
Ph.D. 1918
L. R. Jones

C. Elliott
Ph.D. 1918
L. R. Jones

M. W. Gardner
Ph.D. 1918
L. R. Jones

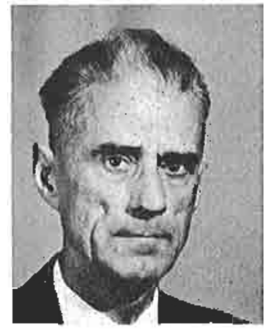
N. J. Giddings
Ph.D. 1918
L. R. Jones

J. Johnson
Ph.D. 1918
L. R. Jones

E. W. Roark
Ph.D. 1918
Keitt

J. C. Walker
Ph.D. 1918
L. R. Jones

L. R. Byars
Ph.D. 1919
L. R. Jones



H. G. MacMillan
Ph.D. 1919
L. R. Jones

D. Atanasoff
Ph.D. 1920
A. G. Johnson

E. E. Clayton
Ph.D. 1920
L. R. Jones

C. N. Frey
Ph.D. 1920
Gilbert

H. H. McKinney
M.S. 1920
L.R. Jones

B. L. Richards
Ph.D. 1920
L. R. Jones

E. Seymour
M.S. 1920
L. R. Jones

W. H. Snell
Ph.D. 1920
L. R. Jones

W. B. Tisdale
Ph.D. 1920
L. R. Jones

J. G. Dickson
Ph.D. 1921
L. R. Jones

E. Gerry
Ph.D. 1921
L. R. Jones

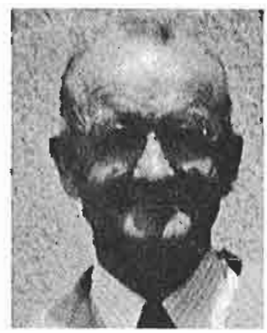
F. T. McFarland
Ph.D. 1921
L. R. Jones

W. G. Stover
Ph.D. 1921
J. Johnson

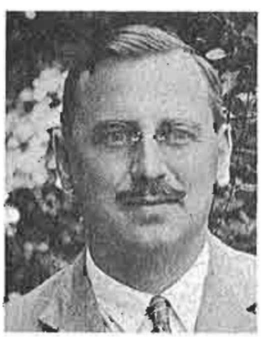
W. H. Davis
Ph.D. 1922
L. R. Jones

C. J. Humphrey
Ph.D. 1922
L.R. Jones

L. K. Jones
Ph.D. 1922
Keitt



T. E. Rawlins
M.S. 1922
J. Johnson



O. Reinking
Ph.D. 1922
L. R. Jones

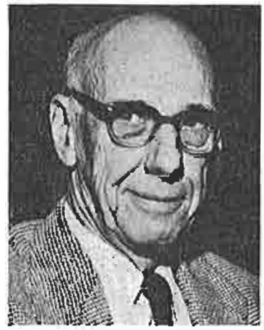
C. A. Richards
Ph.D. 1922
Gilbert

A. J. Ricker
Ph.D. 1922
Keitt

G. F. Weber
Ph.D. 1922
A. G. Johnson

H. Fellows
Ph.D. 1923
L. R. Jones

G. H. Godfrey
Ph.D. 1923
L. R. Jones



R. W. Goss
Ph.D. 1923
L. R. Jones

E. E. Hubert
Ph.D. 1923
L. R. Jones

C. C. Lindegren
M.S. 1923
Walker

J. Monteith
Ph.D. 1923
L. R. Jones

G. O. Ocfemia
Ph.D. 1923
Dickson

C. S. Reddy
Ph.D. 1923
J. Johnson

N. G. Teodoro
Ph.D. 1923
Walker

R. J. Davis
Ph.D. 1924
Dickson

R. B. Streets
Ph.D. 1924
L. R. Jones

E. C. Tims
Ph.D. 1924
Walker

M. N. Walker
Ph.D. 1924
L. R. Jones

G. Dungan
Ph.D. 1925
Dickson

T. P. Dykstra
M.S. 1925
L. R. Jones

C. W. Hungerford
Ph.D. 1925
L. R. Jones

G. Janssen
Ph.D. 1925
Dickson

B. Koehler
Ph.D. 1925
Dickson

C. M. Tompkins
Ph.D. 1925
J. Johnson

H. W. Albertz
Ph.D. 1926
Dickson

C. W. Bennett
Ph.D. 1926
Keitt

A. N. Brooks
Ph.D. 1926
Keitt

G. H. Conant
Ph.D. 1926
L. R. Jones

F. Markin
M.S. 1926
L. R. Jones


R. Smith
Ph.D. 1926
Dickson


H. H. Haymaker
Ph.D. 1927
Dickson


I. Hoggan
Ph.D. 1927
J. Johnson


M. B. Linford
Ph.D. 1927
L. R. Jones


E. E. Wilson
Ph.D. 1927
Keitt


H. R. Angell
Ph.D. 1928
Walker


P. Hoppe
B.S. 1928
Dickson


P. M. Simmonds
Ph.D. 1928
Dickson


F. L. Wellman
Ph.D. 1928
Walker


R. M. Caldwell
Ph.D. 1929
Dickson


J. M. Hamilton
Ph.D. 1929
Keitt


P. W. Miller
Ph.D. 1929
Keitt

N. Mogendorff
Ph.D. 1929
J. Johnson

R. G. Shands
Ph.D. 1929
Dickson

W. J. Zaumeyer
Ph.D. 1929
L. R. Jones

W. M. Banfield
Ph.D. 1930
Keitt

L. M. Blank
Ph.D. 1930
Walker

H. L. Blood
Ph.D. 1930
Walker

T. G. Fajardo
Ph.D. 1930
Dickson

E. J. Kohl
Ph.D. 1930
Keitt

W. B. Ogden
M.S. 1932
L. R. Jones

M. Backus
Ph.D. 1931

A. S. Dahl
Ph.D. 1931
L. R. Jones

E. M. Hildebrand
Ph.D. 1931
Riker

C. B. Sumner
Ph.D. 1931
Walker

M. E. Anderson
Ph.D. 1932
Walker

L. W. Boyle
Ph.D. 1932
Dickson

B. J. Dippenaar
1932

W. L. Gordon
Ph.D. 1932
Dickson

M. R. Harris
Ph.D. 1932
Dickson

S. S. Ivanoff
Ph.D. 1932
Riker

K. L. Koch
Ph.D. 1932
Johnson

W. V. Ludbrook
Ph.D. 1932
Walker

A. Murphy
M.S. 1932
Walker

D. H. Palmiter
Ph.D. 1932
Keitt

H. L. Shands
Ph.D. 1932
Dickson

L. Shaw
Ph.D. 1932
Keitt

A. L. Smith
Ph.D. 1932
Dickson

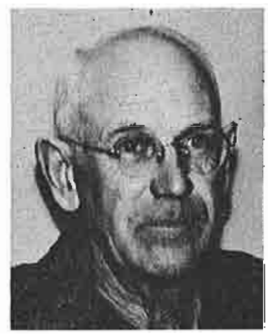
W. C. Snyder
Ph.D. 1932
Walker

W. H. Tharp
Ph.D. 1932
Dickson

T. J. Grant
Ph.D. 1933
Keitt & J. Johnson

W. H. Pierce
Ph.D. 1933
Walker

L. J. Alexander
Ph.D. 1934
Walker



E. C. Blodgett
Ph.D. 1934
Keitt

R. H. Larson
Ph.D. 1934
Walker

R. O. Magie
Ph.D. 1934
Keitt

C. J. Nusbaum
Ph.D. 1934
Keitt

C. E. Owens
Ph.D. 1934
L. R. Jones


J. A. Pinckard
Ph.D. 1934
Riker


T. C. Ryker
Ph.D. 1934
Walker


T. C. Scheffer
Ph.D. 1934
Keitt & Duggar


O. F. Smith
Ph.D. 1934
Dickson


A. J. Ullstrup
Ph.D. 1934
Dickson


C. E. Yarwood
Ph.D. 1934
Dickson


J. F. Adams
M.S. 1935
Walker


H. H. Foster
Ph.D. 1935
Keitt


J. H. Jensen
Ph.D. 1935
Duggar


M. W. Stubbs
Ph.D. 1935
Walker


B. B. Bayles
Ph.D. 1936
Dickson


S. B. Locke
Ph.D. 1937
Riker

D. R. Ozanne
M.S. 1937
Walker

A. F. Ross
Ph.D. 1937
Tottingham

C. T. Wei
Ph.D. 1937
Walker

W. B. Allington
Ph.D. 1938
J. Johnson

A. C. Braun
Ph.D. 1938
J. Johnson

J. H. Torrie
Ph.D. 1938
Duggar

O. C. Whipple
Ph.D. 1938
Walker

D. H. Bowman
Ph.D. 1939
Dickson

A. E. Dimond
Ph.D. 1939
Duggar

E. T. Edwards
Ph.D. 1939
Dickson

D. E. Pryor
Ph.D. 1939
Walker

B. J. Sallans
Ph.D. 1939
Dickson

W. Bever
Ph.D. 1940
Dickson

C. N. Clayton
Ph.D. 1940
Keitt

R. W. Fulton
Ph.D. 1940
J. Johnson

M. H. Langford
Ph.D. 1940
Keitt

J. G. McLean
Ph.D. 1940
Walker

L. J. Meuli
Ph.D. 1940
Riker

L. R. Roth
Ph.D. 1940
Riker

C. H. Spiegelberg
Ph.D. 1940
Riker

R. B. Stevens
Ph.D. 1940
Gilbert

J. Van Lanen
Ph.D. 1940
Riker

W. J. Virgin
Ph.D. 1940
Walker

J. B. Carpenter
Ph.D. 1941
Keitt

B. W. Henry
Ph.D. 1941
Riker

J. P. Jolivette
Ph.D. 1941
Walker

L. M. Josephson
Ph.D. 1941
Dickson

W. T. Schroeder
Ph.D. 1941
Walker

P. G. Smith
Ph.D. 1941
Walker

M. W. Felton
Ph.D. 1942
Walker

W. J. Hooker
Ph.D. 1942
Walker

F. J. LeBeau
Ph.D. 1942
Walker

E. C. Stevenson
Ph.D. 1942
Dickson

D. C. Arny
Ph.D. 1943
Dickson & H. L.
Shands

D. W. Chamberlain
Ph.D. 1943
Dickson

W. W. Hare
Ph.D. 1943
Walker

G. S. Pound
Ph.D. 1943
Walker

J. R. Shay
Ph.D. 1943
Keitt

R. H. Gruenhagen
Ph.D. 1944
Riker

H. E. Heggestad
Ph.D. 1944
J. Johnson

E. C. Calavan
Ph.D. 1945
Keitt

R. E. Foster
Ph.D. 1945
Walker

A. C. Hildebrandt
Ph.D. 1945
Riker

J. E. Kuntz
Ph.D. 1945
Walker

J. D. Moore
Ph.D. 1945
Keitt

S. H. Ou
Ph.D. 1945
Walker

C. C. Leben
Ph.D. 1946
Keitt

C. W. Schaller
Ph.D. 1946
Dickson


J. O. Andes
Ph.D. 1947
Keitt


W. C. Hatfield
Ph.D. 1947
Walker


J. B. Kendrick Jr.
1947


E. L. Moore
Ph.D. 1947
Dickson


J. E. Thomas
Ph.D. 1947
Riker


C. Wang
Ph.D. 1947
Dickson


G. W. Bruehl
Ph.D. 1948
Dickson


O. H. Calvert
Ph.D. 1948
Pound


W. F. Chiu
Ph.D. 1948
Walker


A. M. Gorenz
Ph.D. 1948
Walker & Larson


R. G. Grogan
Ph.D. 1948
Walker


D. J. Hagedorn
Ph.D. 1948
Walker

J. E. Mitchell
Ph.D. 1948
Riker

K. S. Thind
Ph.D. 1948
Keitt

M. J. Thirumalachar
Ph.D. 1948
Dickson

N. M. Utech
Ph.D. 1948
J. Johnson

D. M. Boone
Ph.D. 1949
Keitt

J. S. Boyle
Ph.D. 1949
Keitt & Moore

C. T. Fang
Ph.D. 1949
Riker

M. E. Gallegly
Ph.D. 1949
Walker

M. N. Grant
Ph.D. 1949
H. L. Shands &
Dickson

R. C. Ladeburg
Ph.D. 1949
Larson

J. H. Owen
Ph.D. 1949
Walker

R.L. Self
Ph.D. 1949
Walker

F. B. Struble
Ph.D. 1949
Keitt

T. N. Theis
Ph.D. 1949
Riker

E. K. Wade
M.S. 1949
Keitt

P. V. V. Weber
Ph.D. 1949
Keitt

M. D. Whitehead
Ph.D. 1949
Dickson

D. G. Wells
Ph.D. 1949
Dickson

G. H. Bridgmon
Ph.D. 1950
Walker

J. F. Carter
Ph.D. 1950
Dickson

R. W. Earhart
Ph.D. 1950
H. L. Shands &
Dickson

W. C. Faan
Ph.D. 1950
Keitt

R. M. Gilmer
Ph.D. 1950
Keitt & Moore

J. F. Schafer
Ph.D. 1950
Dickson

P. C. Cheo
Ph.D. 1951
Pound

A. A. Cook
Ph.D. 1951
Walker

J. F. Darby
Ph.D. 1951
Larson

E. C. Gasiorkiewicz
Ph.D. 1951
Larson

A. L. Hooker
Ph.D. 1951
Dickson

R. A. Kilpatrick
Ph.D. 1951
Dickson & Hanson

A. R. Mohajir
Ph.D. 1951
Arny & H. L. Shands

R. D. Raabe
Ph.D. 1951
Pound

W. H. Sill
Ph.D. 1951
Walker

A. B. Wiles
Ph.D. 1951
Walker

M. C. Futrell
Ph.D. 1952
Dickson

J. W. Guthrie
Ph.D. 1952
Keitt & J. Johnson

R. Kiesling
Ph.D. 1952
Dickson

R. F. Patton
Ph.D. 1952
Riker

R. P. Scheffer
Ph.D. 1952
Walker

R. W. Scott
Ph.D. 1952
Riker

D. A. Slack
Ph.D. 1952
Keitt & Moore

H. E. Smith
Ph.D. 1952
Keitt & Moore

G. J. Stessel
Ph.D. 1952
Keitt

E. H. Varney
Ph.D. 1952
Keitt & Moore

R. E. Webb
Ph.D. 1952
Larson

C. H. Beckman
Ph.D. 1953
Riker

J. R. Bloom
Ph.D. 1953
Walker

P. N. Drolsom
Ph.D. 1953
Dickson


G. J. Green
Ph.D. 1953
Dickson


G. R. Grimm
Ph.D. 1953
Dickson


E. D. Jones
Ph.D. 1953
Dickson


E. L. Kendrick
Ph.D. 1953
Dickson


J. B. LeBeau
Ph.D. 1953
Dickson


J. L. Lockwood
Ph.D. 1953
Keitt


D. S. MacLachlan
Ph.D. 1953
Larson


J. P. MacKinnon
M.S. 1953
Larson


R. L. Pelletier
Ph.D. 1953
Keitt


C. F. Purson
Ph.D. 1953
Walker


C. B. Skotland
Ph.D. 1953
Hagedorn


S. J. Warnock
Ph.D. 1953
Hagedorn

L. G. Weathers
Ph.D. 1953
Pound

N. N. Winstead
Ph.D. 1953
Walker

J. G. Berbee
Ph.D. 1954
Riker

L. R. Brown
M.S. 1954
Larson

N. D. Fulton
Ph.D. 1954
Hanson

C. H. Graves
Ph.D. 1954
Hagedorn

K. Helms
Ph.D. 1954
Pound

H.A. Lamey
Ph.D. 1954
Keitt

P. M. LeRoux
Ph.D. 1954
Dickson

W. C. McDonald
Ph.D. 1954
Dickson

A. O. Paulus
Ph.D. 1954
Pound

K. R. Shea
Ph.D. 1954
Riker

I. J. Thomason
Ph.D. 1954
Dickson

R. D. Tinline
Ph.D. 1954
Dickson

E. P. Van Arsdel
Ph.D. 1954
Riker

N. Armolik
Ph.D. 1955
Dickson

J. B. Bancroft
Ph.D. 1955
Pound

H. R. Cameron
Ph.D. 1955
Keitt & Moore

J. E. Duffus
Ph.D. 1955
Keitt & Moore

E. Z. Echandi
Ph.D. 1955
Walker

D. H. Hall
Ph.D. 1955
Walker

J. E. Halpin
Ph.D. 1955
Hanson

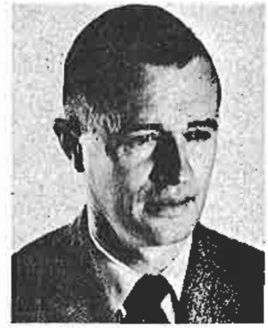
G. D. Lindberg
Ph.D. 1955
Walker

W. H. Muir
Ph.D. 1955
Riker

J. R. Parmeter
Ph.D. 1955
Kuntz

J. B. Sinclair
Ph.D. 1955
Walker

W. P. Skoropad
Ph.D. 1955
Arny



R. H. Bagnall
Ph.D. 1956
Larson

L. V. Busch
Ph.D. 1956
Walker

C. Cardona
Ph.D. 1956
Walker

R. V. Clark
Ph.D. 1956
Dickson

C. R. Drake
Ph.D. 1956
Kuntz

L. V. Edgington
Ph.D. 1956
Walker

C. Garces
Ph.D. 1956
Pound

H. C. Horton
Ph.D. 1956
Pound

D. M. Kline
Ph.D. 1956
Keitt


M. M. Thaung
Ph.D. 1956
Walker


P. Tsao
Ph.D. 1956
Keitt


K. L. Callahan
Ph.D. 1957
Moore & Keitt


G. D. Easton
Ph.D. 1957
Larson


C. G. Ehlers
Ph.D. 1957
Keitt & Moore


D. B. Robinson
Ph.D. 1957
Larson


R. T. Sherwood
Ph.D. 1957
Hagedorn


J. L. Troutman
Ph.D. 1957
Fulton


S. D. Van Gundy
Ph.D. 1957
Walker


G. W. Welkie
Ph.D. 1957
Pound


L. K. Edmunds
Ph.D. 1958
Hanson


A. L. Flangas
Ph.D. 1958
Dickson

A. J. Hansen
Ph.D. 1958
Larson

W. S. Kim
Ph.D. 1958
Hagedorn

M. R. Nelson
Ph.D. 1958
Pound

V. G. Perry
Ph.D. 1958
Darling

W. R. Phelps
Ph.D. 1958
Kuntz

R. J. Shepherd
Ph.D. 1958
Pound

G. P. Singh
Ph.D. 1958
Pound

D. N. Srivastava
Ph.D. 1958
Walker

R. Syamananda
Ph.D. 1958
Dickson

G. E. Templeton
Ph.D. 1958
Dickson

C. C. Chi
Ph.D. 1959
Hanson

E. B. Cowling
Ph.D. 1959
Riker

L. R. Faulkner
Ph.D. 1959
Darling

P. Knox Davies
Ph.D. 1959
Dickson

R. H. Kurtzman
Ph.D. 1959
Hildebrandt

J. P. Martin
Ph.D. 1959
Hanson

M. V. Nayudu
Ph.D. 1959
Walker

J. E. Nighswander
Ph.D. 1959
Patton

G. B. Orlob
Ph.D. 1959
Arny

F. J. Pelet
Ph.D. 1959
Hildebrandt

J. L. Peterson
Ph.D. 1959
Pound

T. Sasaki
Ph.D. 1959
Kuntz

E. Schieber
Ph.D. 1959
Dickson

J. G. Shaw
Ph.D. 1959
Larson

L. V. White
Ph.D. 1959
Darling

J. Cervantes
Ph.D. 1960
Larson

R. C. DeGroot
M.S. 1960
Kuntz

R. K. Grover
Ph.D. 1960
Moore

R. E. Hampton
Ph.D. 1960
Fulton

J. S. Kankam
M.S. 1960
Arny

J. M. Klisiewicz
Ph.D. 1960
Pound

G. F. Kollmer
Ph.D. 1960
Larson

G. C. M. Latch
Ph.D. 1960
Hanson

M. S. Pavgi
Ph.D. 1960
Dickson

T. P. Pirone
Ph.D. 1960
Pound

W. L. Seaman
Ph.D. 1960
Larson

G. C. Smart
Ph.D. 1960
Darling

T. Tamaoki
Ph.D. 1960
Hildebrandt

C. H. Walkinshaw
Ph.D. 1960
Larson

S. L. Wasuwat
Ph.D. 1960
Walker

B. J. Williams
Ph.D. 1960
Boone

J. L. Anderson
Ph.D. 1961
Walker

K. R. Barker
Ph.D. 1961
Walker

D. L. Coyier
Ph.D. 1961
Hildebrandt

J. L. Cunningham
Ph.D. 1961
Hagedorn

O. J. Dickerson
Ph.D. 1961
Thorne

J. Heyns
Ph.D. 1961
Thorne

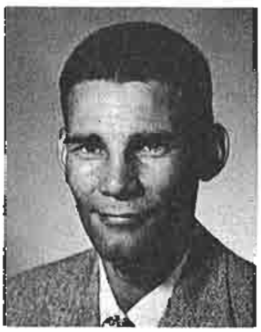
D. Houston
Ph.D. 1961
Kuntz

A. G. Kais
M.S. 1961
Smalley

B. H. Lee
Ph.D. 1961
Dickson

A. A. Reyes
Ph.D. 1961
Mitchell

E. E. Rosenkranz
Ph.D. 1961
Hagedorn



D. J. Rossouw
Ph.D. 1961
Fulton

M. O. San Juan
Ph.D. 1961
Pound

O. P. Sehgal
Ph.D. 1961
Boone

H. Spurr
Ph.D. 1961
Hildebrandt

M. Starzyk
Ph.D. 1961
Mitchell

P. Tsao
Ph.D. 1961
Hagedorn

G. L. Worf
Ph.D. 1961
Hagedorn

R. V. Anderson
Ph.D. 1962
Darling

R. D. Berger
Ph.D. 1962
Hanson

P. Chen
Ph.D. 1962
Hildebrand

T. Geary
Ph.D. 1962
Kuntz

L. Gonzalez
Ph.D. 1962
Pound

G. Griffin
Ph.D. 1962
Darling

S. Humphries
M.S. 1962
Moore

R. Krebill
Ph.D. 1962
Patton

M. Lortie
Ph.D. 1962
Kuntz

E. Martinez
Ph.D. 1962
Hanson

P. N. Patel
Ph.D. 1962
Walker

A. J. Prey
M.S. 1962
Kuntz

R. E. Reinert
Ph.D. 1962
Hildebrandt

J. Riffle
Ph.D. 1962
Kuntz

C. Rivera
Ph.D. 1962
Pound

A. Ross
M.S. 1962
Kuntz

E. Ruppel
Ph.D. 1962
Hagedorn

K. Shrivastava
M.S. 1962
Walker

R. Wall
Ph.D. 1962
Kuntz

H. E. Waterworth
Ph.D. 1962
Fulton

P. H. Williams
Ph.D. 1962
Pound

C. B. Willis
Ph.D. 1962
Fulton

R. W. Berry
Ph.D. 1963
Arny & Dickson

G. P. Blair
Ph.D. 1963
Darling

L. Carlson
Ph.D. 1963
Boone

J. N. Chand
Ph.D. 1963
Walker

S. Kumar
Ph.D. 1963
Hildebrandt

G. C. Marks
Ph.D. 1963
Berbee

J. D. Rogers
Ph.D. 1963
Berbee

R. C. Sievert
Ph.D. 1963
Hildebrandt

J. C. Wilmar
M.S. 1963
Hildebrandt

A. D. Boettcher
M.S. 1964
Hildebrandt

K. C. Ling
Ph.D. 1964
Pound

J. Maduewesi
Ph.D. 1964
Hagedorn

C. E. Main
Ph.D. 1964
Walker

M. L. Mee
M.S. 1964
Moore

G. V. M. Nair
Ph.D. 1964
Kuntz

T. H. Nicholls
M.S. 1964
Patton

A. V. Ravenscroft
M.S. 1964
Mitchell

S.F. Rickard
Ph.D. 1964
Walker

C. Rodrigues
Ph.D. 1964
Arny

A. T. Saad
Ph.D. 1964
Boone

D. Stuteville
Ph.D. 1964
Hanson

A. J. Webber
M.S. 1964
Barker

W. W. Wilcox
Ph.D. 1964
Kuntz

C. Y. D. Yang
Ph.D. 1964
Mitchell

F. F. Angell
Ph.D. 1965
Pound

K. S. Amin
Ph.D. 1965
Sequeira

L. L. Black
Ph.D. 1965
Pound & Williams

G. Holcomb
Ph.D. 1965
Hildebrandt

L. H. Huang
M.S. 1965
Hagedorn

D. Huisingh
Ph.D. 1965
Durbin

J. W. Martens
Ph.D. 1965
Arny

A. C. Pizarro
Ph.D. 1965
Arny

C. J. Rabie
Ph.D. 1965
Smalley

J. R. Stavely
Ph.D. 1965
Hanson

M. Teliz-Ortiz
Ph.D. 1965
Mitchell

M. Temp
Ph.D. 1965
Hagedorn

S. M. Yang
Ph.D. 1965
Hagedorn

R. Alconero
Ph.D. 1966
Hagedorn

H. Bagga
Ph.D. 1966
Boone

Z. Darunday
M.S. 1966
Hanson

C. DeLeon
Ph.D. 1966
Pound & Williams

D. T. Gordon
Ph.D. 1966
Arny

G. Hsu
M.S. 1966
Mitchell

D. Lachance
Ph.D. 1966
Kuntz

R. Maheshwari
Ph.D. 1966
Hildebrandt

A. Q. Paulsen
Ph.D. 1966
Fulton

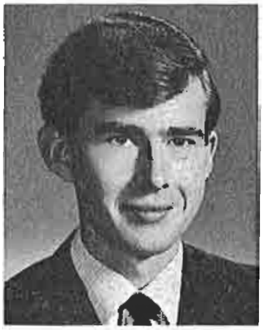
A. Saettler
Ph.D. 1966
Pound & Williams

P. E. Thomas
Ph.D. 1966
Fulton

P. A. Arneson
Ph.D. 1967
Durbin

A. Campos
Ph.D. 1967
Darling

R. Gettens
M.S. 1967
Kelman



H. Harding
Ph.D. 1967
Williams

H. A. Hoitink
Ph.D. 1967
Hagedorn

C. G. Iverson
Ph.D. 1967
Kuntz

M. L. Kalil
Ph.D. 1967
Hildebrandt

L. S. Leu
Ph.D. 1967
Boone

W. T. McGrath
Ph.D. 1967
Patton

R. H. Phelps
Ph.D. 1967
Sequeira

D. Singh
Ph.D. 1967
Smalley

J. O. Strandberg
Ph.D. 1967
Williams

P. Torrealba
Ph.D. 1967
Darling

T. C. Wang
M.S. 1967
Hagedorn

M. O. Adegbola
Ph.D. 1968
Hagedorn

D. J. Bagga
Ph.D. 1968
Smalley

O. W. Barnett
Ph.D. 1968
Fulton

J. A. Bartz
Ph.D. 1968
Mitchell

D. A. Biris
Ph.D. 1968
Moore

J. P. Crill
Ph.D. 1968
Hanson & Hagedorn

R. J. Friend
Ph.D. 1968
Boone

N. T. Keen
Ph.D. 1968
Williams

J. W. Klink
Ph.D. 1968
Mitchell

H. T. Bone
Ph.D. 1969
Kuntz

R. J. Copeman
Ph.D. 1969
Sequeira

J. M. Duniway
Ph.D. 1969
Durbin

C. Fribourg-Solis
M.S. 1969
DeZoeten

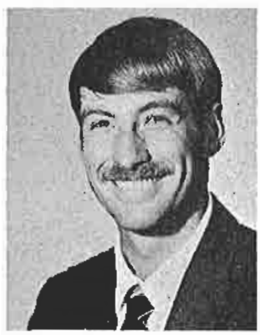
W. F. Marasas
Ph.D. 1969
Smalley

E. S. Megahed
Ph.D. 1969
Moore

D. T. Myren
Ph.D. 1969
Patton

R. D. Piney
Ph.D. 1969
Hildebrandt

S. M. Saad
Ph.D. 1969
Hagedorn



J. R. Steadman
Ph.D. 1969
Sequeira

J. C. Sutton
Ph.D. 1969
Williams

W. G. Thies
Ph.D. 1969
Patton

W. Woodbury
Ph.D. 1970
Williams

J. R. Aist
Ph.D. 1971
Williams

J. R. Hartman
Ph.D. 1971
Kelman

B. J. Jacobsen
M.S. 1971
Williams


D. W. Johnson
Ph.D. 1971
Kuntz


J. T. Kliejunas
Ph.D. 1971
Kuntz


J. L. Ladipo
Ph.D. 1971
deZoeten


J. P. Mildenhall
Ph.D. 1971
Williams


H. C. Newton
Ph.D. 1971
Sequeira

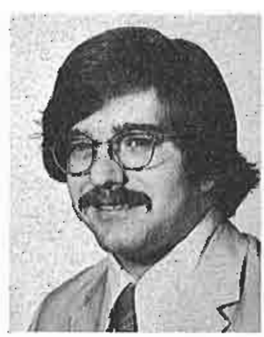

P. O. Oyekan
Ph.D. 1971
Mitchell

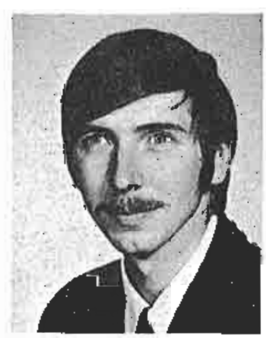

S. Shanmugasundaram
M.S. 1971
Williams


T. Staub
Ph.D. 1971
Williams


P. A. Taylor
Ph.D. 1971
Durbin


J. C. Watterson
M.S. 1971
Williams


D. L. Coplin
Ph.D. 1972
Sequeira

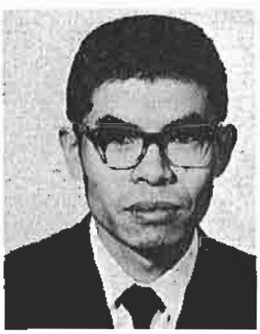

E. Hansen
Ph.D. 1972
Patton

M. F. Heimann, O.S.F.
M.S. 1972
Hildebrandt

H. C. Hoch
Ph.D. 1972
Mitchell

C. Lozano
Ph.D. 1972
Sequeira

W. R. Stevenson
Ph.D. 1972
Hagedorn



K. Yoshii
Ph.D. 1972
Hagedorn

H. S. Bhalla
Ph.D. 1973
Mitchell

G. Bonn
Ph.D. 1973
Sequeira

F. Morales-Bance
M.S. 1973
Moore

P. T. Onesirosan
Ph.D. 1973
Arny

P. E. Still
Ph.D. 1973
Smalley

M. Abo El-Nil
Ph.D. 1974
Hildebrandt

L. Corcuera
Ph.D. 1974
Upper

T. German
Ph.D. 1974
deZeoten

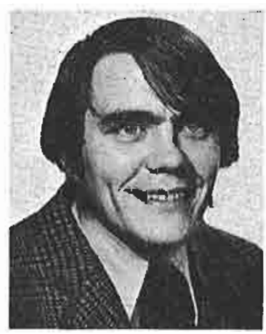
A. R. Gotlieb
Ph.D. 1974
Berbee

S. Hadi
Ph.D. 1974
Berbee

H. Humaydan
Ph.D. 1974
Williams

L. S. Loesch
Ph.D. 1974
Fulton

M. D. Porto
Ph.D. 1974
Hagedorn



R. G. Pratt
Ph.D. 1974
Mitchell

D. TeBeest
Ph.D. 1974
Kuntz

S. Tontyaporn
Ph.D. 1974
Boone

T. J. Wacek
Ph.D. 1974
Sequeira

T.C. Zalewski
Ph.D. 1974
Sequeira

Z. Abul-Hayja
Ph.D. 1975
Williams

R. J. Ehr
M.S. 1975
Williams

P. Fenn
Ph.D. 1975
Kuntz

R. E. Fries
M.S. 1975
Hanson

P. McCabe
M.S. 1975
Hildebrandt

D. J. Merlo
Ph.D. 1975
Kemp

R. Howard
Ph.D. 1975
Williams

G. Murray
Ph.D. 1975
Maxwell

R. Sushak
Ph.D. 1975
Hildebrandt

J. Omuemu
Ph.D. 1975
Berbee

M. Woodward
Ph.D. 1975
Helgeson

M. Albers
M.S. 1976
Berbee

V. Armentrout
Ph.D. 1976
Maxwell

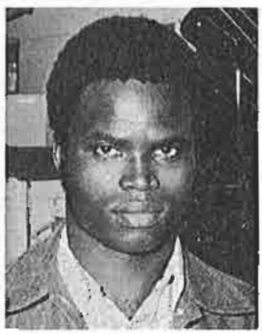

D. Cuppels
Ph.D. 1976
Kelman


S. H. DeBoer
Ph.D. 1976
Kelman


R. F. Hepp
Ph.D. 1976
deZeoten


B. Holroyd
M.S. 1976
Kemp


M. Khan
Ph.D. 1976
Maxwell


V. O. Otoide
M.S. 1976
Patton


J. Pronos
Ph.D. 1976
Patton


J. Cardosa
M.S. 1977
Hildebrandt


B. Cours
M.S. 1977
Williams


E. Halk
Ph.D. 1977
Fulton


S. Lindow
Ph.D. 1977
Arny


C.A. Lopes
M.S. 1977
Hagedorn

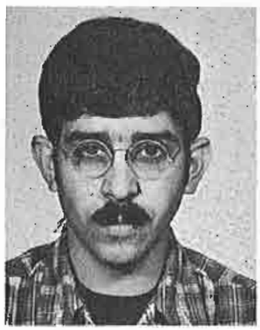
W. T. Nishijima
Ph.D. 1977
Smalley

J. A. Phillips
M.S. 1977
Kelman

M. T. Ribeiro
M.S. 1977
deZeoten

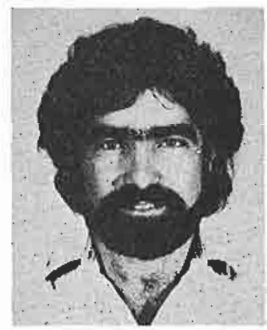
O. Tortolero
M.S. 1977
Sequeira

J. Victoria
Ph.D. 1977
Kelman



J. Castello
Ph.D. 1978
Berbee

C. D'Arcy
Ph.D. 1978
deZeoten



M. deAssiss
M.S. 1978
Hildebrandt

R. V. James
M.S. 1978
Williams

H. Modjo
M.S. 1978
Mitchell

L. Nadolny
M.S. 1978
Sequeira

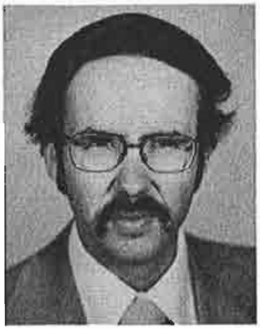
J. B. Perry
M.S. 1978
Andrews

D. Webster
Ph.D. 1978
Sequeira

J. Campbell
M.S. 1979
Helgeson

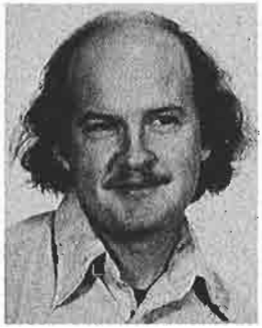
L. Ciampi
Ph.D. 1979
Sequeira

M. E. Daub
Ph.D. 1979
Hagedorn



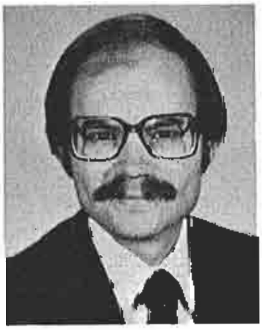
W. Fett
Ph.D. 1979
Sequeira

R. Martin
Ph.D. 1979
Berbee



R. Reeleder
Ph.D. 1978
Hagedorn

F. Reifschnieder
Ph.D. 1979
Arny



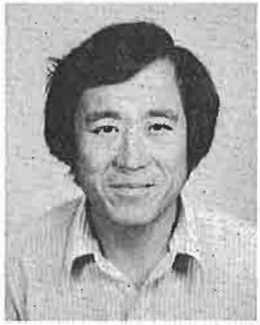
M. Stough
M.S. 1979
Mitchell

P. Suleman
M.S. 1979
Arny & Grau

J. Bowman
M.S. 1980
Sequeira

P. Delwiche
Ph.D. 1980
Williams

E. Hack
Ph.D. 1980
Kemp

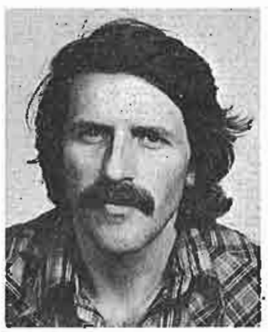


Y. I. Hahm
M.S. 1980
Slack

J. Irwin
Ph.D. 1980
Maxwell

M. Mmbaga
Ph.D. 1980
Arny & Grau

J. O'Laughlin
M.S. 1980
Andrews

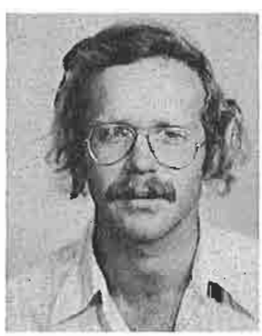


T. Pastalka
Ph.D. 1980
Berbee

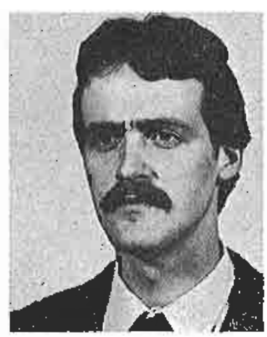
M. A. Pfannesteil
Ph.D. 1980
Slack

H. Tanaka
M.S. 1980
Sequeira

G. Weidmann
Ph.D. 1980
Boone



R. Avenius
M.S. 1981
Andrews



D. Cullen
Ph.D. 1981
Smalley

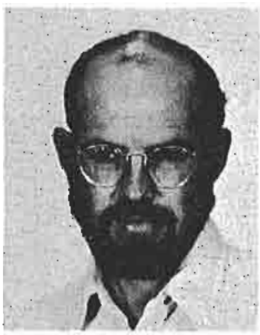
G. Granada
Ph.D. 1981
Sequeira

E. Khonga
M.S. 1981
Andrews

J. Leach
Ph.D. 1981
Sequeira

J. Lindemann
Ph.D. 1981
Arny

K. Y. Lum
Ph.D. 1981
Kelman



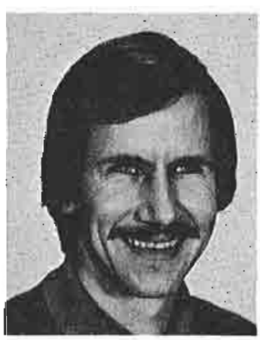
W. Pfender
Ph.D. 1981
Hagedorn

V. Radke
M.S. 1981
Grau

M. Schwarz
Ph.D. 1981
Boone

J. Sherwood
Ph.D. 1981
Fulton

S. Simmons
M.S. 1981
Berbee

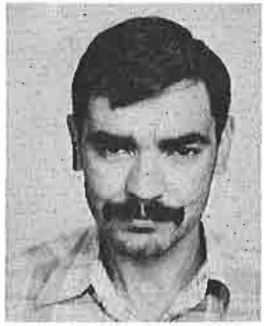


S. Antonius
Ph.D. 1982
Hagedorn

P. Blenis
Ph.D. 1982
Patton

K. Brown
M.S. 1982
Boone

J. Duvick
Ph.D. 1982
Sequeira



J. Faria
Ph.D. 1982
Hagedorn

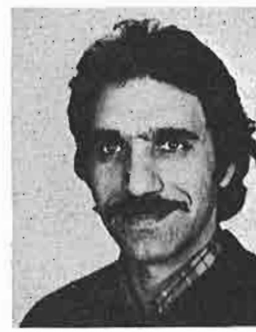
C. Heye
Ph.D. 1982
Andrews

J. Kempe
M.S. 1982
deZeoten

K. Kobriger
Ph.D. 1982
Hagedorn

S. Miller
Ph.D. 1982
Maxwell

C. Monkman
M.S. 1982
deZoeten



M. Rahimian
Ph.D. 1982
Mitchell

P. Reeser
M.S. 1982
Rouse

D. Styer
Ph.D. 1982
Durbin

N. Tisserat
Ph.D. 1982
Kuntz

P. Tooley
Ph.D. 1982
Grau

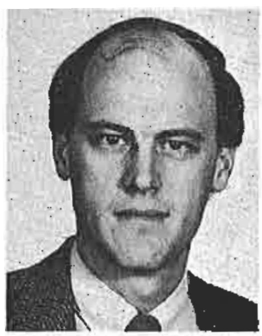
J. Cummings
M.S. 1983
Berbee

J. Lukens
Ph.D. 1983
Durbin

R. McGuire
Ph.D. 1983
Kelman

L. Orchard
Ph.D. 1983
Kuntz

M. Grasmick
Ph.D. 1984
Slack



M. Havey
Ph.D. 1984
Maxwell

H. Leung
Ph.D. 1984
Williams

P. Sanderson
M.S. 1984
Andrews

A. Wyszogrodska
Ph.D. 1984
Williams

A. Bishop
Ph.D. 1985
Slack

T. Zinnen
Ph.D. 1985
Fulton

Kendall/Hunt
Publishing Company
Dubuque, Iowa

A 403790 01
ISBN 0-8403-3790-6