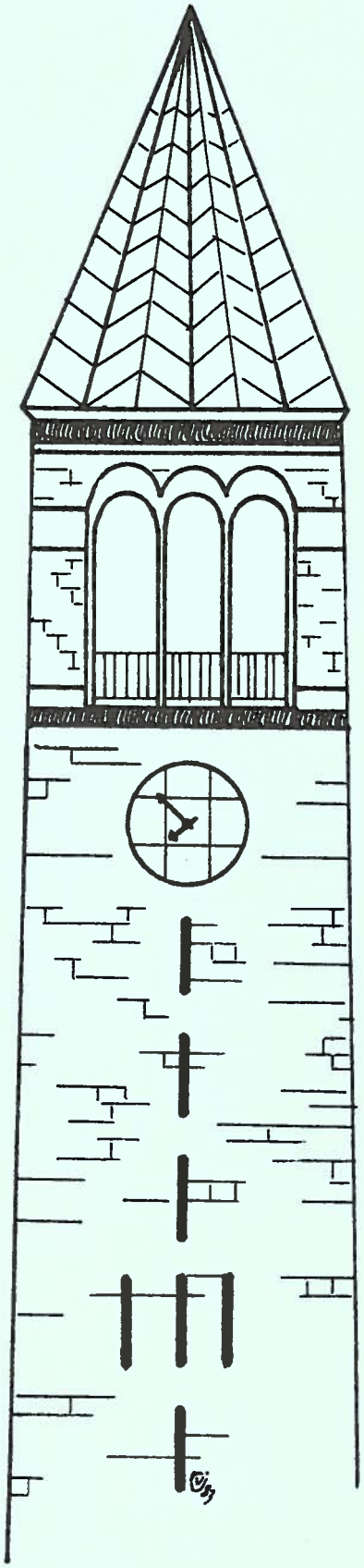

Plant Pathology at Cornell ~ Ithaca

Historical Highlights

G.C. Kent, A.G. Newhall

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INTRODUCTION

One of the three professors related to agriculture at the opening of Cornell in 1868 was A, N. Prentiss, trained as a mycologist at Michigan State College. Prentiss was Professor of Botany, Superintendent of Grounds, and Director of Manual Labor. One of the courses he offered was "Parasitic Fungi". By 1873 his title was Professor of Botany and Horticulture. The responsibility for horticulture was separated from Botany on the appointment of L. H. Bailey in 1888.

In 1874 the Botany Department, viewed as a suitable arena for young ladies and providing them excellent opportunity for exercise, was moved into the new Sage Hall. The first two bulletins issued by the Experiment Station on plant diseases were the work of two young lady Fellows in Botany in 1888 and '89.

In 1886 the first doctorate in the sciences was granted to John Charles Arthur, a D. Sc, based on studies of fire blight conducted while working as the first plant pathologist on the staff of the New York State Agricultural Experiment Station at Geneva.

The Cornell University Experiment Station was organized with little or no support in 1879. After passage of the Hatch Act in 1885, the Station was reorganized as the Cornell University Agricultural Experiment Station in 1888 in order to utilize the Hatch funds which had finally been allocated to Cornell by the New York State Legislature.

Also in 1886, W. R. Dudley, having no support for research in his specialty of mycology, published "The Cayuga Flora" as the second bulletin in the science series from Cornell.

In the report for 1897 Atkinson reported that Duggar, the first staff member actually trained to investigate plant disease, was engaged in "practical and scientific studies". In 1898 Duggar mentioned experiments on control of peach leaf curl, a pear disease, onion blight, and late blight of celery. These appear to be the first control tests by a plant pathologist. For 10 or more years after Bailey's appointment in Horticulture, he and his assistant, E. G. Lodeman, appear to have conducted all the field trials on spraying for disease control, schedules and materials.

In 1906, H. H. Whetzel was appointed Assistant Professor of Botany and Head of the Department of Botany in the newly organized New York State College of Agriculture, following passage by the Legislature of the Administration Act for the College. The department was housed in the basement of the Old Dairy Building where the west wing of the Plant Science Building now stands. The Annual Report, 1906, contained Whetzel's first report for the Department of Botany in the College of Agriculture. He reported on the teaching enterprise, plans and recommendations for the ensuing year, and investigations listing bean anthracnose, alternaria blight of ginseng, fire blight, septoria blight of tomatoes, control of hollyhock rust, and pea root rot. Perhaps as illuminating is the supplement to Bulletin 237, in 1906, titled Alfalfa, by J. L. Stone, J. W. Gilmore, and S. Fraser. The supplement lists, under Horticulture, spraying experiments on peaches, plums, and grapes.

In 1907 at Whetzel's request, the name of the Department and his title were changed to Plant Pathology and Whetzel was advanced to Professor. Some plant disease work was continued in other departments, especially on control, but Plant Pathology began a rapid expansion in work and staff. In the Annual Report for 1907, Whetzel described the work on black rot of grapes under Assistant Donald Reddick, and the establishment of a field laboratory, well equipped for microscopic and cultural work, in a large Niagara vineyard near Romulus, N.Y. He indicated plans to expand the number of field laboratories and noted that the Plant Disease Survey was initiated during 1907. Years later he likened it to "the intelligence arm of a modern army."

By 1908 there was also a field laboratory for bean investigations at the Burt Olney Canning Company of Oneida. In that year the Department moved into the attic of what was later called Stone Hall. By that year Whetzel reported that 85 of 224 bulletins issued by the Station since 1888 were wholly, or in part, concerned with plant diseases.

The field laboratories grew to 7 in 1909, five of which were largely supported financially by growers. The President reported that because of limited funds and a wealth of problems, the department would hereafter only be able to undertake those investigations to which growers felt warranted to give support. In 1909 also, Niagara Sprayer Company of Middleport, N.Y. established the first Industrial Fellowship in the department and in the College. In the second year of the fellowships, 1910, Acting Director Webber had to insert in the grant the provision that the grantor must not use results for advertising. By the next year there were 8 industrial fellowships, three provided by grower groups, and one commercial grant providing 2 fellowships. Ultimately there were to be over 75 industrial fellowships, with some still in force in 1983.

An outstanding contribution to the science was the series of 9 books contributed by the staff from 1909, beginning with B. M. Duggar's "Fungus Diseases of Plants" to 1925 when Chupp published his "Manual of Vegetable Garden Diseases" (revised by Arden Sherf in 1960).

Whetzel rapidly built up the staff, developing specialists within the field. The majority came from Wabash, as had Whetzel, and received their doctorates in the Department. Vigilance against outbreaks was increased and 84 spray rings on potatoes and vegetables were set up over the State.

Massey directed the department for 28 years, from 1922, and developed a staff with leadership in their programs in fruit, ornamentals, potatoes and vegetables. He was an excellent administrator and returned the staff to a coherent, smoothly functioning group.

The department moved from the attic of Stone Hall to the basement of Bailey Auditorium in 1913, and in January of 1932 moved into modern, expanded quarters on the 3rd and part of the 4th floor of the new Plant Science Building. Those quarters provided for the departmental program until the early 50's. During all of this period the primary foci of the programs of the staff and students were field oriented with some students leaving for field locations in April or May and returning after harvest in the fall. Their class work, especially laboratories, was difficult under this arrangement.

Many changes occurred during the 30s and 40s. Of particular interest was the institution of the Dutch elm disease program in cooperation with the Boyce Thompson Institute; in 1934, the disease was not present then at Ithaca. The establishment in 1938, by Massey and C. E. Palm, Head of Entomology, of the Annual Insecticide-Fungicide Conference continues today. The vegetable research program at Riverhead, Long Island was transferred from the Geneva Station to Ithaca for administrative purposes; and, the initiation of the golden nematode research program under quarantine regulations on Long Island occurred in 1945.

Massey turned the administrative duties of the department to G. C. Kent in 1950, partly because of health and partly because the faculty was facing a rebuilding period. The 1950s brought the retirement of most of the original faculty. Staff replacements were made, the instructional program was reorganized, extension became more of an agent training operation, and the research program was expanded to cover areas more or less neglected since the mid-twenties, and moved from field orientation into the laboratory to get at mechanisms and reasons.

Outside Plant Science Building the expansion included construction of the Virology-Nematology Laboratory for modern facilities in these areas, inauguration of the College-wide Pesticide Research Laboratory, expansion to new facilities for ornamentals research and golden nematode programs on the grounds of the Long Island Agricultural and Technical College at Farmingdale, the cooperation at the Cohn Fruit farm at Sodus, the Vegetable Research Laboratory provided by the Orange County growers, the initiation of the Cornell-Uihlein Foundation Seed Potato Farm at Lake Placid, and renovations of facilities and programs at Riverhead.

By 1970 the staff was facing another series of changes as a result of retirements, and in that year D. F. Bateman became head of the department. Bateman brought in a group of young well-trained staff members who are again incorporating new directions and new approaches in the research, teaching and extension programs. These changes called for further expansion in the supporting staff. New programs included the physiological aspects of disease, disease and pathogen cytology, turfgrass disease research, and nematology.

INSTRUCTION

One of the several courses offered in Botany when the University opened was "Parasitic Fungi" by A. N. Prentiss. The program of instruction in Plant Pathology began officially in 1907, when the department was established. It was during these formative years that Whetzel's philosophy of teaching took shape. About 1908 or 1909, when Plant Pathology courses were in the cramped quarters in the attic of Stone Hall, Whetzel instituted his practice of accepting undergraduate students on the basis of their academic average, rather than a first-come, first-accepted basis. This practice upset some faculty and dismayed many seniors who had postponed taking plant pathology.

By 1908/09 the offering in Plant Pathology consisted of several courses: Plant Pathology, Principles of Plant Disease Control, Laboratory Methods in Plant Pathology, Advanced Plant Pathology, Etiology of Plant Diseases, Research, and Seminar. In 1910 the number of courses in the Department was raised to 8, and there were 206 registered students. These courses required 5 teaching assistants, and there were 9 majors and 16 minors. During the next 10 years, the following courses were added: Diseases of Field and Truck Crops, Diseases of Fruit and Fruit Trees, Diseases of Forcing-House and Florist Crops, Dendropathology, Phytopathological Histology, Timber Decay and Its Prevention, two courses in Mycology, and Bacterial Diseases of Plants.

In 1913, the Department moved from the attic of Stone Hall to the basement of Bailey Hall, directly underneath the *very* powerful organ.

By 1929/30, just before moving from Bailey Hall basement to the new Plant Science Building, the course offering was much as it continued for 20 years, although several of these courses were filled infrequently. The courses included: Plant Pathology, Advanced Plant Pathology, Principles of Plant Disease Control, Forest Tree Pathology, Shade Tree Pathology and Tree Surgery, Comparative Morphology of Fungi, Introduction to Mycology, Mycology 221, Mycology 222, History of Phytopathology (a course which Whetzel taught until his death in 1944), German phytopathological readings, research, seminar, and literature review.

During the late '50s and early '60s, the courses were fully rearranged as to content and place in the training of students. The undergraduate series was to prepare general agriculturalists, pest managers, and potential graduate students with a general understanding of plant diseases and their control. The graduate program consisted of a general course to lay a uniform foundation of understanding of the principles of individual disease occurrence and disease in plant populations. Supplementing this were current topics courses covering work by students, and information from current literature. At the end of the program was a capstone course dealing with principles and concepts to bring the knowledge gained in specialty courses, research, etc., into a structure or philosophy of the science.

In 1947, Ross developed what became a course in Plant Virology. In 1954 Mai began the teaching of Nematology as a part of Advanced Plant Pathology, and there are now 3 courses in Nematology.

In 1961 Millar originated the Summer Field Program designed to enable graduate students to become more informed about diseases in field situations, plant diseases in the perspective of crop production, as viewed by growers, and the research philosophy of faculty with field oriented problems. He supervised the program till 1967, since then it has been continued by other faculty.

In 1963 Bateman initiated the Disease and Pathogen Physiology course, which is currently handled by VanEtten and Yoder. In 1965 Dickey began the Bacterial Plant Pathogen course. In 1966 Millar originated a course titled, "Biological Aspects of Disease in Plants", an undergraduate course for students majoring in biological sciences. In the mid-1970's Arneson developed a capstone course in pest management: Pest Management for Plant Protection.

In 1982/83, the courses offered in the Department of Plant Pathology were as follows:

No.	Cr.		
301	4	Introduc. Plant Pathology	Sinclair
309	4	Introduc. Mycology	Korf or Lorbeer
402	3	Plant Disease Control	Arneson
443	5	Pathology and Entomology of Trees and Shrubs	Hudler
504	4	Pest Management for Plant Protec.	Arneson
641-65	1	Special Topics Courses	Faculty
681	1	Seminar	Faculty
701	4	Advanced Plant Pathology	Millar
711	4	Biology of Plant Pathogens	Beer & others
735	4	Plant Virology	Zaitlin
736	3	Plant Nematology	Mai & Harrison
737	3	Bacterial Plant Pathogens	Dickey
738	3	Molecular Mechanisms of Pathogenesis	VanEtten & Yoder
739	4	Advanced Mycology	Korf
756	3	Advanced Plant Nematology	Mai, Harrison,Brodie
759	4	Taxonomy of Fungi	Korf

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EXTENSION

In 1869, A. N. Prentiss, Professor of Botany, with George C. Caldwell, Professor of Agricultural Chemistry, and James Law, Professor of Veterinary Medicine, conducted a series of lectures for groups of farmers throughout New York. This appears to have been the first extension activity of the University.

When L. H. Bailey came to Cornell he soon began working with growers to determine problems, provide solutions, and conduct practical tests. An early contact with grape growers in Chatauqua County, was with John W. Spencer and S. Fred Nixon in diagnosing their problem as black rot. Nixon, a representative in the Assembly from the area, sponsored through the Legislature a bill allocating $8,000 for extension work in Horticulture in the 5th Judicial District in 1894. The appropriation and coverage, by 1898, were enlarged to cover the entire state and disciplines of the Station, so that $34,000 was available to the College for its extension work. It was, in fact, "Nixon Funds" that supported Durand, VanHoch, Smith, Duggar, and in 1904 and '05, H. H. Whetzel, in the work they did leading up to the founding of the Department.

The other vineyardist, John W. Spencer, later a professor at the College, was the famous "Uncle John" who did much to promote agricultural extension throughout the State, and got support for the College from the State government.

Discussing extension work in his 1908 Annual Report, Whetzel says correspondence with growers reached 200 letters per week. Here the first mention was made of exhibits at state and county fairs, and that these exhibits were to become a fixed feature of the extension program of the Department. By 1910 the correspondence had grown to 4,000 letters to growers per year. Extension contributions also included circular letters, articles for newspapers, exhibits, etc.

Then in 1911, M. F. Barrus was appointed as the first staff member with responsibilities for extension work. Subsequent extension contributions to farm trains and exhibits at state and county fairs, and at grower meetings continued until World War II. Extension specialists organized and lectured or demonstrated at various grower meetings throughout the State, often in cooperation with the Farm Bureau, as well as the local agent. Many, field demonstrations and applied research tests were established.

Beginning in 1917 and continuing to the 60s, a highly organized spray information service was developed for and among fruit growers providing daily information on the weather and disease occurrence, and suggestions for spray materials and application. During World War II this service was continued by radio and the system telephone hook-ups started about 1926-28. During part of this time the staff promoted spray-rings for fruit and potato growers, and in some cases provided graduate students as operators. There were 94 spray-rings in operation by 1948.

Beginning about 1925 K. H. Fernow began his work on field identification and elimination of "seed-borne" problems of the potato. Fernow became an authority on field identification and certification techniques. This work culminated under E. D. Jones in 1961 in the establishment of the Cornell-Uihlein Foundation Seed Potato Farm providing a superior source of foundation seed stocks for seed-potato producers.

By 1950, Professor Charles Chupp completed 20 years of research into the growing of better tomato seedlings by the contract growers of the State and a movie film showing approved practices was produced in the Department Photographic Laboratory for use in the extension program.

About the mid-twenties the extension staff, with the staff in Entomology, initiated a weekly newsletter reporting current information to the county agents and other interested individuals, especially representatives of fungicide and insecticide manufacturers. In these reports, agents and field men reported first appearance of diseases and insects in various areas of the State. After 25-30 years these records provided information on probable first appearance of pest problems over the State, which served as a *very* valuable guide to growers, agents, and farm advisors.

Cereal disease control was long an extension activity in the State, based on control of seed-borne organisms and resistant varieties primarily from the plant breeding programs. Stem rust has resulted in an occasional epiphytotic, but never enough to justify a state-wide barberry eradication program. However, in the early 1950s R. S. Dickey conducted several successful local barberry eradication programs.

The Extension operation of today is a highly developed educational program which involves in-service training of Extension field staff, providing technical information at various levels, conducting of demonstrations and applied research, cooperating in a number of inter-disciplinary and interagency programs over the State, and maintaining administrative and reporting operations at various interdepartmental, intercollege, and interinstitutional levels.

The extension staff members develop educational programs from their own research, research of other staff members in Ithaca, Geneva, and other research installations, in neighboring states or provinces. The programs not only serve growers directly, but also coordinate the information provided to the grower by County or Regional Extension Agents, industry, grower organizations, and the State Department of Agriculture and Markets. Thus, Professor Mai serves as nematologist for the New York State Department of Agriculture and Markets.

Administrative aspects of extension programs are coordinated by T. A. Zitter, who serves as Extension Leader in the Department.

RESEARCH

Research on plant diseases took the form of thesis problems, problem solving, or response to grower requests until about 1910 when continuing programs dealing with problem areas or specialization within the discipline began to emerge,

Fruit

In the 1st Annual Report of the Agricultural Experiment Station, Dudley mentioned studies on strawberry diseases. These studies were published as Bulletin 14 of the Station in 1889, on "The Strawberry leaf blight organism", and "Another Disease of Strawberry". A footnote indicated the bulletin was primarily the work of Miss J. W. Snow, Fellow in Botany. The controls reported, spraying with copper carbonate and burning mulch in spring, were quoted from the work of others.

The next year W. A. Murrill in Bulletin 180 - The Prevention of Peach Leaf Curl -continued Lodeman and Duggar's work on the control of curl with 6-6-50 Bordeaux mixture in April as the buds are swelling.

In 1907 Donald Reddick established the first field laboratory to work on grapes in Lansing and Romulus. The next year, with C. S. Wilson, he issued the first of his reports on black rot of grapes and its control. In 1909, he moved his grape field laboratory to Fredonia.

In 1908, E. Wallace the first Industrial Fellow, began his monumental study on apple scab. He first tested lime-sulfur in the Frear Orchard near Ithaca, while spraying apples and grapes. He then published a bulletin (335) on apple scab giving a complete description of the life history of the fungus and the nature of the disease. He substituted lime-sulfur for Bordeaux mixture for control and stressed the importance of the pre-blossom sprays.

In 1910 new bulletins were issued on fire blight of pears, apples, and quinces (272) and on peach leaf curl (276).

As the staff and support expanded, the research became continuing programs of investigations, publications increased, and the staff joined in making available other avenues for publication. Over the next 21 years a large number of contributions were made, among which the following may be mentioned. In 1912, F. M. Blodgett, who had tried dusting for hops in 1910, tested sulfur dust for the control of apple scab. Subsequently, several staff members studied aspects of dusting as a disease control technique. Reddick in his work on grapes demonstrated the importance of the application of spray just before a rain.

C. T. Gregory conducted the first detailed investigation of downy mildew of grape and first observed the germination of the overwintering oospores which produce the primary inoculum for initiation of the disease.

L. R. Hesler studied apple tree canker following winter injury and F. M. Rolfs investigated the bacterial leaf and fruit spot of peaches and plums. R. A. Jehle showed that brown rot canker of peach was caused by a native fungus, *Sclerotinia fructicola*, distinct from the brown rot pathogen of Europe.

A. J. Mix studied drought spot of apples which was later taken up by A. B. Burrell who established the cause as boron deficiency.

The study of fire blight, which had been sporadic in New York since Arthur studied it at Geneva in 1883, was renewed by Whetzel and continued by V. B. Stewart, who stressed fire blight in nursery stock, A. L. Piestorff who demonstrated toxin production by the bacteria, H. E. Thomas and K. G. Parker on orchard eradication, the role of bees in overwintering of the bacteria, and new treatments to destroy the organisms in hold-over cankers; and E. M. Hildebrand on overwintering, canker treatments, and blossom invasion and its prevention by spraying or dusting.

Following a severe fire blight epidphytotic that affected apples (particularly young dwarf plantings) in western NY in 1972, the College research efforts on the nature and control of the disease were increased substantially. A joint project was developed under the direction of S. V. Beer at Ithaca and-H. S. Aldwinckle at Geneva, that covered virtually all aspects of the disease. Studies of the epidemiology, control and physiology of fire blight were carried out under the Ithaca portion of the project, while varietal differences in susceptibility and improved screening techniques for resistance were emphasized at Geneva.

From 1945 to 1970 K. G. Parker and students conducted a series of outstanding studies on the viruses of fruit trees, especially *Prunus* species. These studies included basic work on the virus, virus interaction, effect of viruses on the host plants, spread in the orchard and controls. The greatest benefit, however, was the transfer of information into extension programs, and improvement of production in the State.

Field Crops

W. R. Dudley in a report of investigations in 1889, mentioned work on clover rust and Cladosporium on wheat. These studies by Miss J. K. Howell, a Fellow in Botany, were published under her name in Bulletin 24, 1890. It records connecting the aecial and uredial stages of the causal fungus by inoculations.

Studies by J. G. Horsfall, resulted in his Memoir 130 on Meadow Crop Diseases in New York. Later work in this area was done by L. J. Tyler, D. A. Roberts, and R. L. Millar. Roberts, 1951-1958, conducted surveys on incidence and severity of forage diseases, and with a graduate student published on root rots of red clover, and trefoil, red clover vein mosaic and Fusarium blight of trefoil. Millar, 1959 to present, has investigated alfalfa root rot, but most emphasis was placed on physiology of infection, e.g., 1) pathogen enzymes associated with tissue degradation; 2) phytoalexins in relation to resistance in alfalfa and trefoil; and 3) cyanogenesis in relation to resistance in trefoil and white clover.

The work on cereal crop diseases has been sporadic and seldom has had full-time attention by any staff member. R. J. Haskell developed the so-called "dry formaldehyde" method of treating oats for the control of smuts. It was included in the extension program by Barrus and Chupp and long used throughout the State. Chupp then went on to perfect and bring into general use wholesale elevator disinfestation of cereal seeds. R. S. Kirby undertook the earliest thorough study of take-all disease and the causal fungus. His work was basic to further study and control of the disease in the U. S.

The idea of dusting cereals for control of rusts, mildew and leaf blights was first suggested by Whetzel and tested by C. V. Kightlinger in 1924, and later in tests never published. This work was later continued, broadened, and modernized by K. D. Butler.

L. J. Tyler studied the smuts of small grains, especially dwarf bunt of wheat, and cooperated with N. F. Jensen of Plant Breeding in the development of smut resistant varieties. G. C. Kent studied the rusts, especially on rye in the field, and the relation of mixed infections, and cooperated with N. F. Jensen in developing rust resistant varieties.

Corn diseases were long considered as "normal" in the field and neglected by plant pathologists. More recently C. W. Boothroyd and his students have contributed studies on stalk rot, smut, leaf blights, and a destructive virus disease.

W. F. Rochow has conducted a full-scale basic investigation of barley yellow dwarf virus of cereals, as reported under Virology.

G. C. Bergstrom joined the department in late 1981. He is responsible for extension and research. His initial emphasis concerns integrated pest management of field crops and interactions between insects and pathogens.

Ornamentals

L. M. Massey conducted studies on diseases of gladiolus and rose that received world-wide recognition. His work on black spot of roses and its causal agent, and on rose mildew established a better understanding of these diseases and their control under greenhouse and garden situations. His work established the efficacy of dusting with sulfur and led to the formulation of special rose dusts and sprays and the elimination of spraying in greenhouses to hold down black spot. Other valuable contributions were made by B. H. Davis on leaf spot of roses and by Cynthia Westcott on brand canker.

H. H. Whetzel conducted pioneering studies on the botrytis blight and other diseases of peony, while Hopkins made the first important investigation of botrytis blight of tulips.

C.E.F. Guterman, F. A. Haasis and D. K. O'Leary conducted a series of basic studies of the mosaics and other diseases of lily, narcissus, and other bulbous ornamentals, with results that have greatly increased the successful culture of these ornamentals.

L. M. Massey and C.E.F. Guterman and their students applied the "dry formaldehyde method" to the disinfestation of greenhouse soils to insure good stands of seedlings.

From 1937 till 1972 A. W. Dimock and his students conducted a wide ranging series of studies on diseases of ornamentals and the conditions controlling such problems, including soil moisture and salt relations, control and spread of pathogens by spraying or dusting, the relation of cultural practices to spread of pathogens, and the integration of disease control methods with good greenhouse operations. One of his outstanding contributions was the pathogen-free indexing of vegetatively propagated plants, especially chrysanthemums. He developed a number of control schedules for fungus, bacterial, leaf nematode, and floral blights, and perfected a successful and efficient testing technique using single plants of a number of species in each spray plot. His cooperation with K. F. Baker in California led to a number of new approaches and explanations, such as why chrysanthemum rust was controlled by copper in New York, but by sulfur in California.

In 1971, Dimock and R. K. Horst described a new disease of chrysanthemum which was distinctly different from several previously reported viruses in chrysanthemums. On the basis of work done by Horst and his students, this disease (chrysanthemum chlorotic mottle) is now known to be caused by a viroid—a new class of subviral pathogen. Chrysanthemum stunt is also now known to be caused by a viroid.

Following general studies by M. B. Harrison, R. W. Smiley began to develop a turfgrass disease research and extension program in 1973. Evaluations of new varieties, management programs, and pesticides are conducted in several geographic areas of the State, including the 12-acre turfgrass field research facility established at Ithaca in 1976. Smiley and his students emphasize studies of interactions between soil mircoorganisms and soil-borne pathogens, the influence of fungicides on non-target microorganisms, and the development of new fungicides.

Potatoes

In 1896, E. G. Lodeman published Bulletin 113, "Diseases of the Potato", in which he included a colored plate of late and early blights with a discussion of these diseases, as well as scab and treatment of fungus diseases. There were also sections on insects and spraying of potatoes. In Bulletin 114, "Spray Calendar", E. G. Lodeman included recommendations for control of potato problems.

Beginning about 1915, a massive study of potato problems was developed by Barrus, Blodgett, Chupp, Fernow and Reddick with their graduate students. Artschwager's histological studies on virus diseases, especially leaf roll, were outstanding in themselves, and led to a particularly productive career. Blodgett revived and perfected the "tuber indexing" method of planting as a valuable tool in freeing seed potato stocks of leaf roll, mosaic, etc. Fernow demonstrated the value of, and perfected symtomological identification of, virus-infected plants for use in freeing stocks of infection and in the commercial production of high-grade "seed". These studies were particularly valuable in setting standards for seed potato inspection and certification in the State

Barrus and Chupp identified yellow dwarf of potatoes and its threat to industry. L. M. Black determined its cause to be a virus and the vector role of the clover leafhopper. E. 0. Mader worked out control measures which were either effective or else the disease disappeared.

0. C. Boyd and E. 0. Mader later demonstrated the value of copper lime dust as a substitute for Bordeaux mixture in controlling late blight under normal conditions. E. 0. Mader, and later a series of graduate students under the direction of F. M. Blodgett, studied modern materials and spray schedules for the control of late blight, early blight, and other stem and foliage disease of potatoes on Long Island and upstate. These tests demonstrated the value of copper sprays, the advantage of obtaining leaf coverage early in the season, the accumulation of copper in surface soil, and the economic benefit of potato spraying.

F. M. Blodgett, C. F. Taylor, L. C. Peterson, R. C. Cetas, and others restudied potato scab with special reference to the soil relations involved and various materials and methods for its control. It was disclosed that mercury seed treatments may increase scab in alkaline soils. Blodgett and his students introduced the use of calomel and yellow oxide of mercury as more efficient seed treatment materials.

Blodgett, with his students, conducted spray trails involving various materials, schedules, and machinery, in upstate and Long Island areas, providing guidance for growers, manufacturers, spraying operators, and local distributors. They conducted wide ranging tests on the influence of cultural conditions, and control methods, on several wilt problems, rhizoctonia disease, tuber rots, and field aspects of virus diseases and ring rot.

Donald Reddick and his students studied the biological details of *Phytophthora infestans*, its overwintering, its sporulation, and most important, its “ennobling” attributes on resistant lines. Reddick collected lines of *Solanum* species with resistance and studied the transferral of resistance to commercial potato stocks producing so-called “immune” varieties.

D. Reddick with W. R. Mills, and L. C. Peterson helped lay the groundwork for the designation of pathogenic specialization in *P. infestans*. Later L. C. Peterson and W. R. Mills, who was then in Pennsylvania, contributed information essential to the establishment of a set of international designations for races of the pathogen and resistance factors in the potato.

L. C. Peterson, and later H. D. Thurston, continued these studies in ẹooperation with R. L. Plaisted of Plant Breeding, and incorporating the results of F. M. Blodgett s selection program for scab resistance, produced high yielding varieties containing high resistance to late blight, scab, viruses, and golden nematode.

The resistance to the golden nematode in the New York varieties Hudson and Peconic came from *Solanum andigenum* (andigena), the potato species most commonly grown in the Andes of South America, and the species form which *Solanum tuberosum* (the "Irish potato") of Europe and North America evolved. The potato varieties now grown in Europe and North America are highly selected clones from a narrow genetic base. In 1963 a program was started at Cornell with material from Scotland, plus material collected in Peru, Ecuador, and Colombia to widen the germ-plasm base in the Cornell potato-breeding program. Recurrent selection has improved the yield and appearance of this andigena population. This andigen population has been found to have resistance, not only to the golden nematode, but also general resistance to late blight, scab, VerticiIlium wilt, the root-knot nematode, virus X, and virus Y. Brodie identified the root-knot resistance.

W. F. Mai, with B. F. Lownsbery, b. Lear, M. B. Harrison and others, conducted detailed studies of the golden nematode on Long Island, laid the groundwork for a State and Federal quarantine program, developed a successful control program, and developed the basic information and materials for the inclusion of resistance in potato varieties. The golden nematode program was operated on Long Island under quarantine regulations from 1945 to 1976, when it was moved to Ithaca and supervision passed from M. B. Harrison, who had replaced Mai in 1965, to B. B. Brodie, a USDA employee stationed in the Department.

During the early 40's, W. H. Burkholder, F. M. Blodgett, and J. B. Skaptson conducted laboratory and field tests basic to the control of ring-rot of potatoes. This waș followed by basic studies of the black leg organism by W. L. Smith working under Burkholder s direction.

V. L. Frampton initiated basic studies on the viruses of potatoes, especially the yellow dwarf and X-virus. The studies were greatly expanded by A. F. Ross, who made outstanding contributions to multiplication, movement, cross-protection, and virus action of several potato viruses.

F. M. Blodgett, with his students, conducted a series of investigations on leaf roll of potatoes, while K. H. Fernow studied symptoms and field spread. The basic investigations of the virus in the host plant were continued by A. F. Ross and his students, especially H. C. Kirkpatrick and D. A. Roberts.

R. E. Wilkinson demonstrated the value of *Gomphrena globosa* as a local lesion host of potato virus X.

W. E. Fry has quantitated the "field resistance" of certain potato cultivars to *Phytophthora infestans*, allowing optimization of fungicide efficiency by adjusting fungicide dosage to this "field resistance" when the fungicide is applied according to a forecasting technique.

The Uihlein Farm of Cornell University was established in 1961 as the official foundation seed potato farm in New York State. The initial seed release began in 1964 and by 1977 spring planting over 5000 cwt of elite foundation seed had been released, reaching an annual level of about 6000 cwt. Since the initial release, black leg has been reduced from a major to a minor problem in the susceptible Sebago variety enabling New York seed growers to capture the Florida market. Over the past 3 years techniques have been developed for the production of seedstocks from meristem tissues. Research by E. D. Jones, Professor in charge of the farm, and students demonstrated that tubers free of potato virus X were significantly more susceptible to Fusarium dry rot than tubers infected with a mild strain of virus X and that tubers from plants sprayed with Paraquat when the plants were actively growing will break down under certain environmental conditions. Professor Jones served as the principle author of the first U. S. Standards for Grades of Seed Potatoes.

Trees

One of the very early Industrial Fellowships was established by Davey Tree Expert Co. to study heart rots of forest, shade, and fruit trees.

In the period 1915-25 W. H. Rankin and P. J. Anderson conducted basic work which contributed greatly to understanding the cause, spread, and prospects of control of Chestnut blight.

V. B. Stewart investigated the leaf blight of horse-chestnut and demonstrated the efficacy of sulfur dusting for its control.

D. S. Welch made an intensive study of the Nectria canker of basswood and other forest trees. He also initiated a long-term series of studies on wound-parasites and wound rots in fruit and shade trees.

In 1933, with the appearance of the Dutch elm disease (DED) in New York City, a DED research program was initiated in cooperation with the Boyce Thompson Institute at Yonkers, NY under the direction of D. S. Welch, with L. J. Tyler and K. G. Parker of our staff located at the Institute. That program, conducted with the cooperation of the Entomologists at Cornell and at the Institute, made a number of outstanding contributions to the knowledge of the pathogen, the disease, spread, and survival of the pathogen, and control, especially through clean culture. Students writing Ph.D. dissertations on DED during and after the Cornel1-BTI project were S. Pope, F. W. Holmes, and G. B. Ouellette. A collection of potentially resistant American elms was made in 1935-37, moved to Ithaca when the program at Yonkers was phased out in 1943-45, and ultimately produced several resistant individuals which were all subsequently found susceptible to elm phloem necrosis. Studies on the resistant trees and other aspects of DED, conducted after 1962 by W. A. Sinclair and students, were supported in part by the Elm Research Institute and the Allegheny Foundation.

Research other than on DED by students under D. S. Welch during the several years before his retirement in 1962 included C. R. Hibben's study of maple decline in New York woodlands, J. M. Staley's examination of the interactions of insects, drought, and root fungi on oak mortality, and Sinclair's work on epidemiology and control of Annosus root rot of conifers in New York.

Research by Sinclair and students other than on DED in recent years included studies on oxidant injury to eastern white pine and the attack of injured foliage by fungi interactions of host nutrition and lesion nematodes on Verticillium wilt of maple and elm water relations of peach stems affected by Valsa canker several aspects of elm phleom necrosis ectomycorrhizae of Douglas-fir seedlings, Fusarium root rot of coniferous seedlings, root protection by ectomycorrhizal fungi before or in absence of mycorrhizal formation, and assorted disease control trials.

In late 1976 Dr. Hudler, Extension Associate with responsibility for extension work and applied research on tree diseases, joined the Department and took up work on etiology and control of juniper blight and cankers of honeylocust.

Vegetables

Bulletin 206, Some Diseases of Beans, is a compilation on anthracnose, blight and rust.

M. F. Barrus began his work on bean this one, diseases in 1906. In 1908 he established the second field laboratory, for bean investigations, at the Burt Olney Canning Co. in Oneida. In this work he demonstrated the existence of strains of the organisms causing bean anthracnose (*Colletotrichum lindemuthianum*), the first evidence of physiological specialization in the Fungi Imperfecti. In 1909 Barrus initiated a program to control bean diseases by the distribution of clean (pathogen-free) seed.

Following Barrus' work, D. Reddick and W. H. Burkholder, cooperating with R. A. Emerson in Plant Breeding, developed bean varieties resistant to the strains of bean anthracnose organism and other bean pathogens. Burkholder and his associates made many important contributions to knowledge of bean diseases and at the same time developed much basic information about bacterial pathogens of plants.

C. Chupp conducted basic studies on club root of cabbage that stimulated investigations on the disease and its control by others in the U.S.

Onion mildew, first noted by Dudley and studied by Duggar and Whetzel, was investigated by H. C. Cook, who proposed the organism was seed transmitted. Newhall continued these studies and turned to analysis of spread of the pathogen and its relation to epiphytotics. The pathogen overwintered in perennial top set onions grown in backyard gardens. Spores were subsequently dispersed to commercial fields in the spring. Eradication of diseased top set plantings near commercial onion fields was a cheap and effective control.

In 1917, H. W. Dye initiated research on bottom rot of lettuce. The disease is especially destructive on muck soils of the State. The studies of the agent and conditions essential for disease establishment and control were continued by G. R. Townsend. These studies demonstrated an effective, profitable control which consisted of dusting the soil underneath the plants with one of the organic mercury compounds to control the causal fungus, *Rhizoctonia solani.*

Lorbeer and his students have sorted out the *Botrytis* spp. responsible for onion leaf blight (*B. squamosus*), neckrot (*B. allii*) and brown stain (*B. cinerea*) and have continued to develop appropriate fungicidal schedules to control them.

The seed transmission of pathogens of vegetable diseases was first demonstrated by Barrus for bean anthracnose. Reddick and Stewart proved seed transmission of the virus causing bean mosaic and Newhall found seed transmission of lettuce mosaic. Rogueing out infected plants by California seed producers eliminated the problem quickly.

I. C. Jagger, followed by H. W. Dye and others, investigated Whetzel's early trials of formalin sterilization of soil. Jagger, Dye, and Newhall demonstrated the value of formalin for the control of onion smut, while Whetzel, Chupp, and C. E. F. Guterman perfected methods for its use in greenhouse soils.

P. P. Pirone demonstrated the value of copper-lime dust for the control of the destructive Altemaria blight of carrots.

A. G. Newhall expanded muckland vegetable disease studies to carrots, spinach, lettuce, celery, onion, etc., operating all over the State on a wide range of problems. He made contributions on celery blights by spraying of seedlings, and on onion smut, onion bulb nematode, onion blast, lettuce yellows, in cooperation with M. B. Linn, and soil sterilization and fumigation techniques.

The leadership of the muckland vegetable disease research program was assumed by J. W. Lorbeer in 1960. He and his graduate students conducted extensive basic and applied studies at Ithaca and throughout the State on the biology and control of several species of *Botrytis* attacking onion, as well as in depth investigations on a number of onion diseases, including Fusarium basal rot, bacterial blights and decays, yellow dwarf, and smut. The construction of the Orange County Vegetable Research Center in 1964 by the Orange County Vegetable Improvement Association and the Association's continued support of a research assistantship in the department allowed for expanded field studies in Orange County on diseases of onions, lettuce, and celery by Lorbeer and his graduate students. Because of continuing and serious disease problems on lettuce in Oswego County during the 1970s, research was expanded or initiated in 1977 on bottom rot, drop, downy mildew, and root rot by Lorbeer and his group.

Several cooperative programs were carried out with the plant breeders to produce varieties of celery resistant to yellows leaf blights, pea-beans to mosaic, cucumbers and melons to mosaic and wilt, tomatoes to viruses, beans to blight and anthracnose, lima beans to mildew by various staff members.

Following early assistance by Wilkinson and Sherf to a cooperative program in Vegetable Crops and Agricultural Engineering, 0. C. Yoder in 1971 set up a study of postharvest diseases of vegetables focusing on manipulation of the storage environment to reduce decay and breeding and selection for storability.

A. F. Sherf has reexamined and modified seed treatments for cabbage, tomato, celery, and beets using either hot water or warm thiram soaks. He has also developed soil fumigation techniques using clear plastic strips on muskmelons, peppers, and eggplant. A. A. MacNab, with Sherf showed that sudden decline of muskmelons may be caused by "shock" invasion by the cucumber mosaic virus.

R. E. Wilkinson has continued studies on vegetables on mineral soils demonstrating the value of local lesion host plants for lettuce mosaic virus and cucumber mosaic virus; the presence, of tobacco ringspot virus, tomato ringspot virus, and cucumber mosaic virus in several woody plants; that infection of winter squash by *Mycosphaerella* to produce black rot in storage originates primarily in the field; that a canker of parsnip roots caused by *Itersonilia* also results from inoculum from leafspot and, with A. G. Newhall, that liquid nabam can control the onion smut organism in soil.

Wilkinson replaced Burkholder on the bean program, concentrating on root rot, developing techniques for standardizing resistance ratings, for identifying resistant plants and saving them for seed production; demonstrated that resistance of bean to *Fusarium* and *Thielaviopsis* is associated with rapid production of phytoalexin after penetration of the pathogen; that resistance to *Fusarium* and *Thielaviopsis* are not linked and each is multigenie; that resistance to root rot is linked to small seed size, although resistance has been located in some large seeded material. In cooperation with Plant Breeding and Vegetable Crops, RedKote, a light red kidney bean resistant to halo blight and mosaic, was released in 1964, Red Kloud, an early halo blight tolerant and mosaic resistant red kidney, was released in 1974, and Aurora, an early halo blight and mosaic resistant small white bean, was released in 1973.

R. Loria joined the department in 1980 to assume responsibilities for vegetable research and extension at the Long Island Horticultural Research Laboratory. She has emphasized biological and cultural controls in research, and has highlighted integrated pest management in extension.

Control of Various Diseases

Much of this traces back to at least 1891 when in Bulletin 27, L. H. Bailey reported the use of sulphide of potassium on greenhouse pipes to control Verbena mildew. In Bulletin 32 the same year, E. G. Lodeman discussed the requirements of a good spray material as: effective, not phytotoxic, and readily applicable.

The first Industrial Fellowship was initiated by Niagara Sprayer Co. of Middleport, NY. Soon thereafter the Union Sulfur Co. of New York City set up the two Herman Frasch Fellowships which supported studies on the use of sulfur and its compounds as fungicides, for control of apple scab and other diseases.

In the continuous study of disease control the staff members have contributed to the substitution of lime-sulfur for Bordeaux mixture, the substitution of mild sulfur formulations, or organic fungicides for lime sulfur and the rapid replacement of the broad spectrum materials, which had yield depressing effects on many plants, with milder, narrow spectrum organic materials, as sprays and for seed treatments.

F. M. Blodgett saved the hops industry by his study of powdery mildew of hops and its control. In this work from 1910-1916 he developed the first accepted programs for dusting as a substitute for spraying.

The basic work in the U. S. on laboratory testing of fungicides was devised by D. Reddick and E. Wallace, and improved and perfected by S. E. A. McCallan in connection with the latter's classical work on the nature of the fungicidal action of Bordeaux mixture.

Newhall and his students (Stark and Lear) conducted a series of investigations as to materials methods and equipment for the fumigation of soil both under greenhouse and field conditions. The studies of B. Lear in this area were transferred by Lear to early advancement of soil treatments for golden nematode control '46-'49.

Following W. D. Mills; tests of fermate for the control of apple rusts in the Hudson Valley in '37-'38 several members of the staff initiated investigations evaluating various organic fungicides, schedules, and methods of application on the fruit, vegetables, potato, ornamental or other crops for which they held responsibilities. Outstanding were the studies of Dimock on ornamentals, including his efficient screening methods, Newhall on vegetables, Cetas on potatoes, and Burrell and Parker on fruit.

L. M. Massey, K. G. Parker, and A. B. Burrell conducted a series of studies on spray machinery development looking to improvements thereby in application, schedules, timing, efficiency in material usage and coverage, lasting from 1945 to the late '50s. Burrell particularly emphasized spraying with concentrated materials.

Recently, W. E. Fry has incorporated epidemiological studies into control strategies to improve the efficiency of the use of fungicides in potato disease control.

Mycology

Mycology was the discipline of A. W. Prentiss, W. R. Dudley, G. F. Atkinson, E. J. Durand and essentially that of B. M. Duggar. The early bulletins and reports of the Botany Department on strawberry leaf spots, clover rust, apple scab, celery blights, etc. were mycological studies. Atkinson not only conducted many investigations of the life histories of pathogenic fungi, but is generally acknowledged as having been one of the most outstanding American students of the mushrooms. His publications on mushrooms began in 1897 (#138), and continued through over a hundred bulletins and journal articles for over 20 years. Duggar s early studies on the production of spawn from the spores (Miss Ferguson under his direction first germinated the mushroom spores in 1901) and tissue plantings of cultivated mushrooms laid the foundation for the modern production of pure culture spawn which has provided the greatest improvement in mushroom production since the beginning of that industry.

H. M. Fitzpatrick joined the department in 1911 and developed the research and instruction in Mycology. His contributions are many, but his book on the Phycomycetes and his excellent mimeographed "outlines" of the fungi used in his courses have been the greatest contribution to his colleagues and students. He also gave the first course on phytobacteriology in the department.

Fitzpatrick's papers on the life history and cytology of *Eocronartium* and *Rhizina*, and his monographic studies of the *Coryneliceae* are models of accurate, painstaking and polished research.

P. J. Anderson and W. H. Rankin determined the life history of the chestnut blight pathogen. L. R. Hesler made an extensive study of the Sphaeropsis causing New York apple tree canker and discovered its perfect stage. Rosenbaum did pioneer work on the taxonomy of the genus *Phytophthora* and Sherbakoff produced the outstanding treatise on the *Fusarium* species on potatoes.

C. N. Jensen in 1912 published the first extensive study of the soil fungi. W. H. Burkholder found the perfect stage of the raspberry anthracnose pathogen and C. D. Chupp began his 40 year study of species of *Cercospora* during his graduate work and continued it, mostly at nights and weekends, during his entire extension career. After retirement he devoted full time to this project until 1954 when he privately published "A Monograph of the fungus genus *Cercospora*".

H. H. Whetzel and E. E. Honey and other students conducted outstanding studies of the Ciborioideae of the Discomycetes, many of which are destructive pathogens of fruit and forest trees, vegetables and ornamentals.

Drayton discovered the apothecial stage of the gladiolus dry rot fungus, *Sclerotinia gladioli*, and first demonstrated the sexual role of the microconidia.

V. J. Tapke, Gage and more recently L. J. Tyler made important additions to our knowledge of the smut fungi. D. S. Welch in addition to his studies on wound-associated rots of forest trees monographed the genus *Cucurbitaria* for North America. J. H. Miller contributed outstanding additions to our knowledge of the genera *HypoxyIon* and *Xylaria* of the Pyrenomycetes.

On the death of Professor Fitzpatrick the decision was made to maintain the emphasis in the mycological program on comparative and systematic mycology and to continue the herbarium as an extremely valuable facility for the plant pathological program. Dr. R. P. Korf, one of Fitzpatrick s students, has continued the program at a high level. He has, in addition to a full teaching program, developed a most productive research program encompassed within the broad title of morphology, taxonomy, life histories, nomenclature, and terminology of fungi. His researches and those of his students have been broad, in depth, and critical of species, genera and families, centering on monographic studies of the Discomycetes. Starting with floristic studies of the genera and species in New York, and projecting to coverage of the U. S., it soon became clear that speciation required world-wide attention. Korf's major projects have been involved in floristic studies of the Discomycetes of Japan, of Southeast Asis, of the Neotropics, and of Macronesia, and world monographs of Chlorencoelia, Chlorociboria, Chlorospenium, Dipodascus, Geopora, Hemiphacidiaceae, Hypoderma, Jafnea, Lambertella, Ostropales, Psilopezia, Pyronema, Scutellinia, Theleboleae, Vibrissea, and Volvariella. Developmental studies of Anthracobia, Cochliobolus, Gelatinodiscus, Pyronema, and of sparassoid discomycetes and the development of gel tissues have also been significant contributions. He has extensive cooperative work with scientists in India and throughout Europe after spending sabbatics in Asis and in Belgium especially. Korf is perhaps best known for his work in botanical nomenclature, and for the preparation of the keys to the genera of Discomycetes and Tuberales in the major, multi-volume text, "The Fungi: An Advanced Treatise."

Nematology

The first recognition of nematodes as plant pathogens appears to have been W. R. Dudley's observation on the "destructive 'Clematis disease' which he reported in 1890. In 1891 L. H. Bailey reported the nematode galls on tomatoes in greenhouses and a method of control.

Little further was done with nematodes until Newhall's work on onion bloat and root knot and their control by soil treatment.

The golden nematode of potatoes was discovered on Long Island in 1942 and W. F. Mai initiated the research program on it in 1946. With B. Lear, B. F. Lownsbery, M. B. Harrison and graduate students and cooperation with USDA nematologists, Mai developed the knowledge of the organism and its action on the potato in North America.

The golden nematode research program obtained basic information for survey and fumigation of soil and equipment. It helped produce nematode resistant potato cultivars and identified various cultural and chemical control methods. A significant portion of the research was directed at obtaining basic information on biology and epidemiology of the nematode and the disease.

Following several separate cooperative programs with the USDA, the golden nematode program has recently been concentrated in Ithaca and a Steuben county farm under B. B. Brodie of the USDA, and a professor in the department.

Mai expanded the golden nematode program into one of general nematology programs on fruit, vegetables, ornamentals, forage, etc., and instituted a teaching program in this area. Collaborating with H. H. Lyon, Visual Aids Specialist, he produced the very useful book, "Genera of Plant Parasitic Nematodes" in 1960, now in its 4th edition. He initiated a particularly productive program on nematode problems of orchards, some in cooperation with the pomologists as well as county agents.

Controls were developed for the replant problem on tree fruits caused by lesion nematodes, and other factors. Other nematodes investigated include sugar beet cyst nematode, and northern root knot nematode.

General nematological studies have involved interactions of nematodes in complex diseases of several plants, identification of nematodes, variation within species; the role of pectolytic enzymes, and transmission of virus.

Virology

The first effort in virus diseases of plants in the department is not clear. It likely was the work of Donald Reddick on bean mosaic and the seed transmission of the virus.

C. E. F. Guterman, L. M. Massey, and D. K. O'Leary conducted a series of studies on viruses and virus diseases of lily, narcissus, and other bulbs.

F.. M. Blodgett and his students, studied the virus diseases of potatoes and the viruses that caused them. L. M. Black's studies on yellow dwarf and its vector was a particular example.

V. L. Frampton joined the staff to initiate a program specifically on the study of viruses and contributed in the area of the determination of various physical constants of the tobacco mosaic virus protein and the use of electrophoresis in the study of plant pathogens.

A. F. Ross began in 1946 his studies on potato viruses, double infections, and various local immunity-type reactions in the host plants. Following studies of ethylene production at local lesions he went on to studies on the nature of local lesions, immune reactions around local lesions, and the transfer of such reactions through certain plants following various conditions and mixed infections, as explanation of acquired resistance. He began a very productive instructional program about 1950.

M. Zaitlin was appointed in 1973 to the position vacated upon the retirement of Dr. Ross. His program, which relates to the replication of plant viruses, is supported by the National Science Foundation. He studies the nature of the nucleic acids and proteins involved in virus replication and their relevance to the disease syndrome. He has recently collaborated with several others in the department to investigate the nature of viroids and diseases they cause.

W. F. Rochow, ARS, USDA, chose to locate in the Department in 1955 to initiate research on barley yellow dwarf. He has developed a broad program on the mechanism and role of specificity between plant viruses and aphid vectors. Support for his program has been provided for many years by NIH, NSF, and private foundations. The research has made barley yellow dwarf virus the most useful representative for basic studies of luteovirus-aphid relationships. In 1975 the International Committee on Taxonomy of Viruses created a new virus group, luteoviruses, with barley yellow dwarf virus as the "type". Recently, similarities between barley yellow dwarf virus and beet western yellows virus confirm the close relations among luteoviruses.

The importance of vector specificity as a kind of variation among isolates of barley yellow dwarf virus in nature was demonstrated. Other research showed the relative nature of the vector specificity; the stability of the phenomenon; and the importance of understanding factors that affect the specificity, as temperature, age and clone of aphid, and age of tissue from which aphids acquire virus. Results of these studies led to the development of the current working hypothesis based on interaction of virus capsid proteins and aphid salivary glands.

Phytopathogenic Bacteria

The relation of bacteria to plant diseases was first reported in the work by J. C. Arthur for his D.Sc. in 1886. W. R. Dudley attempted to relate bacteria to winter blight of tomatoes in 1892, and in 1898 B. M. Duggar raised the question of the relation of bacteria to damping-off.

Soon after the Department of Plant Pathology was formed, M. F. Barrus and later W. H. Burkholder, studied the bean blight organism, and H. H. Whetzel, V. B. Stewart, A. L. Pierstorff, H. E. Thomas, K. G. Parker and E. M. Hildebrand contributed a long series of studies on the fire blight pathogen.

W. H. Burkholder became increasingly concerned with the bacterial pathogens and because of his contributions to this area was long the author of the section of Bergy's Manual of Determinative Bacteriology dealing with the plant pathogens. Under his direction the work of F. M. Clara on the green fluorescent bacterial plant pathogens (Cornell Memoir 159, 1934) and C. F. Taylor on the genus *Actinomyces* are especially outstanding. Burkholder himself made many contributions to methods of study, relationships, and nature of action of plant pathogenic bacteria. He was extremely cooperative and assisted many co-workers at Cornell and elsewhere in identifying and naming plant pathogenic bacteria.

R. S. Dickey took over the responsibilities for this area when Burkholder retired and has made many contributions to an understanding of the soil activities, histological relations, mode of action, and accurate description of the pathogens.

Disease Physiology

W. R. Dudley in 1890 mentioned the need for study of "physiological derangements", and forecast that vegetable physiologists would enter the field. B. M. Duggar felt the need for training to study the physiological interactions in diseases and after further training and experience returned to Cornell as professor of plant physiology.

Over the years a number of studies were conducted under the heading of parasitism or physiology. Most of these were studies of the growth of pathogens under artificial laboratory conditions. A few early studies were conducted as that of D. K. O'Leary on enzymatic degradation of cutin during penetration of host plants.

In 1960, D. F. Bateman joined the staff to initiate a program in disease physiology. The basic objective was to prove or improve the statement or definition of disease developed by H. H. Whetzel and used in the department. The research effort focused on the molecular mechanisms of plant tissue disruption by fungal and bacterial pathogens, with emphasis on cell wall degrading enzymes. These studies included demonstration that purified pectic enzymes are responsible for plant tissue maceration; for plant cell death; demonstration of the synergistic actions of oxylate and pectic enzymes in plant tissue breakdown during pathogenesis; the pathway of oxalate biosynthesis in *Sclerotium rolfsii*; production of phosphatide

degrading enzymes by pathogens; development of procedures for purifying cell wall degrading enzymes

Currently the disease physiology program includes H. D. VanEtten, concentrating on phytoalexin research, O. C. Yoder working on host specific toxins, R. L. Millar on phytoalexins and cyanogenic glucosides.

In recent years O. C. Yoder has turned attention to combining genetical and biochemical studies in an attempt to understand the molecular control of specificity in plant disease and of disease development in general.

Disease and Pathogen Cytology

Dudley's program of histological relations of parasitic cryptogamic organisms and their host plants was short-lived due to his departure for Stanford University. Several studies on histological or cytological relations of pathogen and suspect were conducted over the years; that by F. M. Blodgett on "Perithecial development of *Sphaerotheca humuli*" is said to be the shortest Ph.D. thesis ever submitted.

The more lasting program in the area of disease and pathogen cytology was initiated with the appointment of H. W. Israel and J. R. Aist. Dr. Israel began cooperating in the electron microscopy aspects of virus activity in local lesions (with A. F. Ross) while he was in the Laboratory for Cell Physiology, and later transferred to Plant Pathology, where he continued his studies and cooperates with M. Zaitlin, J. R. Aist, etc.

Professor Aist joined the staff in 1973, setting up a new laboratory for cytological studies of plant disease. With students he has described the fine structure of the conidium-conidiophore attachment of *Helminthosporium maydis* race T, the relation of preinoculation heat shock to host cell papilla formation and the relation of penetration failures of papillae to failure of penetration attempts on compatible hosts, and the relative ability of 2 fungi to penetrate preformed papillae versus papillae-free wall regions, indicating that papillae can prevent fungal ingress.

International Agriculture

International Agriculture was established as a major component of the N.Y.S. College of Agriculture in 1962. H. D. Thurston was appointed in 1964 to develop the international program in Plant Pathology as a part of his responsibilities. He later assumed leadership in the department's part of the interdepartmental program of breeding potatoes for resistance to disease under conditions in New York and many foreign countries.

Arrangements are made for both foreign and U.S. students to conduct thesis research in a tropical overseas environment. Thurston also aids in the initial orientation of foreign students from tropical countries. Approximately one-third of his time is spent overseas in the tropics in research, working with students, teaching, and other duties connected with the I.A.D. program. He teaches a current topics course concerning tropical plant diseases (Plant Pathology 655 - Plant diseases in tropical agricultural development), and also collaborates with other professors in teaching I. A. (International Agriculture) 602 - Special studies of problems of agriculture in the tropics, which includes a 14 day field trip to Mexico.

Miscellaneous

The photographic laboratory had made outstanding contributions to the instructional, extension, and research programs of the department. In addition to black and white and colored illustrations and slides, there have been marked improvements in slides for talks and reports, microfilms, movies, illustrations for texts on nematodes and ornamental pests especially, and a complete file of pictures and slides made in the department. The movie films include tomato seedling production, golden nematode control techniques, *Prunus* viruses, apple mildew, and *Phytophthora infestans* invasion.

The book by Johnson and Lyon "Insects That Feed on Trees and Shrubs", all in color, has come through three reprintings since 1976, and has been a moneymaker for Cornell Press. The "Pictorial Key to Genera of Parasitic Nematodes", by Mai and Lyon has been distributed over the world.

Felix discovered the value of copper sulfate in the rehabilitation of unproductive muck soils in the State and the use of minor elements in the control of nutrient problems of plants in New York.

One of the earliest Industrial Fellowships was on the effect of cement dust on fruit, and foliage. P. J. Anderson and L. M. Massey developed much of the basic knowledge of this area of plant pathology.

One of the outstanding contributions was A. W. Dimock's application of his experience in greenhouses to the development of basic criteria for the design and manufacture of chambers for the control of light, temperature, moisture, and gaseous composition of the air in the study of plant disease; about three-quarters of a century after Atkinson reported the serious need of such facilities.

The Plant Pathology Herbarium is one of the best in the country. It began with Whetzel's private collection, and is particularly rich in tropical items.

TALES SELDOM TOLD

Whetzel

Prof once told his colleagues that his first initials stood for "hurry-hurry".

He believed deeply in the worth of students. They were important for the world and to him. He once wrote an article for the College paper entitled, "Shall I go to college?" In it he placed a number of questions for a prospective student. If someone could answer them honestly, affirmatively, he should not worry, but "pack his bag and come on to the school of his choice". Money was helpful, but not essential if one was willing to work hard. He had worked his way through Wabash, and came to Cornell with only $35 in his pocket. This story came back to him one day in the early 1940s when a boy came up to him and said "I read your article, and here I am. I have only $35, but I can sure work." After a long talk, Prof realized the boy was his kind and was calling his bluff. He gave the lad a room and paid him to work in his garden as he had done previously for others. He also helped the boy get a scholarship in the hotel school from which he graduated in 1947. Prof's judgment was excellent, because the student whom he had influenced started a restaurant which blossomed into a million dollar chain. As a Cornell alum, this person served on the Cornell Board of Trustees.

No one knows how many other students Whetzel has helped. They are scattered all over the world.

Blodgett

Blodgett was a character right out of Dickens. Perhaps as a reflection of his American Indian heritage, he liked to fish, hunt, and ski. He transported a folding boat with motor in his 12 cylinder car. His hunting and fishing luck with Newhall wasn't very good. Although they spent considerable time trolling in Seneca and Cayuga Lake, they caught few fish. While rabbit hunting, Newhall mistook Blodgett s pointer in the tall grass for a rabbit and shot him.

Blodgett was ahead of his time with respect to experimental design and statistical analysis. He assisted many faculty and students with analysis of their results. Blodgett was an unpretentious dresser and a chain smoker. His clothes often had holes burnt in them. Glowing embers from his cigarettes started many fires in his wastebasket. These fires became so numerous that some students were accused of setting them. A new student once told the Department Chairman that the janitor was stealing equipment from the stockroom after the new student had observed Blodgett walking away with the equipment.

Blodgett was particularly proud of his ability to keep his ancient cars running. One had a screen door spring between the gear shift lever and a wooden platform behind the rear seat. The spring prevented the lever from slipping out of gear.

Fitzpatrick

Fitzpatrick was a good tennis player and enjoyed playing with students. However, it was commonly known among students that they should never beat Fitz the day before an exam. Fitz hated cigar smoke and Whetzel smoked much of the time. He particularly liked to stand in Fitzpatrick's doorway and TALK AND PUFF and watch Fitz squirm. Fitz would later slam open the door and window and then go for a walk.

Barrus

Barrus was the first extension man in the department, and he traveled over the State so much that one morning he called from the train station to learn where it was he was to go that day.