A HISTORY of the DEPARTMENT of ENTOMOLOGY

Kansas State University 1879–1990

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Herbert Knutson[2]

FOREWORD

I have attempted to bring together some widely scattered information on the Department of Entomology's activities during the 12 decades of its existence.

Dr. Roger C. Smith left a few records. The notes of Charles M. Correll, University Historian, were helpful in summarizing minutes of the Board of Regents during the late 1800s.

Mrs. Helyn Marshall typed and retyped the rough drafts of my sometimes poor handwriting and provided helpful suggestions. The final manuscript was typed by Margaret E. Wecker.

The amount of space allotted to an individual or activity may not indicate the relative importance or magnitude. Furthermore, some individuals supplied more information than others, and length of time in the Department differed widely among individuals. I hope I have not omitted any individual.

This booklet was written almost entirely after my retirement in June, 1983.

Herbert Knutson
Emeritus Professor of Entomology

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[1] Contribution number 89-236-D from the Kansas Agricultural Experiment Station.

[2] After Dr. Knutson's death, the manuscript was edited and brought up to date through 1990 by Eileen K. Schofield, Associate Editor, KAES, and T. L. Hopkins, Department of Entomology.

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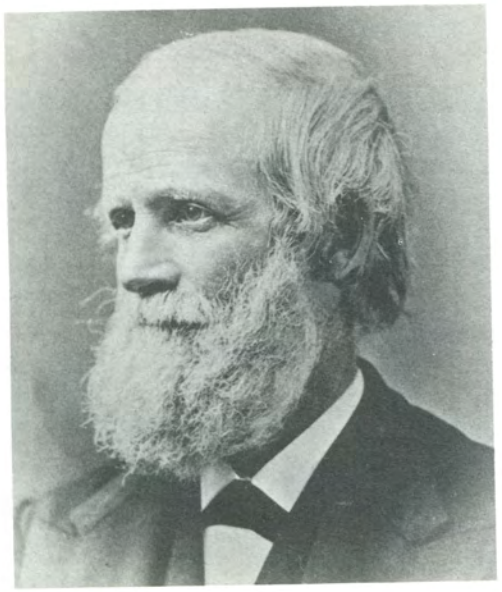
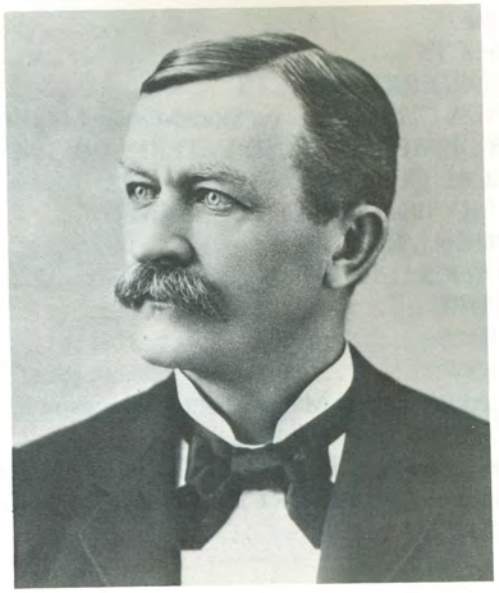
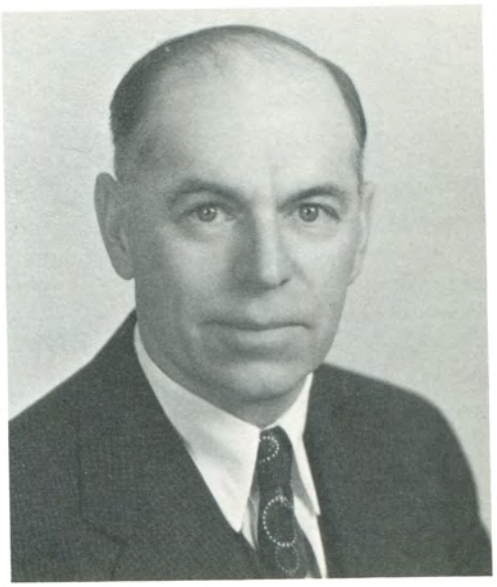


Benjamin F. Mudge



Edwin A. Popenoe

George A. Dean



Roger C. Smith

KANSAS STATE UNIVERSITY

The founders of Manhattan (1855) were well educated Easterners, most of whom preferred that their children receive an education locally rather than sending them back East. Hence, Bluemont Central College, originally sponsored by Methodists, was started in 1860. Fifty-three students attended the first session. A stone marker, located at the corner of Claflin Road and College Avenue, commemorates Bluemont Central College.

After the Morrill Land Grant Act was signed on July 2, 1862, the Bluemont Central College's building, 120 acres of land, equipment, and library (then valued at $20,000) were deeded to the State of Kansas. The Kansas Legislature established its Land Grant College in Manhattan on February 16, 1863, making it the first officially established and funded Land Grant institution in the United States.

Classes were started in 1863-1864 in the Bluemont Central College building, with 108 students. The departments were: Science and Literature, Mechanic Arts, Agriculture, and Military Science and Tactics. The A.B. degree was offered. In 1880, classes were moved to more adequate buildings on the present campus location.

The name Kansas State Agricultural College (KSAC) was changed on March 9, 1931, to Kansas State College of Agriculture and Applied Science. On March 20, 1959, it was changed to Kansas State University of Agriculture and Applied Science, and later, to Kansas State University (KSU).

Critics of the mission of the College as a land grant institution began to gain full momentum about 1872, with the main objection that there was not enough emphasis on agriculture.

Carey (1977) wrote:

> "In 1873 the state legislature reorganized the boards of regents of all state educational institutions; on June 27 of that year, the new Kansas State Board resolved 'that we request the faculty and other employees of the Board, without expressing dissatisfaction with any one, to furnish us with their resignations at our next meeting, July 16th.' Except for President Denison, all of the faculty were rehired for the fall term; nevertheless, a strong protest was lodged. The faculty asked Professors Mudge, Gale (both dealt to some extent in entomology), and Denison to act as a committee to express their discontent with the 'summary action' which had inflicted 'personal injury to their reputations.' This committee presented the regents with a communication to record the faculty's 'sense of injustice' for being asked to resign when the Board has acknowledged it had found no fault 'with our services hitherto'."
>
> "Reverend Denison was thanked for his services to the State and Reverend Anderson was elected to take over the presidency on September 1, 1873. The new president soon made it clear that during his term, the 'objective of this institution was to give prominence . . . to the school branches of learning which relate to Agriculture and the Mechanic Arts according to the directness and value of their relation'."

The following account of the influence of the Populist Party is taken largely from Correll (1969). "The greatest turmoil at KSAC was produced by the Populist Party. This party consisted of social, economic, and political atmospheres which had accompanied a period of great unrest and swelling of tides of reform, an 'agrarian revolt'. Farmers and laborers were in financial trouble and this affected other parts of the economy . . . debtor classes of society believed they were victims of unfair, unjust, and selfish manipulation of the agencies for distribution and exchange of wealth, including public finance, great corporations, and trusts which, apparently, even dominated state and national governments."

The depressed group believed that the way to gain relief was regulation and social control of big businesses by restoring the government to the people. This party and its activities were particularly identified with Kansas, although this conservative philosophy occurred, less dramatically, in several adjacent states.

As a result, a major impact was felt at KSAC during the later 1880s, probably because it was an agricultural college and the Populists were mostly farmers. "A revolution swept away a long-established regime in favor of a new college administration which was, in turn, overwhelmed by a counterrevolution which installed a third group of leaders."

The so-called conservatives told the world that 'the great agricultural college' was being replaced by an academy of socialists. A separate agricultural curriculum was set up, agricultural buildings were constructed, additional agricultural courses were taught, and the Agricultural Experiment Station was revitalized. "The vitality of the college was such that it continued to grow, not because of the political disturbance, perhaps, but in spite of it."

During the 1892 election, the Populists elected the Governor and a majority in the Senate, but did not control the House, so the Populists were unable to enact their reform bills. But the Governor and Senate could make appointments. A Populist-controlled Board of Regents resulted. The majority of the Board considered there to be "marked inefficiency and unproductiveness by some professors and experiment station personnel." Of greatest significance were courses in economic science and the history of industry and science, which were believed not to include emphasis on current problems of monopolies, exchanges, and public finance. As a result, Thomas E. Will was brought in to teach these subjects, plus some additional courses concerning socialism, social reforms, taxation, and tariffs.

In 1894, the Republicans regained control of the State government, and the makeup of the Board of Regents became, according to the Republicans, "safe and sane." Will's public lectures were discontinued, and his respon-

sibilities were reduced to more routine duties.

In 1897, the Populist-dominated Board of Regents passed a resolution including the statement that . . . "the term of employment of all the present employees shall expire June 30, 1897." These employees could apply individually for reemployment. President Fairchild apparently resigned rather than wait and be dismissed. The Board promptly appointed Professor Thomas E. Will as President (1897-1899). There were violent protests to the Populist movement not only in Kansas, but in many other states, because of political interference in academic life. The majority of the faculty was reemployed, a few decided not to reapply, and the remaining few were not reappointed.

Hence, students who entered in the fall of 1896 received their assignment from President George T. Fairchild (who resigned in 1897); they progressed through their second and third years under President Thomas E. Will, and were handed their diplomas by President Ernst R. Nichols.

The Populists were defeated in their last important bid in 1898.

The boxelder bug, *Leptocoris trivittatus,* is still called by some the "Populist Bug" or the "Democrat Bug" (the Populists and the Democrats joined forces in 1892). Some tell me that this lowly bug was also called the "Republican Bug."

ENTOMOLOGY LIBRARY

The early departmental library consisted largely of personally owned volumes and some acquired from other entomologists or their descendants.

Later, until 1977, a separate room was maintained in the Department for duplicates of journals in Farrell Library and certain other literature. Personal volumes of technical journals and some other items owned by me were transferred to the Hays and Garden City Branch Stations and to Farrell Library for exchange purposes.

In general, the entomological literature in Farrell Library includes a good representation of the U.S. and perhaps fair for Germany, United Kingdom, France, and some nations in Central and South America. A wave of fund cuts during the 1970s and early 1980s made it necessary to cancel some periodicals.

The library courier service makes other literature available within a short time. This service makes daily contact with the Linda Hall Library in Kansas City, the Kansas State Library in Topeka, and the libraries at Emporia State University, Wichita State University, the University of Kansas, and other institutions.

KANSAS ENTOMOLOGICAL COMMISSION AND SUCCESSORS

The Commission was established in 1907, in response to an outbreak of San Jose Scale, to suppress or eradicate certain noxious insects and plant diseases.

It was comprised of the heads of the Entomology Departments at Kansas State University and the University of Kansas, the Secretary of the State Horticultural Society, a commercial nurseryman, and the Secretary of the Kansas State Board of Agriculture. The two Department heads were designated State Entomologists.

The nursery inspection was divided into the northern (Kansas State University) and the southern (University of Kansas) halves (Divisions) of the State. During the early days, the respective Department Heads received a stipend and were assisted by paid, temporary, student assistants. These jobs helped students financially and provided experience. Later, nursery inspection as well as other duties were done by full-time assistants. Subsequently, the Heads were not compensated, and permanent personnel were headquartered in the State Board of Agriculture in Topeka.

State Entomologists in the Northern Division were: E. A. Popenoe, July 5, 1907-September 1, 1907; T. J. Headlee, 1907-1912; George A. Dean, 1912-1944; R. C. Smith, 1944-1953; and Herbert Knutson, 1953-1963, when the Commission was abolished.

Responsibilities of the Commission included enforcement of quarantines, such as that to prevent the European corn borer from spreading west; certifying that all shelled corn had been passed through a screen to filter out cobs and other debris that might harbor borers; certifying that other plant shipments were free of dangerous insects and diseases; and checking qualifications of plant nurseries for phyto-sanitary certification.

Legal challenges on the constitutionality of certain powers of the Commission were upheld in 1911. The question had arisen if plants with San Jose Scale could be eradicated by the Commission, with the owner being charged for the cost.

Later, the question arose whether funds could be used for control of chinch bugs, grasshoppers, and other indigenous field-crop insects. Limitation of nursery stock insects and insects newly introduced or still limited in distribution was resolved by the Commission several decades ago.

Elimination of common barberry was another obligation, because it is an alternate host of wheat stem rust. The cooperative, barberry eradication program was completed in the early 1980s and is now handled as a part of the nursery inspection program.

Apiaries were inspected for diseases, particularly American Foul Brood (AFB). If AFB were found, the law required that the colony be burned and the remains buried. Colonies without movable frames were illegal because they could not be inspected for disease. The State Apiarist acknowledged that sulfa drugs would mask the disease, but would not eradicate it unless treatment was carefully and thoroughly repeated. Hence, a good beekeeper's bee yard would be free of disease anyway, whereas a poor beekeeper would merely sprinkle sulfa when he noticed the disease or, more commonly, after an inspector had discovered the disease.

J. H. Merrill was State Apiarist from 1918-1925; R. L.

Parker, 1925-1957; Roger B. Boren, 1957-1961; Norbert M. Kaufeld, 1961-1964; Gary Ross, 1964-1966; William Iselin, 1966-1972; and Gary Ross, 1971-present.

Published insect population summaries commenced in 1930. The Department introduced a new scoring method of recording insect populations by counties for each year, and annual summaries were published. For the first time, insect populations could be listed in mathematical terms, making possible comparisons between years. These published records included a summary of weather and crop data and observed effects of climate and natural enemies on each species recorded. They were published primarily in the Journal of the Kansas Entomological Society, the Transactions of Kansas Academy of Sciences, and the reports of the Kansas State Board of Agriculture.

Kansas was the third state (1956) to establish an economic insect survey program and a separate survey entomologist in cooperation with the Plant Pest Control Division (APHIS) of the USDA. David L. Matthew was the first from 1954-1958; Leroy Peters, 1958-1965; John H. Simpson, 1965-1970; and Kermit O. Bell, 1970-present).

In 1953, the Kansas Pest Control Act went into effect. It charged the Commission with the responsibility to examine and certify termite and pest control operators, to check their work, and when necessary to withdraw their licenses after due process.

In 1963, the Kansas Entomological Commission was abolished at the recommendation of all members of the Commission. They felt that regulatory work should not be a part of a university's obligations. A Division of Entomology, with H. Dean Garwood as Director, was created in the Kansas State Board of Agriculture.

The position of Survey Plant Pathologist was created in 1975 to compile and report plant disease survey data. This position has been filled by Thomas Sim since 1975. All professional employees of the Division of Entomology actively participate in the collection of insect and plant disease survey data.

In 1977, the Pest Control Act was replaced by the Kansas Pesticide Law. This new law continued to require the consumer protection function of licensing pest control businesses and added the requirement that any person who applies restricted-use pesticides be examined and certified.

In September 1985, these activities were reorganized and combined by the State Board of Agriculture into a Plant Health Division. This Division is concerned with such regulatory activities as protecting plants from insects; pesticide use, safety, and registration; examining and licensing of pest control operators; and noxious weed control.

KANSAS ENTOMOLOGICAL SOCIETY

On April 9, 1925, an informal meeting was held at Manhattan, attended by entomologists from the University of Kansas and KSAC. A committee was formed to begin preparing a list of insects of Kansas: Warren Knaus (Chairman), R. H. Beamer, and H. R. Bryson. The Kansas Entomological Society was organized with Paul B. Lawson, president, and J. W. McColloch, secretary. It was decided that the new Society hold its meetings in connection with those of the Kansas Academy of Science. Later, the Society met with the Academy only when the meeting was at Manhattan or Lawrence. The Society now meets every other year at Manhattan or Lawrence and meets in a rotation fashion on alternate years on the campuses of Oklahoma State University, University of Arkansas, University of Missouri, and the University of Nebraska. The Society's second name, usually in parentheses, is "Central States Entomological Society," which is more geographically descriptive. The Society is also affiliated with the Entomological Society of America.

The Journal of the Kansas Entomological Society of America was founded in 1927. During early years, authors were largely from the Kansas institutions, with most papers dealing with taxonomy and general biology. Now, papers from the entire nation and other countries are published. Despite its high standards of quality, we at Kansas State University have had some difficulty at times convincing non-entomology administrators that it is a prestigious journal and greater in scope than just Kansas.

INSECT FOSSILS IN KANSAS

One of the two, major, insect fossil beds of the Lower Permian (about 250,000,000 years ago) was discovered in 1899, three miles south and one-half mile east of Elmo, Dickinson County, Kansas. (A similar one was found in northeast Oklahoma in 1940.)

Fossil insects were first collected by Dr. E. H. Sellards of Texas, among a collection of plant fossils. He visited the site again in 1902 and 1903, collecting more than 2,000 specimens.

In 1921, C. O. Dunbar of Yale University collected specimens and sent them to R. J. Tillyard of Australia.

F. M. Carpenter of Harvard University first visited the bed in 1925 and conducted a more extensive expedition in 1927.

Tillyard visited the bed in May 1928, accompanied by KSAC staff from Entomology, Zoology, and Geology.

Many subsequent collecting trips have been made to the bed by Kansas State University staff, students, and others. The owners, at least up until the last visit, never refused access to the bed but never would consider selling the land.

The rock at the Elmo bed is fine-grained and nearly white. It was deposited by a fresh water, shallow lake inhabited by mostly aquatic insects, crustaceans, and small king crabs. Most of the fossils are well preserved, some even showing coloration and minute hairs on the wings. When Kansas was mostly covered by the sea, this fresh water area was shallow and marshy, which favored insects becoming buried and fossilized.

The Department of Entomology has a cross-section sketch and a colored picture showing the insect-producing layer. There is a thin layer of soil and broken rock at the top, a thin layer of blue shale, a relatively thick layer of limestone with good cleavage bearing the insect fossils, 1 ½ inches of black clay, a hard layer containing plant fossils, then 10 inches of shale, and finally, cherty limestone. Insect fossils are best recovered by taking the pieces of limestone back to a laboratory, letting them dry out, and then tapping them on the edge so that the break often occurs where the fossil is located.

The fossilized insects are predominantly forerunners of cockroaches and dragon flies. Bees, butterflies, flies, and beetles had not evolved then. Perhaps the most spectacular find was a nearly perfect imprint of a dragon fly wing with a span of nearly 16 inches from tip to tip. (Modern dragon flies seldom measure more than 4 inches tip to tip.) The opposite imprint is in the Museum of Comparative Zoology at Harvard. This dragon fly wing was found in May 1939, by Floyd A. Holmes, then of Prescott, and Otto E. Wenger, a KSAC student.

Further publications of the Elmo bed are by Dr. George A. Dean, *in* Insects in Kansas, first edition, p. 25-27, 1943; by Lowell Brandner in the Kansas City Times, November 18, 1954; and portions of numerous technical publications by F. M. Carpenter, C. O. Dunbar, and T. J. Tillyard.

EVOLUTION OF THE DEPARTMENT OF ENTOMOLOGY*

Entomology was first taught by Benjamin F. Mudge when he came to the College in 1865. Mudge also taught many other courses. He left the College in 1874.

The actual founding of Entomology, per se, was when Edwin A. Popenoe came in 1879. From 1879 to 1897 and from 1899 to 1907, he was the first professor of entomology and entomologist in the Agricultural Experiment Station. He was transferred from the chair of Horticulture and Entomology to that of Entomology and Zoology in 1894.

From 1877 to 1883, entomology was taught by the "Professor Botany and Horticulture;" entomology was not recognized in the title. In the 1894 catalog, Entomology was listed as a separate subdepartment, along with geology, under Horticulture and Botany.

Administrators of Entomology to various degrees were Mudge (1865-1873), J. S. Whitman (1873-1876), E. A. Popenoe (1879-1897, 1899-1907), Ernest E. Faville (1897-1898), and Thomas J. Headlee (1907-1912). Subsequent heads of Entomology were George A. Dean (1912-1943), Roger C. Smith (1943-1953), Herbert Knutson (1953-1976), Richard J. Sauer (1976-1980), Robert G. Helgesen (1980-1989), and C. Michael Smith (1990-present).

* There are some discrepancies in dates and titles for Mudge and Popenoe in notes and published literature. I present the most likely ones.

In 1897, Horticulture and Entomology were again consolidated. Reasons were probably that entomological studies were strongly oriented toward insects attacking horticultural crops and both departments were relatively small. Zoology, with which Entomology was previously associated, was transferred to Veterinary Medicine. Entomology, previously in the "Science Hall," was moved to the upper floor of the "Armory," which had been vacated by Veterinary Medicine.

Entomology was later reunited with Zoology, and the departments were then divided in 1912-1913, with Dean as Head of Entomology and R. K. Nabours as Head of Zoology. The Entomology Department remained in Arts and Sciences until July 1, 1953, when it was transferred to Agriculture.

Kansas is one of only two states (the other being California) with more than one, traditional, major entomology department: Kansas State University and University of Kansas. Both have been established for more than a century. During the early days, both engaged in basic and applied research. The passage of the Morrill Act and the establishment of the Kansas Agricultural Experiment Station at KSAC, designated it, among other things, to study and find means of controlling insects injurious to agriculture.

A file of letters and memoirs, mostly from 1910-1912 between S. J. Hunter, Head of Entomology at the University of Kansas, and T. J. Headlee, Head at KSAC, reveals some early jockeying for position regarding cooperation and assignment of areas to be assumed by each Department.

In a letter dated December 16, 1910, Hunter proposed, on a two-year trial basis, two divisions (1) the division of prevention and remedy, all field work to be at KSAC; and (2) the division of fundamental research and investigations to be done in the laboratory and museum at the University of Kansas. When necessary to move to the field from the laboratory, KSAC was to be contacted but work would be under the direction of the University of Kansas. Conversely, when KSAC anticipated laboratory work, the University of Kansas was to be contacted. (In some places students were mentioned, so it is assumed that both faculty and students were to be involved.) In cases of emergencies, provision was made to proceed with the studies while formal transitions were being made. Meetings of the two faculties were to be held at least once each semester to avoid any present or future duplication and to inform each other of their studies. Sharing of equipment when not in use was another objective.

Headlee responded that fundamental as well as economic investigations were authorized in the Agricultural Experiment Station at KSAC and pointed out the close relationship between field and laboratory work. Headlee agreed on the need to inform each other about current and future plans, exchange of equipment, literature, and ex-

change of student credits.

Early leaders of entomology at the University of Kansas not only had many interests in applied entomology, but devised and directed control programs against chinch bug, greenbug, Hessian fly, webworms, grasshoppers, and scale insects.

The staff at Lawrence stressed the importance of diseases for control of insect pests, including distribution of insects that had died of disease. This method of attempted control became popular, partly because it was much easier than, for example, distributing Kansas Bait for grasshoppers. Letters requesting these disease materials for control were frequent here at Manhattan from about 1910 until as late as 1935.

But the necessity of specific weather conditions for adequate reproduction and effectiveness of pathogenic fungi and bacteria was recognized early. Heavy rainfall of at least 5.5 inches in 15 to 20 days and cool temperatures were needed. When such favorable conditions prevailed, diseases developed in the field, indicating that they had been present and ready to reduce insect populations. Therefore, dissemination was not necessary.

Major Grants to the Department and Faculty

The first record of an official grant was $500 from the American Horse and Mule Association, obtained in 1932 to study certain insects that affect these animals.

Starting after I arrived in Manhattan in 1953, extramural financial support for entomological investigations increased rapidly. Initially, research on chlorinated, organic phosphorous and other synthetic insecticides contributed substantially to this increase. Soon, financial help was provided by Federal, commercial, private, and foundation sources. There were accompanying increases in staff, graduate students, and technicians.

Industry representatives were helpful in supplying their own unpublished data as well as that from other people doing similar studies. We published freely, including results with competitive insecticides, and never did industry object or interfere with any results appearing in publications.

Major Federal support came from the National Science Foundation (NSF) which favored "basic research;" the National Institutes of Health (NIH) of the U.S. Public Health Service; the USDA, which contributed primarily through Cooperative Agreements; and some military services, primarily the Army.

During at least one year in the late 1950s and 1960s, the Department of entomology had as much as 20% of all extramural grants for research to the University. During some years in the late 1960s, half or more of all the Department's budget was from extramural support. The number of graduate students soared above 50. (Placement of graduates was easy in those days.) Much of their research was done in the field or in insectaries because of inadequate greenhouse and rearing room facilities at the time.

Major specific grants in the 1960s and early 1970s that particularly helped the Department as a whole included matching grants from NIH and NSF toward a $400,000 remodeling and equipping grant to the Department in 1964-1965 (discussed under "Facilities"); NSF Graduate Traineeship grants in 1966-1971, which, among other things, supported four graduate students; an NIH Training Grant, 1965-1971 of $175,000 for a medical and veterinary entomology graduate training program; and a $50,000 grant from the Kansas Water Resources Institute and U.S. Department of Interior, 1966-1970.

C. C. Roan was particularly helpful in initiating grant proposals for himself and encouraging others to seek grants.

Entomology became known in the late '50s and '60s on campus as a "rich" department because of grants, and the Administration adjusted by reallocating funds from Entomology to other Departments. This low support from State and Hatch funds continued through leaner years in the early 1970s. State and University funds to Entomology increased substantially after I stepped down as Head in 1976, back to the level where they should have been for the past 20-25 years.

Facilities

The first, separate, office-laboratory building for entomology (and horticulture) was a one-story, stone structure. Part of its funding came from the first Federal appropriation under the provisions of the Hatch Act; $1,950 was spent for the building and $2,100 for the propagating houses. These houses were later removed, and the stone structure was subsequently used for other, unrelated purposes.

The Department then occupied portions of the second and third (attic) floors of Fairchild Hall (erected 1894) from 1894 to 1965. This building was fire susceptible. Each evening at 5:00, I patrolled our part of Fairchild Hall and provided substitutes when I was out of town. Never was a potential blaze found, but one international student was found at 5:10 p.m. by himself. He had just soaked his trouser leg with concentrated ethyl parathion! He was taken immediately to the Lafene Health Center; he survived, without any temporary or permanent difficulties. Knotted ropes were coiled and anchored near some windows in addition to the three stair escapes. Demonstrations were conducted frequently on the use of the fire extinguishers.

President James A. McCain took the Board of Regents on several tours of the Entomology quarters. One Regent told me that we could count on different and better quarters, if he never had to take that tour again!

Part of Fairchild's attic contained the stored-product insects office and laboratories. A large room for graduate students was finished-off in the attic, next to a new fire escape. There were also two offices and space for the insect collection.

I quote from Paul Dahm's letter describing alterations in Fairchild Hall before I came:

> "Initially, a windowless room in the northwest basement area of Fairchild Hall (somewhat across the hall from the fireproof storage vault) was pro-

vided. This small room was near the entrance of steam lines into the building and was often uncomfortably hot and lacking in ventilation. The room was shared with Howard Smith. He was screening chemicals for nematocidal efficacy. Because of the crowded conditions, albino rats used in the toxicology research program were kept in cages in the east-west basement hallway outside the laboratory. One summer the student newspaper wrote a story, with pictures, critical of this practice. We researchers were in a difficult situation, however, because administrators had accepted research grants requiring animal rearing facilities but none were provided."

"Later, an open area in the museum on the east side of Fairchild Hall was floored over to make a more acceptable laboratory for insecticide toxicology. This room also provided desk and research space for Dr. Philip Bonhag."

"Another aspect of our struggle for research facilities was our search for an insect rearing room for house flies and cockroaches. After some negotiating with Dr. Donald Ameel, then head of the Department of Zoology, Dr. Roger Smith obtained permission for us to clean out and refurbish a small room under the north, outside steps of Fairchild Hall. Access to this room was possible only by going out-of-doors from the building, which made for some quick trips in the winter!!"

Dean and Nabours (1915) published on humidity and temperature controlled chambers built within the old greenhouse.

An insectary was constructed in 1942 west of the old football stadium on the west side of Sunset Avenue. A building was moved in 1942 to the corner of Claflin Road and McCain Lane. This apiary building was later remodelled and made into a toxicology laboratory but was abandoned because of insufficient ventilation. the land and building were later sold to the endowment Association, which then sold it to commercial developers. Houses now cover the site of the former apiary building and orchard. Underground rearing facilities were constructed in 1941 in an insectary building on Sunset Avenue west of the old football stadium.

Greenhouse space was also appalling for many years. In 1957, Entomology built a 15' x 50' corrugated, fiberglass greenhouse north of Justin Hall. An extension of 20 feet to the east was added later. Still later, it was traded to Horticulture for a run-down portion of a glass greenhouse north of Dickens Hall, which was remodeled primarily for immediate use by L. Roy Taylor to study aphids.

These greenhouses were demolished upon completion of the new, modern greenhouses adjacent to the remodeled dairy barn, which was modified as a headhouse. This headhouse contains 15 growth chambers, four wet laboratories, three rearing rooms, and a work room. Our greenhouses now include two large rooms totaling 3,250 sq. ft.; growth chambers and rearing rooms totaling 2,234 sq. ft.; storage space of 1,424 sq. ft.; and a corridor of 1,200 sq. ft. There is a separate greenhouse used by the USDA for Hessian fly studies.

Experimental work in the field was largely conducted on privately owned land and to a lesser extent on land controlled by other Departments.

In 1949, the Hessian fly plots on Sunset Avenue west of the old football stadium were destroyed to form a parking lot. At the time, Professor Reginald H. Painter was on a Sabbatical Leave at Ohio State, writing his classical book on host plant resistance. (Later, I had great temptation, despite my interest in football and basketball, to erect a sign noting that this area was once the site where many of Kansas' valuable wheat varieties were developed.) The Board of Regents' minutes stated that, in compensation, a two-wheel trailer was authorized to "haul plants to and from the new location." The new location was the "Rifle Range," a sloping field with many different soils, which made replicated plots difficult. This Range is now occupied by sorority houses. The Rocky Ford Experimental Field has been used subsequently.

The Department in 1964 received $110,377 from the NIH, $29,200 from the NSF, and the remaining from state funds totaling $400,000 for remodeling and equipping portions of West Waters Hall and Annex. It was the custom for a subcommittee of two of the Board of Regents to visit each site prior to recommendations on capital improvements by the Board to the Legislature. I laboriously prepared a condensed, illustrated set of reasons to justify Entomology's request. Before I could get this expertly prepared evidence into their hands during our meeting, one Board member remarked to the other, defining entomology and its need for support. The other nodded and it was approved! I never said a word nor did I hand out my supporting document!

Entomology moved into portions of West Waters Hall and its Annex in 1965, following completion of remodeling. This more than tripled the existing space to 25,500 sq. ft. It consisted of 40 laboratories including 10 rearing rooms, 2,600 sq. ft. for teaching (4 rooms), and 15 offices. Some additional space was subsequently assigned, including a new suite of offices for extension; new laboratories for insect-plant relations, ecology, field crops, biocontrol, insects affecting horticulture, and insect pathology; and an additional teaching room. Some of this space became available when other departments moved to the new plant science building, Throckmorton Hall.

A scanning electron microscope was acquired and housed in the Department during the 1970s. About 1,410 ft^2 is occupied, including such major items as an ETEC U-1 SEM, photographic darkroom facilities, critical point and freeze-driers, energy dispensing x-ray detector, hood, and vacuum evaporator. Although located in, and utilized extensively by Entomology, the laboratory is available to the entire University community and other agencies. Charles W. Pitts originated the drive for funds from NSF and chaired the committee to obtain the microscope, and Entomology and the Director of the Agricultural Experiment Station aid in its operation and maintenance. The Graduate School contributed to physical remodeling of the rooms. A full-time operator, L. John Krchma, gives advice and assistance to investigators in specimen preparation and is responsible for microscope operation.

INSECT COLLECTING AND COLLECTIONS

Investigations prior to the establishment of the Agricultural Experiment Station (1887) consisted mostly of collecting and classifying insects. B. F. Mudge, as early as 1871, reported "A majority of our native insects have been collected monthly" (Eleventh Annual Report, Department of Public Institutions in Kansas, 1871, p. 262). J. S. Whitman proposed that a standard entomological collection be established (*Nationalist*, April 10, 1874) and commenced a formal, organized collection that year.

Formal collections of insect specimens began about 1877-1879, and were housed in the old Armory Building, which was later razed.

The first major contributions to the collection were from E. A. Popenoe, 1879-1897 and 1899-1908. In 1886, Popenoe stated, ". . . the entomological museum has received important accessions through the purchase from a student of about 1,200 specimens, and the collections from Kansas and Colorado of about 10,000 specimens by myself (Popenoe) and assistants . . ." (5th Biennial Report, 1885-1886, pp. 81-82).

Early insect collectors in Kansas included Fernald F. Crevecoeur (1862-1931), who lived alone near Onaga, Kansas, and collected insects and birds for recreation (Smith 1931). He sold his first insect collection to Ottawa University, Ottawa, Kansas, in 1917 but started another one. He is said to have had the ability to collect rare and unusual species. KSAC purchased his second collection and the larger part of his technical library for a token payment at public auction soon after his death. This collection consisted of 186 cigar boxes of pinned specimens, plus unmounted small specimens in cigarette-like rolls of paper.

Warren Knaus avidly collected insects for over 50 years, especially beetles from the sand hills north of Hutchinson, Kansas, but also from several western states and from Mexico. His excellent insect collection of some 10,000 species and 90,000 specimens, and his technical library, were acquired by the Department in 1937, soon after his death. The collection filled 300 Schmitt boxes.

In 1902, George A. Dean began collecting and adding to the collection. Students who collected and added specimens from its beginning included: C. L. Marlatt, F. A. Marlatt, L. B. Parker, C. D. Adams, J. B. Norton, Mrs. Bertha Kimball-Dickens, David Lantz, C. P. Hartley, L. M. Peairs, T. J. Scheffer, A. F. Turner, and a Mr. Towne.

Later, the chief contributions to the collection were made by faculty: J. W. McColloch, William P. Hayes, H. R. Bryson, R. C. Smith, D. A. Wilbur, R. H. Painter, R. L. Parker, and P. G. Lamerson. The first three were especially active in collecting and adding beetles.

An Asilid collection by Painter was received in the 1970s.

The collection received additional specimens and determinations slowly. It did not have an official part-time curator until 1965, when H. Derrick Blocker was appointed to the staff. Later, an Assistant Curatorship was established.

The collection at this writing consists of approximately 750,000 specimens, housed in 1,800 modified USNM drawers within 36 steel cabinets. The type collection contains approximately 100 holotypes and over 900 secondary types. The decision to include holotypes was made in 1979, accounting for the smaller number.

In this general collection, the best represented insects are beetles (Knaus), bee and robber flies (Painter), leafhoppers (Blocker), and grasshoppers (Wilbur and Knutson). Hymenoptera and other Diptera also are well represented. A research collection of spiders was started in 1979 and presently contains 800 vials of determined specimens. A research collection of mites was initiated by R. J. Elzinga. He also maintains a teaching collection of immature insects and arachnids.

The majority of specimens is from the U.S. west of the Mississippi River, but there is much other New World material, both Nearctic and Neotropical, and some Old World specimens.

ENTOMOLOGY CLUB

The Popenoe Entomology Club was organized on February 5, 1921. The object of the club was "chiefly to serve as a medium for the discussion of entomological problems, such as new discoveries, exchange of experience, proposed investigations . . . Early in its history it fostered the compilation of a list of Kansas insects." In cooperation with the University of Kansas, the Popenoe Entomology Club founded the Kansas Entomological Society.

Later, its name was changed to KSC Seminar, then the Entomology Club, and subsequently to KSU Entomology Club. During one year (1977) a lengthy newsletter was prepared; it was designated the "Flinthills Entomologist" and contained letters from many former students and faculty.

COURSES AND MISCELLANEOUS STAFF NOTES

Virtually all professors at Manhattan have had split appointments or duties to various degrees between resident teaching and research and some unofficial extension work. Only those at Branch Stations were virtually all research, but some serve as guest lecturers and on committees of the Department and unofficially do some extension work.

Extension personnel, until the 1970s, were all stationed at Manhattan. Then some personnel were placed in certain Extension Areas.

Although USDA personnel were stationed both in Manhattan and in other areas of Kansas for many years, in the

1970s some formal Adjunct appointments were made in the Department.

The information given below is mostly extracted from the University's catalogs.

Three years after the College was founded (1863), Benjamin F. Mudge taught "Insects Injurious to Vegetation" for juniors in Agriculture within the "Science Course" (1866-1873). C. V. Riley taught the course in 1872-1873 at Mudge's invitation.

A course entitled "Entomology" was taught in 1869, containing considerable economic entomology. Hence, this College probably offered the first course in economic entomology in the U.S., which has been taught continuously ever since. It appears that the College was second in the U.S. to continuously teach a general course in entomology. (The first was taught by T. W. Harris, 1866-1874, who lectured at Harvard University.)

During 1870-1871, "Entomology" was listed under the "Agricultural Course" as well as courses in "Literary," "Mechanic Arts," and "Military Science." "Entomology" apparently included most of the former courses in "Insects Injurious to Vegetation." A course description of Entomology read: ". . . course should include those insects which come into the most direct and serious conflict with farmers' interests, either by depredating upon growing crops or harvested grain and fruits, and those that infest domestic animals as well as their predaceous and parasite enemies are taken in the order of importance to the agriculturist."

In the "Women's Course," special attention was given to the "insects that infest the home and garden, either in the larvae or fully developed state."

In the 1871-1872 catalog, the instructor's name is identified with the course taught. The Rev. E. Gale was listed as Professor of Horticulture and Superintendent of the Nursery but he did some teaching of entomology. Mudge was listed as Professor of Natural Sciences, a change in title, and taught Botany, Meteorology, Geology, Natural Philosophy, Entomology, Zoology, and Physical Geography. (Later, he also was listed as teaching Physiology, Astronomy, Physics, and Agricultural Chemistry!)

J. S. Whitman (1873-1875) replaced Mudge. His title was Professor of Botany, Entomology and Geology and he taught beginning and advanced courses 1873-74. Whitman also taught "drawing." He emphasized insect collecting and rearing. E. Gale gave a series of lectures in 1878, presumably on horticultural insects. H. E. van Deams taught an entomological course in 1879.

The May 17, 1876 Board of Regents' minutes read, "That in order that more practical application shall be had by students at Kansas State Agricultural College in the study of Botany, and that they may become more conversant with this science, in all its details, it is hereby ordered that Prof. E. Gale of the Horticultural Department have at the commencement of the new college year exclusive charge of the Botanical studies, and that the services of Prof. J. S. Whitman are dispensed with at the end of the preceding scholastic year." Gale was dismissed August 30, 1878.

The 1877-1880 catalog lists Popenoe as Professor of Botany and Horticulture.

C. V. Riley, while State Entomologist of Missouri (1868-1877), gave courses in 1870-1873 at the College and delivered a series of public lectures in 1875-1876. The Department has 92 of Riley's hand painted and illustrated charts, mostly in color, showing life histories of insects, all of economic importance. These charts were given to the Department by his widow.

A course "Entomology and Anatomy" was listed as having ". . . special reference to its economic relations with agriculture and horticulture. A brief course in the principles of classification is followed by a more extended study of the life history of beneficial and injurious insects, and means of encouragement of one and control of the other." References were "Packard's Guide to the Study of Insects, Harris' Insects Injurious to Vegetation, Riley's Reports, LeBaron's Reports, Reports of the U.S. Entomologist, Transactions of the American Entomological Society, and others." Entomology was taught for seven weeks and anatomy for three weeks.

In 1881-1882, Popenoe was listed as Professor of Zoology and Superintendent of Orchards-Gardens.

In 1883-1884, Entomology was listed separately and anatomy with the zoology courses.

In 1880, Popenoe reported "as an adjunct to the course in horticulture, entomology is studied for six weeks." The instruction was given entirely by lectures, illustrated by the insects themselves and by charts and drawings.

In 1885-1886, Charles L. Marlatt was listed as a resident graduate student in entomology. He was an Assistant Entomologist from 1887-1888. His research involved use of insecticides to control various destructive pests in the greenhouse. He joined the Bureau of Entomology, U.S. Department of Agriculture in 1889.

Books of reference for the Entomology course were "Insects Injurious to Vegetation, Riley's Reports, LeBaron's Reports, Fitch's Reports, Thomas' Reports, Reports of U.S. Entomologist, Transactions of the American Entomological Society, Canadian Entomologist, Psyche, and others."

During 1886-1887, the M. S. degree was authorized in Entomology along with M. S. Degrees in Botany, Chemistry, Zoology, Physics, Agriculture, Horticulture, Engineering, Architecture, and Domestic Economy.

Personnel of the "Experiment Station" were listed for the first time in the 1887-1888 catalog. Popenoe was one of six members of the Council. C. L. Marlatt was an Assistant and Foreman of Gardens and Orchards. He resigned to accept a position with the Bureau of Entomology, U.S. Department of Agriculture.

For the first time, there was a summary of graduates in the 1889-1900 catalog, starting with 1867. This was of little value to me, however, because only addresses and current occupations were given. There was no mention of majors.

Entomology in 1891-1892 was described: "This science is studied with special reference to its economic relation to agriculture and horticulture. A brief course in principles

of classification is followed by a more extended study of the life-history of beneficial and injurious insects, and means for encouragement of the one and control of the other. The instruction is presented in the form of lectures. Illustrations are furnished from the individual collections of the students, and from entomological collections belonging to the College. Charts and drawings from nature are used to illustrate points of value in classification. The pocket lens used in botany is required in this study."

Frederick A. Marlatt was listed as an Assistant in the Experiment Station.

The faculty had expanded to 23 members but Popenoe remained the only entomologist in 1894-1895. Courses were expanded to include General Entomology, Economic Entomology, Systematic Entomology, and Entomological Methods.

The "extended course" (advanced course of study) was described: "The student electing entomology in his fourth year reviews through the fall and winter terms the general subject as a necessary introduction to the special work of the terms following. The work of those two terms, however, is complete in itself. The work is Comstock's Manual, extended. In the spring term, the time is given to entomological methods, including field work in observation and collecting, laboratory work in preparation, dissection, and presentation, and in the studies of life histories by the aid of the vivarium."

"In the fall and winter terms of the fifth year, the student pursues the independent and critical study of systematic entomology, the work in which may be restricted when desired to groups of special agricultural importance. This course is followed in the spring term by lectures and practice in economic entomology."

In 1895-1896, F. A. Marlatt was one of eight Assistants, and in 1896-1897, Percival J. Parrott (1897-1907) was one of five Assistants in the Experiment Station.

Popenoe was replaced from 1897 to January 1, 1899, by E. E. Faville, as Professor of Horticulture and Entomology. During Faville's tenure (1897-1898) no entomology Assistants were listed among the 27 Assistants, and none among 31 Assistants in 1898-1899. Popenoe came back on January 1, 1899.

In 1899-1900, "Advanced Entomology" was listed for the first time. G. A. Dean was appointed as Assistant on March 1, 1902.

In 1904-1905, The Department title was changed to "Entomology and Zoology." Popenoe resigned in 1907.

In 1907-1908, Thomas J. Headlee replaced Popenoe, and the title was changed from Professor of Entomology and Geology to Professor of Zoology and Entomology and Professor of Entomology in the Experiment Station. Dean became an Assistant Professor.

Courses offered were: General Entomology, Economic Entomology, Systematic Entomology, Histology of Insects, an untitled course on "structure, physiology and development," and a course of independent study under guidance.

In 1908 and 1909, John B. Parker, from Ohio State University was listed as Assistant Entomologist in staple crops and Harry P. Evans as Assistant in Fruit Insects. Leonard M. Pearis became an Instructor in Entomology and Assistant in Fruit Insects.

Francis B. Milliken became an instructor in Zoology and Assistant Entomologist in "General Entomological Investigations." Dean's title became Assistant in Milling and Grain Insects Investigations.

Two of 12 M. S. candidates were in entomology, after an absence of several years.

During 1909-1910, for the first time, faculty and staff listings in the catalogs included degrees, dates, and institutions; ranks and academic experience; and titles of those on the Experiment Station staff, with their specialty.

In 1911-1912, Joseph H. Merrill was listed as an instructor in Entomology. In 1915-1916, he was titled Assistant Entomologist, Fruit Insect Investigations. Research in entomology was first listed as a formal credit course.

In 1912-1913, M. C. Tanquary and James W. McColloch were listed as Instructors and Assistant Entomologists in the Experiment Station.

Insect Morphology, Horticultural Entomology, Household Entomology, and General Economic Entomology were added to the list of courses.

In 1913-1914, Paul S. Welch was added as an Assistant Professor. Courses in Advanced Applied Entomology and Milling Entomology were included.

In 1915-1916, Thomas J. Talbert was listed as a Lecturer in the Division of College Extension.

McColloch became an Assistant Entomologist in Staple Crop Insects, and William P. Hayes became an Assistant in Entomology, working on the same subject.

Welch was listed as teacher for 11 courses (General Entomology, Horticultural Entomology, General Economic Entomology, Insect Morphology I and II, Taxonomy of Insects I and II, Advanced General Entomology, Insect Histology, Medical Entomology, and Entomological and Zoological Literature)! It is likely that several of these courses were not taught, but it was the intention to list them for use after WW I.

Dean was listed as the teacher of Household Insects, Apiculture, and Milling Entomology.

In 1917-1918, Maurice C. Tanquary and Joseph H. Merrill were listed as teachers of General Entomology, Economic Entomology, and Apiculture, respectively.

In 1918-1919, Tanquary, McColloch, Welch, and Hayes were listed as "teachers." The courses remained the same except "Zoology and Entomology Seminar" was added. Welch was again listed as the instructor for most of the courses, but Tanquary taught Medical Entomology.

In 1919-1920, Summer School courses were listed for the first time: General Entomology, Apiculture, and a new course, Advanced Apiculture.

Tanquary left to take a job at Texas A & M; Roger C. Smith replaced him. Smith was listed as instructor for the nine courses previously assigned to Welch, plus co-teaching of General Entomology with Dean!

"Entomology Problems" was added in 1921-1922.

In 1923-1924, the following courses were transferred to Hayes: Insect Morphology I and II, Principles of Taxonomy, and Taxonomy of Insects I and II.

Harry R. Bryson, an Assistant Entomologist, replaced Hayes in 1924-1925.

In 1925-1926, Merrill was no longer listed. He was replaced by Ralph L. Parker, who taught the apiculture courses, Horticultural Entomology, and a new course, Insect Physiology.

In 1926-1927, the following appeared in this catalog:

Course No.	*Undergraduate*
111	Apiculture - Parker
116	Milling Entomology - Dean
	Graduate and Undergraduate
201	Horticultural Entomology - Parker
203	General Entomology - Dean and Bryson
206	General Economic Entomology - McColloch
211, 212	Insect Morphology I and II - Smith
216	Principles of Taxonomy - Smith
217, 218	Taxonomy of Insects I and II - Smith
221	Advanced General Entomology - Smith and Parker
226	Medical Entomology - Smith
227	Advanced Apiculture A - Parker
228	Advanced Apiculture B - Parker
231	Entomological and Zoological Literature - Smith
234	Insect Physiology - Parker
236	Zoology and Entomology Seminar
238	Entomological Problems
316	Research in Entomology

Reginald H. Painter was added in 1927-1928, and he and Smith were listed as jointly teaching Advanced General Entomology.

During 1929, Smith was on Sabbatical Leave; Donald A. Wilbur was added to teach Advanced General Entomology and Medical Entomology.

Painter taught Insect Morphology, Principles of Taxonomy, Entomological and Zoological Literature, and a new course, Field Entomology.

In 1931-1932, Staple Crop Entomology was added with Dean and Wilbur the instructors. Internal Insect Morphology was added with Painter as the instructor. Advanced Insect Physiology was added, taught by Parker.

In 1931, offering of the Ph.D. was authorized in Entomology, Chemistry, Bacteriology, and Milling Industry.

In 1934-1935, Insect Ecology was added, taught by Bryson.

In 1935-1936, Paul G. Lamerson was listed as an Assistant Entomologist.

In 1936-1937, Insect Control by Host Plant Resistance was taught by Painter.

The first Ph.D. in Entomology was awarded in 1939.

During 1947-1948, Paul A. Dahm and Louis Keitert were added as new staff, when enrollment was increased by veterans supported by the "G. I. Bill." Keitert moved to the University of Florida after one year. Dell E. Gates joined the faculty in 1949 as extension entomologist.

Pest Control Technology I (household insects) and Pest Control Technology II were offered by Dahm. The latter course covered control techniques for warehouses and public buildings, public health, and rodent control. During 1951-1952, Chemical Control I and II were added.

I became head of the Department in 1953, replacing Smith, who remained on the staff for two years before being assigned to the Kansas State University-India AID project.

In 1954, C. C. Roan replaced Dahm and Insect Toxicology was offered. L. I. DePew became research entomologist at the Garden City Branch Experiment Station.

Hugh E. Thompson arrived in 1956 to handle courses and research on Dutch elm disease and other pests of trees and ornamentals.

During 1956-1958, the following courses were upgraded to strictly graduate credit: Advanced Economic Entomology, Insects of Stored Products, Current Insect Control Practices, and Advanced Insect Morphology. This was in line with the sharp increase in candidates for the Ph.D.

In 1960, T. L. Hopkins joined the faculty to teach and do research in insect toxicology and physiology.

During 1962-1964, Christian C. Burkhardt, A. E. R. Downe, R. B. Mills, Carl W. Rettenmeyer, W. Keith Whitney, Norbert M. Kauffeld, and Charles W. Pitts joined the faculty. Parker took medical retirement. Insect Behavior was added, taught by Carl W. Rettenmeyer.

During 1966-1968, H. Derrick Blocker, A. M. Kadoum, and Gerald E. Wilde joined the faculty. Courses in Properties of Insecticides and Action and Metabolism of Insecticides were added.

General Bee Culture was dropped when Kauffeld left in 1968-1969.

Arachnology was added and taught by Richard J. Elzinga.

In 1970-1971, Ernst K. Horber replaced the late Reginald H. Painter, and J. C. Boling was added to the staff. Gregory Partida and Donald E. Mock were added to the faculty in 1972-1973. In 1973-1974, William H. McGaughey became an Adjunct member of the faculty.

In 1973, the Entomology undergraduate major became the Entomology Science Option in a new Crop Protection Curriculum, which includes both Entomology and Plant Pathology. (This curriculum is now named Pest Science and Management) This option is mainly for those planning to do graduate work in Entomology.

Courses added: Livestock Entomology (service course for undergraduates in Agriculture); Insects of Home, Lawn and Garden, Insect Pest Diagnosis, Internship in Pest Management, and Federal and State Regulations of Pesticides for Crop Protection majors; Reports in Entomology, Taxonomy of Insects II (special insect groups), Insect Toxicology (to replace earlier course) and Action and Metabolism of Insecticides. Principles of Taxonomy was dropped (later offered as a Topics course).

J. D. Stone joined the faculty in 1974-1975 at the Garden City Branch Experiment Station.

Milling Entomology was dropped, and portions of this

subject were combined with a milling sanitation course offered in the Department of Grain Science and Industry by John R. Pedersen.

Entomological and Zoological Literature was dropped. Still offered were Advanced Applied Entomology I (insecticides, types and methods of application, biocontrol, cultural control), Advanced Applied Entomology II (field crops, livestock and stored grain), Advanced Entomology III (fruits, vegetables, turf, ornamental, forest and shade trees). Two Topics courses were introduced: Topics in General and Systematic Entomology (principles of taxonomy, taxonomy of immature insects, arachnology, and biological literature); and Topics in Environmental and Physiological Entomology (behavior, ecology, physiology, and pesticides and the environment).

Advanced Applied Entomology I, II, and III were dropped in 1975-1976. Added were Insects Attacking Field Crops, Grasslands, Livestock, and Stored Grain and Insects Attacking Horticultural Crops and Fruits.

In 1976-1977, F. L. Poston, Richard J. Sauer, Lynne Thompson, and J. H. Hatchett (Adjunct) were added. Sauer replaced me as Head of the Department.

In 1977, Donald C. Cress, Stephen M. Welch, and William A. Ramoska joined the department. Insect Pathology and Biological Control were new courses offered.

In 1978-1979, Robert J. Bauernfeind, Marshall Johnson, and George E. Lippert became department faculty.

Insect and Arachnid Identification was added, a service course between the beginning course and Insect Pest Diagnosis. Biological Control of Insects was added. Integrated Pest Management was changed to Insect Pest Management. Insect Ecology and Population Management was added and Entomological Methods was dropped. Systems Modeling for Biologists was offered by Welch in 1979-1980.

In 1980, R. G. Helgesen became Department Head and Richard W. Beeman, Adjunct faculty member.

Ecology of Insects in Natural and Agronomic Environments was added, and Insect Ecology and Populations was dropped. Systems Modeling for Biologists was dropped, and Modeling Biological Systems added.

In 1982-1983, Livestock Insects Laboratory was developed by A. B. Broce. Internship in Crop Protection and Seminar in Crop Protection was added and Medical Entomology was dropped.

In 1983-1984, Lawrent L. Buschman, Randall A. Higgins, John C. Reese, and Phillip E. Sloderbeck joined the department. The course in Insect Pests of Field Crops, Stored Grain, and Livestock was dropped.

Recent additions to the faculty include James R. Nechols in 1984, David C. Margolies in 1985, Marion O. Harris in 1986, William C. Black IV in 1988, Barry A. Dover in 1989, and C. Michael Smith, who became Department Head in 1990.

New courses include Insect Behavior and Insect Genetics. The current areas in which graduate degrees are offered include plant resistance to insects, insect pest management; insect ecology and behavior; biological control; insect genetics, insect physiology, biochemistry, and toxicology; stored-product insects; veterinary entomology; and morphology and systematics.

The recipients of M. S. and Ph.D. degrees through 1983 were listed in Internal Report 83-001, published by the Department. Recipients of the B.S. degree were listed through 1938 by Dean (1938). Finding subsequent recipients would have been very difficult because of the paucity of records in the Department of Entomology and the College of Agriculture.

TEXTBOOKS

The first edition of Roger C. Smith's *Guide to the Literature of the Zoological Sciences* was printed in 1942. It was revised in 1945, 1952, 1955, 1958, and 1962. Painter was added as the second author in the seventh edition, 1966. The title of the eighth edition, 1972, became *Guide to the Literature of the Life Sciences*, and the authorship, Smith and W. Malcolm Reid. The ninth edition, 1980, became *Smith's Guide to the Literature of the Life Sciences*, with authors W. Malcolm Reid and Arlene E. Luchsinger. Reid was a student of Smith's at KSU and Luchsinger was an associate of Reid. Both are now at the University of Georgia. All editions have been published by the Burgess Publishing Co., Minneapolis, MN.

The *Common Insects of Kansas* by Roger C. Smith, E. G. Kelly, George A. Dean, H. R. Bryson, and R. L. Parker, published in 1943, 440 pages, by the Kansas State Board of Agriculture, was written especially for Kansas high school students and the general public. A revised edition, 307 pages, by Dell E. Gates, Extension Entomologist, and Leroy L. Peters, Survey Entomologist, was published in 1962. Unfortunately, there was a shortage of funds available for publication, so that the text had to be shortened and many of the poorer illustrations reused, particularly for ants, bees, and wasps.

Painter published a summary of the world literature in 1951: *Insect Resistance in Crop Plants*. It was originally published by Macmillian and reprinted in 1968 by the University Press of Kansas. It was translated into Russian by Russian scientists.

Richard J. Elzinga published *Fundamentals of Entomology*, Prentice Hall Inc., Englewood Cliffs, NJ, 1978. A second edition was printed in 1981. Many of the scanning electron microscope photographs have been "borrowed," along with some written text, and incorporated into the latest entomology text in mainland China.

Incentives for textbook writing have not equaled incentive for research publications.

AGRICULTURAL EXPERIMENT STATION AND RESEARCH

The Agricultural Experiment Station was first given the status of a department although administered by a council rather than a head or director. The first support was an annual Federal appropriation of $15,000, authorized by

the Hatch Act of March 2, 1887 (Land Grant Colleges Act), which provided for establishment of the Experiment Station at Manhattan on February 8, 1888. The first annual report by the Department of Entomology to the Station was dated 1888.

The Fort Hays Branch Station was authorized in 1901, with part of the former military reservation being turned over to the Station. There followed branch stations at Garden City, Tribune, Colby, and Mound Valley, later termed the "Southeast" Station.

The first entomologist at the Hays Station was Woodrow W. Franklin (1948-1953), who resigned to take an AID appointment in Liberia. He was followed by T. L. Harvey (1954-present).

Roy F. Fritz, a graduate student, was the first entomologist to be stationed at the Garden City Station, 1938-1940. He was succeeded by Elvin Tilton, then by L. J. DePew, 1954-present. Subsequent entomologists were Jay Stone (1973-1976), then Donald C. Cress (1977-1978), and Marshall W. Johnson (1979-1981).

Gerald L. Greene was Superintendent of the Station from 1976-1982 and subsequently continued as a research entomologist.

The first entomologist at the Wathena Experiment Field was Paul G. Lamerson. After Lamerson's untimely death, Elbert L. Eshbaugh succeeded him until he moved to Manhattan in 1967.

Other current off-campus staff consists of Robert J. Bauernfeind, extension and research, at the South Central Area Extension Office, Hutchinson (1978-present; Lawrent L. Buschman, research, Garden City Branch Experiment Station, Garden City (1981-present); George E. Lippert, extension and research, Southeast Area Extension Office, Chanute (1978-present); and Phillip E. Sloderbeck, extension, Southwest Area Extension Office, Garden City (1981-present). Donald E. Mock was stationed at Garden City, 1973 to 1980, as extension entomologist in charge of a pilot IPM project, then moved to the Manhattan staff.

No research entomologists have been stationed at Colby, Parsons, or Tribune, Kansas.

A list of publications from the Department carrying contribution numbers from the Agricultural Experiment Station has been published as Internal Report 86-001. It includes all publications from 1875 through 1985. This listing will be of particular help to those looking for early papers on Kansas insects. The present total is over 2,000. Contribution number 1, on "The Grasshopper," appeared in the *Kansas Industrialist* in 1875.

During the earlier years, there apparently were no guidelines for determining which publications should receive a contribution number. As stated above, the Staff was under extreme pressure by the Board of Regents and many Kansas citizens to publish up-to-date, relatively brief items on insects of immediate, economic importance. Numerous publications are listed in Dean and Nabours (1937) that did not receive contribution numbers, particularly those of Merrill (on apiculture) and of McCollough, Hayes, and Smith.

The first publications were mostly in the *Industrialist*, the College's first newspaper. It was largely confined to College news, but also contained articles pertaining to the College and of statewide interest. It was a place of publication for most of the Department's early economic reports, many of which were of popular or semi-popular style. This occurred well before the Extension Service was established and provided an opportunity to get entomological information to the public rapidly. For many years, the pages were not numbered; hence, only the volume and number within that volume are given.

Other local publication sources were: Reports, Circulars, Research Publications, Research Papers, Leaflets, General Bulletins, Reports of Progress, and North Central Regional Technical Committees Reports. Papers also began appearing in the Transactions of the Kansas Academy of Science; Kansas Press Bulletins (smaller, semi-popular style releases, with unnumbered pages, discontinued in 1911; replaced by Extension Service publications); Kansas State College Experiment Station Bulletins and Technical Bulletins; Reports to the Kansas Horticultural Society, the Kansas State Board of Agriculture, the Kansas Entomological Commission; and the Journal of the Kansas Entomological Society. Publications began to appear commonly in national and international journals about 1910, mainly in the Journal of Economic Entomology, with lesser numbers in Entomological News (1918), Annals of the Entomological Society of America (1920), Scientific Monthly (1920), Brooklyn Entomological Society (1921), Canadian Entomologist (1922), Ecology (1923), Gleaning in Bee Culture (1923), Journal of Agricultural Research (1926), Journal of the American Society of Agronomy (1926), International Congresses of Entomology (1929), and Science (1932).

Until about the 1950s, this department was probably best known nationally and internationally for the development of resistant varieties of plants and the study of insects that attack stored grains and milled cereal products.

When reviewing the accomplishments of the earlier staff, I was impressed by the extreme versatility and thoroughness of the older, pioneer entomologists, in a period when the basic biology of many insects was less known, funds were very limited, and much of the modern day equipment and information was not available.

There follows a summary of research published on various subjects. Through 1983, the year generally indicates when the research was completed (and thus was available to the staff). From 1984-1988, the date is the year of publication.

INSECTS OF WHEAT

Hessian Fly

Hessian fly was first detected in Kansas in 1871. Development of fly-resistant wheat varieties, planting after fly-free dates, and destruction of volunteer wheat, in cooperation with plant breeders and other scientists, are examples of successful team approaches. Not only was Hessian fly resistance developed, but other favorable characteristics such as increased yield, resistance to disease and lodging, and better quality of flour have been included in the breeding program.

Popenoe first published on Hessian fly in 1901 and 1902 and issued a general bulletin in 1903.

Headlee published what was known about the fly in 1908 and again in 1909 (including greater strawworm). In 1912, he published on date of planting and its relation to oviposition and released another bulletin in 1913.

Dean helped lead the planning and carrying out of the "Hessian Fly Train" (see discussion below) and published a bulletin in 1923.

McColloch, 1910-1920, laid the foundation for development of insect resistant wheats and hybrids, in cooperation with plant breeders, and published a then up-to-date account of the fly. His other publications included migration of the fly larvae (1917), varieties of grains and fly injury (1918), and general publications in 1919 and 1921, and again with S. C. Salmon in 1923 and 1924.

Painter published on the biology of the fly and its strains (1929); on resistant wheat varieties with Salmon and J. H. Parker (1931); and with C. E. Jones, C. O. Johnson, and J. H. Parker (1939) on the transfer of fly resistance and other characteristics from Marquillo spring wheat to winter wheat.

Elmer T. Jones (USDA) conducted Hessian fly research at Hutchinson from 1927 to 1934, when he was reassigned to Manhattan. He retired in 1962.

Painter and Jones published in 1942 on new varieties of hard red winter wheat, especially on resistant Pawnee wheat in 1944 and 1948, and on Ponca wheat with Jones and Elmer Heyne.

Dean, with John R. Harton, Jones, and H. H. Walkden (1945), published on the fly-free dates to minimize fly damage.

H. W. Somsen was the USDA entomologist from 1954 to 1976, but I saw few of his reports, except those that appeared in the Extension weekly newsletters. His work with the fly was largely screening and surveys.

Painter (1968) published on the successes of resistant varieties. The following are excerpts from his report.

> "In Kansas ten different Hessian fly resistant wheat varieties have been released or approved by the Experiment Station. Pawnee . . . was released to Kansas farmers in 1943 and by 1949 had become the leading wheat variety in acreage in the United States . . .
>
> "From 1923 to 1935 the estimated loss from Hessian fly ranged from five million to 18 million bushels of wheat per year. During the years 1947 to 1960 in Kansas many acres were planted with Hessian fly resistant varieties. Over much of the state the insect was absent or nearly so, hence a conservative estimate of saving from planting Hessian fly resistant wheats in Kansas would be five million bushels for each of these 13 years.
>
> ". . . Now more than 19 Hessian fly resistant varieties satisfactory in milling and baking qualities, with high yield and disease resistance as well, are available and recommended by experiment stations in *all* major wheat growing areas of the United States. . ."

J. H. Hatchett and B. S. Gill (1981) published on D-genome sources of resistance to the fly in Triticum tauschii. The expression and inheritance of resistance to the fly in synthetic hexaploid wheat derived from T. tauschii was published in 1981 by Hatchett, T. J. Martin, and R. W. Livers.

Hatchett and Gill (1983) published on expression and genetics of resistance to Hessian fly in T. tauschii. Also in 1983, Tyler and Hatchett wrote on temperature influence on expression of resistance to the fly in wheat derived from that species.

P. A. McKay and Hatchett (1984) published on the mating behavior and evidence of a female sex hormone in Hessian fly.

Hatchett, with H. L. Brooks and W. G. Willis (1984), rated 39 of the available wheat varieties in a greenhouse study. They found six to be resistant to Hessian fly, seven to be moderately resistant, and the remaining 25 to be susceptible. Of the resistant varieties, Arkan, Brule, and Larned were among the major ones planted. Greater emphasis is now being placed on Hessian fly resistance in wheat breeding programs, and resistant varieties are expected to be released on a continuing basis.

T. S. Cox and Hatchett (1986) discussed strategies for deployment of genes resistant to Hessian fly in wheat cultivars.

In 1986, Hatchett reviewed Hessian fly resistance in wheat for the proceedings of the Hard Red Winter Wheat Workers' Conference.

Hatchett and collaborators (1987) published on the expression and inheritance of resistance in 'Marquillo' wheat to Hessian fly Biotype D. With Gill and Raupp in 1987, Hatchett mapped chromosomes of the Hessian fly resistance gene H13 in wheat.

Stuart and Hatchett (1987) studied morphogenesis and cytology of the salivary gland of Hessian fly. In 1988, these authors published further studies on the genetics of Hessian fly-mitotic karyotype analysis and inheritance and behavior of somatic and germ-line-limited chromosomes.

The Hessian Fly Train

In 1915, the Santa Fe railroad was requested to operate a special "Hessian Fly Train," also called the "Hessian Fly Special," after an intermittent series of Hessian fly out-

breaks.

During some previous years, more limited special trains had been utilized for agricultural problems by Santa Fe and other principal railroads, but this "Hessian Fly Train" was the first to be run exclusively for insect control.

The train consisted of a baggage car, two steel day coaches seating 176 persons (used as lecture cars), and a private car for dining and sleeping compartments. Sixty-two stops were made during the week just before the beginning of harvest.

Speakers consisted of three entomologists from KSAC, one USDA entomologist, an agronomist, a "Superintendent of Farmers' Institutes" from the College, and one county demonstration agent. Those not lecturing included Santa Fe and College publicity men and representatives of several newspapers and farm publications.

Crowds of 200 or fewer were handled in the train cars; overflows were taken into the depot waiting room to hear the lectures and see the demonstrations. When the train could not stop at a town, a lecturer was dropped off the train or went to the town in advance, and a meeting was held in the depot or other location. The talks were uniform and well coordinated. Each stop lasted about 40 minutes. Specimens, charts, and illustrated literature were used.

Total attendance was 7,000. All reports indicate it was a well prepared, effective venture (see Dean, 1916).

Other Wheat Insects

Headlee (1908) published on the **greater strawworm**.

R. V. Connin (USDA) did some of the early work in attempting to identify the **vector of wheat streak mosaic**.

Burkhardt (1955) reported preliminary studies on **white grubs** in wheat and later (1959) on the effects of Thimet and various stickers on germination and seedling growth of wheat.

DePew (1957, 1970, 1975, 1982) published on **pale western cutworm**. Early research on chemical control was in collaboration with T. L. Harvey. Later investigations by DePew established economic threshold levels in addition to evaluating less persistent and safer insecticides for pale western cutworm control.

DePew collaborated with C. F. Henderson (USDA) in the mid 1950s on the biology and control of **brown wheat mite** on winter wheat. As a result of this and earlier investigations by Henderson and E. W. Tilton, the life cycle of the brown wheat mite was resolved. In 1960, he reported on the control of O. pratensis, **Banks grass mite**, attacking winter wheat; in 1962, on **brown wheat mite** and its control by systemic insecticides; controlling greenbugs on spring barley (1964), and on army cutworm (1964).

H. W. Somsen did substantial studies on resistance of wheats to the **wheat curl mite** but these results were not published through the Agricultural Experiment Station. H. L. Hackerott, Harvey, and Ross (1975) reported on resistance to **wheat curl mite** in rye and wheat-rye additional lines.

T. J. Martin, Harvey, and R. W. Livers reported on resistance to **wheat-streak mosaic** virus with systemic insecticides (1976).

In 1980, Harvey and Martin reported on the effects of wheat pubescence on **wheat curl mite** and incidence of wheat-streak mosaic. Research had been conducted on the locations of the mite on the wheat plant (1954, Kantack and Knutson). Attempts were made (1958) to prevent inoculation of wheat-streak mosaic by the mite by use of certain systemic seed treatments. Although all mites were killed rather rapidly with some systemics, transmission was not prevented, apparently because the mites inoculated the plant before they died. Registration of wheat germ plasm resistant to wheat curl mite was published by Martin, Harvey, C. G. Pender, D. L. Seifers, and Hatchett (1983). Control of wheat-streak mosaic virus by vector-resistance in wheat was reported in 1984 by Martin, Harvey, and Bender. In 1988, Harvey and Martin worked out a method to measure cultivar effect on populations of wheat curl mite in wheat spikes.

Martin and Harvey (1981) reported on yield loss and cultivar response by the **wheat strawworm**.

Martin, Harvey, and Hatchett (1982) published registration of **greenbug**- and **Hessian fly**-resistant wheat germ plasms. Registration of Arkan wheat followed in 1983, by Martin, W. W. Bockus, L. E. Browder, K. F. Finney, Hatchett, and D. L. Wetzel.

A paper on disease and insect resistance in wild wheats was presented at the Sixth International Wheat Symposium in Kyoto, Japan by B. S. Gill, L. C. Browder, Hatchett, Harvey, Martin, W. J. Raupp, H. C. Sharma, and J. G. Waines.

In 1988, research was published on investigations of a new pest in Kansas, the **Russian wheat aphid**. Harvey and Martin compared its cold tolerance to that of greenbug biotype-E. DePew, Sloderbeck, and Harvey conducted field evaluations of insecticides to control RWA.

INSECTS AND MITES OF CORN

Corn insect problems in Kansas have increased progressively with the increase in acreage brought about by irrigation in northern, central, and western Kansas. The western rootworm has moved eastward, encouraged by continued yearly corn cropping. The European corn borer entered Kansas from the east during WW II and rapidly spread across the State. Southwestern to southcentral Kansas underwent outbreaks of southwestern corn borer, first in sandy land and then in adjacent hard land. The western bean cutworm invaded the western counties from Nebraska. Banks grass mite and other mites became destructive especially in southwestern Kansas. Fall armyworms are destructive with late-planted corn. The corn leaf aphid is considerably more common on sorghum. Painter was among those early contributors to the awareness and peculiarities of biotypes, particularly the four biotypes of the corn leaf aphid. Greenbug and grasshoppers are discussed separately below.

Early Work

Headlee published on the corn earworm in 1910, as did Painter in 1939. McColloch reported on dust sprays for corn earworm (1913) and oviposition (1920).

McColloch, with Dean, prepared a bulletin on corn insects in 1921, and McColloch published on corn leaf aphid in 1921.

Hayes wrote on the maize billbug in 1916 and 1920.

Corn Borers

Bryson and Wilbur (1942) wrote on the southwestern corn borer, as did Wilbur, Bryson, and Painter in 1943. Wilbur and Bryson published on the borer in 1950. Burkhardt (1954) studied the weight differences in the borer when raised on corn vs. teosinte. I published a bulletin in 1975 summarizing what was known to date in Kansas, and Stone (1977) prepared a bibliography on the borer. Poston and Welch (1978) wrote on managing the borer in populations in irrigated Kansas corn. Poston (1979) studied the substrate characteristics in relation to oviposition by the borer and (1977) the value of light traps in surveying for the borer.

Other southwestern corn borer studies included a thermal unit accumulation system by R. J. Whitworth and Poston (1979); managing populations in irrigated Kansas corn by Poston, G. R. TenEyck, D. E. Wassom, and Welch (1978); effects of substrate characteristics on the ovipositional behavior by Poston, Whitworth, J. Loera, and H. Stafford (1979); adjusting light-trap samples for age-class bias by John L. Schenck and Poston (1979); effects of corn maturity on oviposition and population age structure by Loera and Poston (1979); development as affected by diet of selected corn plant tissues by Loera, Poston, and Whitworth (1980); sampling populations after corn harvest by Poston, Welch, Whitworth, and Loera (1980); application of Bacillus thuringiensis through center-pivot irrigation systems for control of both the southwestern corn borer and the European corn borer by S. P. Nolting and Poston (1981); and quantification of feeding and its impact on corn yield by Whitworth, Poston, Welch, and D. D. Calvin (1981).

Calvin, M. C. Knapp, Welch, Poston, and Elzinga (1984) published on the impact of environmental factors on Trichogramma pretiosum wasps reared on borer eggs.

Buschman and coworkers (1985) studied chemigation as a means of controlling corn borers and compared it to standard insecticide applications.

Burkhardt (1950) studied populations of European corn borers in the field, and Wilde (1976) investigated the fate of borer larvae on cobs and detritus in stored grain, in relation to shipping to borer-free states. J. S. Pontius, Calvin, Welch, and Poston (1984) developed software for a model to manage ECB in yellow field corn.

Calvin, Poston, Welch, and others (1986), determined the rate of detrition of European corn borer egg masses in field corn and developed a model to optimize sampling of the egg masses. In 1988, they evaluated a management model for second generation ECB.

Several diets for rearing European corn borers were evaluated by Reese and coworkers (1986).

Painter (1968) wrote on damage among 87 lines of corn by larval feeding of the fall armyworm. Burkhardt (1953) published on feeding and pupation.

DePew reported on the earworm in field corn (1957) and sweet corn (1965).

Corn Rootworm

The only corn rootworm studied intensively in Kansas has been the western one. In 1954, Burkhardt published three papers on the larva and its control and in 1955, described its distribution. In 1961 and 1962, he again published on control and in 1961, on rootworm survey methods. In 1963, he reported on rating levels of damage to corn roots. In 1971, Wilde wrote on adult feeding response to silks of 15 genetic sources of corn and temperature effects on development of eggs and in 1978, on control of corn rootworms in Kansas.

Mites and Others

L. L. Buschman and P. E. Sloderbeck (1982) published on effects of pyrethroids and miticides on spider mite, southwestern corn borer, and predator populations and on miticide efficacy tests. The efficacy of miticides against corn spider mites was updated by these authors in 1986.

Several areas of investigation on Banks grass mite were initiated by J. D. Stone, including work in chemical control, biological control, and delineation of mite-population/yield relationships.

In 1986, Reese and Field discussed defense against insect attacks in susceptible plants, using black cutworm on corn as an example.

D. C. Margolies (1987) published on conditions eliciting aerial dispersion behavior in Banks grass mite. In 1988, Margolies and G. G. Kennedy reported on a fenvalerate-induced, aerial dispersal of the twospotted spider mite.

In 1987 and 1988, Buschman and others did a series of efficacy tests of miticides for corn spider mites. They also documented a seasonal shift in species of spider mites on corn in the western Great Plains.

INSECTS OF SORGHUM

Sorghum is highly adapted to hot, dry weather. In many respects, it is less damaged by insects than corn (attacks by grasshoppers, corn earworm), but the invasion of Biotype B and other biotypes of the greenbug has resulted in major damage to sorghum. The corn leaf aphid occurs in large quantities on sorghum, but rarely produces measurable damage. Greenbug is discussed later under multiple-crop feeding insects.

Ants

Thief ant was reported on by McColloch and Hayes (1916, 1920). Burkhardt compared yields of sorghum when ants were controlled (1959).

Aphids

Painter published on biotypes of corn leaf aphid and resistance of sorghums to them (1956). In 1958, he compared four biotypes of the aphid and then in 1959, discussed distribution and honeydew deposition (including that of the spotted alfalfa aphid). Wilde (1973) studied a parasite of the aphid and parasitism of the convergent lady beetle by a braconid. In 1976, with C. Ohiaga, he wrote on the relationship of the aphid and sorghum yield.

Earworm

Wilbur and Parker (1951) published on corn earworm on grain sorghum. Painter (1957) studied attacks on sorghum heads. Burkhardt evaluated chemical control (1955, 1957), provided notes on earworm behavior (1957), and summarized damage and loss in 1962.

Other Insects

DePew published on the effects of three insecticides on grain sorghum emergence (1970). C. A. Thompson and Harvey reported on effects of disulfoton on grain sorghum production (1980).

Breeding for resistance to greenbug, chinch bug, and dwarf mosaic in sorghum was published by Hatchett, Martin, and Harvey (1984).

Registration of RP1R and RP2B sorghum germ plasms was published by W. M. Ross, S. D. Kinder, Harvey, A. Sotomayer, O. J. Webster, and K. D. Kofoid (1977).

INSECTS OF ALFALFA

Alfalfa is subject to more species of insect attacks than any other major crop, except corn. Invasion of the spotted alfalfa aphid in 1954 and the eastern strain of the alfalfa weevil in 1967 greatly accelerated damage to alfalfa.

Popenoe (1916) prepared a bulletin on insects injurious to alfalfas. Dean and Smith (1936) published on the same subject.

Pea Aphid

Painter and C. O. Granfield (1938) reported on resistance of alfalfa varieties to the pea aphid, and Painter (1939) published on reproduction on different alfalfa plants. W. W. Franklin (1955) produced a general publication on the aphid and on insects and alfalfa seed production. Harvey (1960) reported on selection and evaluation of pea aphid resistant plants.

Hackerott, E. L. Sorensen, Harvey, E. E. Ortman, and Painter (1963) reported on the reaction of alfalfa varieties in the field and greenhouse.

Painter, Sorensen, Harvey, and Hackerott (1964) published on combined resistance of alfalfa to the pea aphid and the spotted alfalfa aphid. Harvey, Hackerott, and Sorensen (1970) reported on comparative injury to resistant and susceptible field alfalfas to the pea aphid.

Harvey, Hackerott, and Sorensen (1972) published on pea aphid resistant alfalfa selected in the field.

Spotted Alfalfa Aphid

This aphid entered Kansas in 1954 and rapidly spread northeastward from the southwestern states. In 1955 it occurred in the remainder of Kansas and several states to the north and east. It did eight million dollars damage in 1956 in Kansas. Some early publications identified the species as the yellow clover aphid, Therioaphis trifolii (Morell) but later it was found to be SSA Therioaphis maculatus (Buckton), probably introduced from the Mediterranean region or India. Damage was so severe that alfalfa dehydrators considered closing their plants, and agronomists and animal scientists asked if they should drop alfalfa from their feeding trials.

Entomologist Harvey and H. L. Hackerott (plant breeder), both of the Fort Hays Branch Station, and Painter and Sorensen (plant breeder) at Manhattan, initiated studies on developing varieties resistant to SAA (1956). They started by selecting apparently naturally resistant plants in the field. "Cody" alfalfa (resistant to SAA) and later "Kanza" (resistant to both this aphid and the pea aphid) were developed in record time.

In 1956, Harvey and Hackerott published on resistance to SAA selected from seedlings of susceptible alfalfa varieties.

In 1957, Burkhardt published on insecticide control, and in 1959 on the effects of malathion and parathion on ejection of young by gravid adult SAA, the effect of heavy, fall infestation on subsequent spring growth, seed treatment with systemic insecticides, and a chalcid parasitizing SAA (and greenbugs), and in 1960, a biological evaluation of certain predators and a three-year overwintering study.

In 1958, Painter reported on varietal differences in survival of alfalfa seedlings exposed to SAA and on effects of grafting resistant and susceptible alfalfa clones.

In 1960, Harvey and several coworkers reported on development and performance of the resistant Cody alfalfa.

DePew and others conducted insecticide tests (1961) until special varieties that effectively suppressed SAA were developed.

S. Ferguson, E. L. Sorensen, and Horber (1982) wrote on resistance to SAA in glandular-haired Medicago.

Alfalfa Weevil

The western strain of the alfalfa weevil (AW) was first found in Kansas in 1960 and had spread to 40 western counties by 1969. Little damage was recorded by the western strain in western Kansas, where there was relatively little alfalfa. The eastern strain was first observed in Maryland in 1951 and was first recorded in Cherokee County in extreme southeast Kansas in 1967. It rapidly spread westward and northward, so that severe damage occurred in most alfalfa fields in eastern Kansas during 1972. It is not known if this damage was done solely by the eastern strain or by a strain with hybrid vigor produced when the two strains met.

Eshbaugh and Sorensen (1974-1976) provided a leaflet on AW and its control. In 1974, these two authors and O. J. Dickerson reported on effects of insecticides and nema-

tocides on alfalfa-stem weevil. Eshbaugh and Sorensen (1977) published on insecticide tests against the weevil, as DePew had in 1969. In 1985, DePew and Sloderbeck published a summary of chemical control of the alfalfa weevil.

In 1979, K. J. R. Johnson, Sorensen, and Horber published on resistance to diploid and tetraploid, annual Medicago species to leaf feeding adult AW and on resistance of glandular-haired Medicago species to feeding of adults. In 1980, they reported on resistance of glandular-haired species to oviposition, on behavior of adults on resistant and susceptible Medicago species in free-choice tests, and effects of temperature on resistance of glandular-haired species to AW larvae. Also in 1980, R. B. Othman, Sorensen, G. H. Liang, and Horber published on density and distribution of erect hairs on annual Medicago species.

Wilde (1972) reported on a study of AW parasites and in 1975, on feeding behavior, damage, and control of adult AW.

K. Currey, C. E. Meloan, and K. Johnson (1983) published on diapause of AW, using the IGRs, Altozar and Altosid.

R. Chiou, Meloan, and Horber (1983) published on the presence of a chemical oviposition depressant. Two olfactory stimulants in alfalfa were described by Currey, Meloan, and Horber (1983). The next year, G. Mohan, Meloan, and Horber identified an ovipositional stimulant in alfalfa and reported on olfactory attractants to the weevil.

DePew (1967) conducted field evaluations of insecticides to control alfalfa weevil larvae.

Potato Leafhopper

The following summary for potato leafhopper was furnished by Horber. Screening for resistance is conducted in the laboratory, greenhouse, and nurseries at the Rocky Ford and Ashland fields. A student, Mitchell Roof, developed a bioassay technique to test the biological activity of fractions of saponins obtained from susceptible and resistant alfalfa cultivars against pea aphid and potato leafhopper. Medicagenic acid was implicated as the most active moiety of the alfalfa saponins.

Painter (1961) studied effects of feeding of potato leafhopper on seedlings of various alfalfas.

Horber (1974) reported on selecting alfalfa seedlings to resist the leafhopper. Antixenosis and antibiosis to potato leafhopper in Medicago were described by Brewer, Horber, and Sorensen (1985). In 1986, Horber, Brewer, and agronomists studied the relationship of stem anatomy to resistance to the potato leafhopper.

Seed Chalcid

The effect of simple and glandular trichomes in Medicago species on the alfalfa seed chalcid was investigated by G. J. Brewer, who also studied the attractiveness of seedpods to chalcids in relation to oviposition preference during seed maturation.

Effects of trichomes on field resistance of Medicago species to the seed chalcid were reported in 1982 by Sorensen and Brewer. In 1983, they continued studies of the role of trichomes in resistance to the chalcid.

Also in 1983, Brewer, Sorensen, and Horber reported on the attractiveness of glandular- and simple-haired Medicago clones with different degrees of resistance to the chalcid tested in an olfactometer. They also published other laboratory techniques to evaluate resistance of alfalfa clones to the chalcid.

In 1984, Brewer and Horber reported on field infestation and chalcid development in different Medicago clones. With Sorensen, they published on trials in annual Medicago.

Also in 1984, Sorensen, Horber, and D. L. Stuteville reported to the 18th Alfalfa Improvement Conference on the development of glandular-haired alfalfas with multiple pest resistance.

Miscellaneous Insects and Other Legumes

Popenoe (1901) reported on clover hay worm.

McColloch in 1916 published on the clover leaf weevil.

Smith (1923) reported on forage looper.

Painter (1967) screened alfalfa seedlings to detect resistance to lygus bugs.

Horber (1970) published the present status of the blue alfalfa aphid and research in the Central States.

Pollination

Painter, Sorensen, and Kauffeld published on performance of two races of honey bees in pollinating several alfalfa clones.

The imported leafcutter bee, Megachile rotundata, has been studied by Horber since 1971, to pollinate isolation plots for increased seed production of early generation alfalfa synthetics. The suitability of different bee boards and shelters was studied under South Central Kansas conditions. Rearing and overwintering of the bumblebee, Bombus pennsylvanicus, in the laboratory was attempted, and its usefulness for pollination of alfalfa was observed in cages and under greenhouse conditions.

Development and Release of Alfalfa with Multiple Resistance

In cooperation with Sorensen (Agronomy and USDA-ARS) and D. L. Stuteville (Plant Pathology), Horber developed and released the following germ plasms and cultivars with multiple resistance:

KS76 was released in 1977, with resistance to bacterial leaf spot, bacterial wilt, downy mildew, anthracnose, summer blackstem, pea aphid, and spotted alfalfa aphid in one germ plasm pool.

KS77 also was released in 1977, with resistance to Phytophthora root rot, downy mildew, anthracnose, pea aphid, and spotted alfalfa aphid.

Riley, a new alfalfa cultivar released in 1978, has a high level of resistance to bacterial wilt, pea aphid, and spotted alfalfa aphid biotypes present in Kansas. riley exhibits moderate resistance to rust, downy mildew, and potato leafhopper. It also has shown resistance to anthracnose in field tests and to summer blackstem.

KS78-10 was released in 1980 with resistance to downy mildew, anthracnose, pea aphid, and spotted alfalfa aphid.

KS80, released in 1983, has resistance to the blue alfalfa aphid, the pea aphid, and spotted alfalfa aphid. This is the first germ plasm in the Midwest to provide resistance to all these aphids. It also is resistant to anthracnose and downy mildew.

KS-145 was released in 1983, with resistance to anthracnose, bacterial wilt, downy mildew, Fusarium wilt, root rot, pea aphid, and spotted alfalfa aphid.

KS-185 with resistance to five diseases and two insects was registered in 1985. KS108GH5, a glandular-haired alfalfa with multiple pest resistance, also was registered (1985).

KS-189 was released in 1986, with resistance to five diseases and three insects.

In 1988, Horber, Sorensen, and Byers wrote a review of breeding for insect resistance for a book on *Alfalfa and Alfalfa Improvement*.

INSECTS OF FRUITS, VEGETABLES, AND ORNAMENTAL PLANTS

Many of the early publications occurred as a result of the settlers' needs to propagate trees as windbreaks, as well as great need for families to grow their own fruits and vegetables. Research was demanded because plants brought from the East often were not adapted to the prairie environment, and there were some new insect pests not previously known to the settlers.

E. A. Popenoe's publications from 1877 to 1906 included crown gall, San Jose scale, fall webworms, plum and apple curculios, apple twig borer, cottonwood, flat headed and other wood borers, buffalo treehopper, pear blight and spraying, scale insects, canker worms, cedar bark beetle and other cedar insects, and spray schedules in general on apple and other trees.

C. L. Marlatt published on the raspberry saw fly, a general booklet on forest tree insects, and apple tree spraying, 1887-1888.

J. S. Whitman reported on tent caterpillar, Colorado potato beetle, and apple tree spraying, 1875-1888.

P. S. Parrott (1897-1900) published on the elm twig girdler, fringe apple bud moth, fruit tree bark beetle, scale insects, potato stalk weevil, spring canker worm, scale insects of Kansas grasses, and fruit tree bark beetle.

E. E. Faville reported on orchard mites in 1898 and on potato stalk borer in 1899.

J. H. Merrill published between 1916 and 1918 on San Jose scale, fruit tree spraying, and insects of garden crops.

G. A. Dean published on San Jose scale (1909-1910), bagworm and fruit insects (1913), spring canker worm and garden webworm (1915), insects of radishes (1915), codling moth (1919), insects of shade trees and ornamentals (1920-1922), house plants and flower gardens (1922), nursery stock insects (1926), mites on fruits (1928), of small fruits (1929), flowers and ornamental shrubs (1932), red spider and European red mites (1932-1936), strawberry insects (1933), codling moth (1936), insects of shade trees (1937), peach tree borer (1940), three red scale insects (1943), elm calligrapha (1946), and codling moth (1946).

T. J. Headlee published on orchard spraying (1911).

L. M. Peairs reported on codling moth (1912), fruit insects (1913), and San Jose scale (1916).

R. C. Smith published on strawberry leaf roller and improved codling moth spraying (1939), sweet potato weevil (1950), and hackberry psyllid (1953).

R. L. Parker and Paul G. Lamerson published on codling moth and various trappings and sprays in addition to lead arsenate from 1932-1950. In 1959, Parker published on the moth's behavior as related to wind, temperature, and light. Parker's studies also included the carrot root weevil, strawberry rootworm and other strawberry insects, twospotted mite on bush beans, redbanded leafroller, red spider mite, redbud leafroller, juniper midge, apple curculio and other apple pests. Parker's activities shifted to apiculture later on.

E. L. Eshbaugh, at the Northeast Experimental Field near Wathena from 1946-1966, studied particularly insects attacking apples and strawberries. He published (1947) on codling moth and red spider mites, twospotted spider mite, and redbanded leafroller (1948), and further on the codling moth (1950)

In 1966, Painter and C. V. Hall published on breeding resistance to insects affecting vegetable crops.

Woodrow W. Franklin and Smith published on garden webworm in 1957.

J. C. Boling served as fruit and vegetable insect specialist from 1970 to 1972. He conducted research pertaining to fruit and vegetable pests in Sedgwick and Riley Counties. Fruit studies included chemical control of codling moth on apple, peach tree borer on peaches, and mites on apples and cherries, and chemical control of cabbage looper. In 1972, he reported on insecticidal control of cabbage looper in small field plots.

H. E. Thompson came here in 1956. His initial thrust was against Dutch elm disease, which was approaching Kansas, and its bark beetle vectors. He did many of his studies in recently infested counties, and there was great demand and appreciation by the municipalities for his surveys, combining extension and research. Thompson and coworkers published on Dutch elm disease (1959); insect pests of shade tree and ornamentals in the midwest (1960); status of Dutch elm disease in Kansas (1962); effect of delayed spraying on cankerworm control (1962); indopol polybutenes control of twospotted mites on euonymus in greenhouse (1962); Dutch elm disease in Kansas (1962); control of hackberry nipplegall maker with new organic insecticides (1962); European elm scale control (1962); some important pests of shade trees and ornamentals in Kansas (1964); controlling elm leaf beetle (1963); controlling European elm scale (1963); systemic insecticides on woody plants: present and future practical applications (1965); late season control of European elm

scale with Bidrin trunk injections (1967); parasites, predators, and other arthropods associated with Choristoneura houstonana on red cedar (1967); external morphology of larvae of C. houstonana (1970); Dutch elm disease and its control in Kansas (1970); mating behavior of the buffalo webworm (1970); biology and control of Nantucket pine tip moth in Kansas (1970); buffalograss webworm attraction to light traps and flight behavior (1976); Colcomegilla maculata (DeGeer), a coccinelid predator of the eggs and larvae of the elm leaf beetle (1976); oviposition site characteristics of the elm leaf beetle (1976); sexing the elm leaf beetle (1976); life history of the buffalo webworm in Kansas (1979); testing ponderosa pine for resistance to pine tip moth (1978); and control of pine tip moth by using sustained release systemic insecticides (1978).

Much of the work on buffalograss webworm by Thompson was done with K. A. Sorensen, that on C. maculata with R. D. Weber and M. V. Holman, and that on C. houstonana with E. A. Heinrichs.

J. R. Nechols came in 1984 as both extension specialist and researcher on biological control and horticultural entomology. In 1987, Nechols published in voltinism, seasonal reproduction, and diapause in the squash bug. In 1988, he investigated the photoperiodic responses of the squash bug, particularly induction and maintenance of diapause.

INSECTS OF SOYBEANS

Soybeans are grown primarily in the east-central portion of the state. The Mexican bean beetle, the bean leaf beetle, the clover leaf worm, and other pests are present but major damage has been reported in Kansas only by stinkbugs. Stinkbugs pierce the pod and feed on the maturing bean, causing deterioration of the bean, which shows up after storage.

R. G. Clark and Wilde (1969, 1970) published on the green stinkbug and the yeastspot disease organism: length of retention, effect of molting, isolation. from feces and saliva, frequency of transmission to the bean, transmission from insect to insect, and isolation from field populations.

INSECTS OF SUNFLOWERS

This cultivated crop is minor in Kansas, perhaps because of the relatively large numbers of insects that attack it.

DePew (1967) conducted field studies on control of Lygus bugs and thrips. In 1978, research was initiated on head moth, a serious pest. Insecticides and synthetic pyrethroids and carbamates looked promising. Studies to determine the effect of planting dates on infestations by sunflower head moth have been conducted by DePew in collaboration with M. D. Witt. DePew (1983) published on oviposition and chemical control of the larvae. Chemical control of this moth was updated by DePew in 1985 and 1986.

Gershenzar, Hopkins, and others contributed a book chapter (1985) on antifeedant terpenoids in wild sunflowers as a possible source of resistance to sunflower moth.

In 1986, DePew identified several noncultivated plant species that harbor the sunflower moth in Kansas. In 1988, he published further studies of selected insecticides to suppress sunflower moths.

INSECTS OF RANGELAND AND GRASSLAND

Although most of the studies on grasshoppers have been on grassland and rangeland, grasshoppers are discussed as a separate topic below (multiple-feeding insects) because of their wide range of economic host plants.

Dean (1904) reported on studies of the mound-building prairie ant.

In 1939, Wilbur described an emergence cage to trap insects. In 1940, he published on grasshopper populations in bluestem pastures. Strip-cropping and its effect on grasshopper problems was published with Painter and R. F. Fritz (1941). In 1944, Wilbur published on insects of grasslands with H. H. Walkden (USDA).

Several graduate students published, under Wilbur's guidance, on insects of individual plant species, such as smartweed and ironweed.

Wilbur (1954) studied *Endira inimica*, the most common leafhopper.

Blocker and Harvey (1971) published on leafhoppers of an upland reseeded pasture near Hays, Kansas. In 1973, Blocker and students studied a stabilized drop trap for unit area sampling of insects on short vegetation, a review and a look at the future (1973), snout beetles from different grassland treatments (1975), leafhopper populations of a tallgrass prairie: collecting procedures and population estimates (1976), the impact of invertebrates as herbivores on arid and semi-arid rangeland in the U.S. (1977), and with Bertwell (1975), beetles from differently managed tallgrass prairies.

Hopkins and collaborators (1985) studied olfaction and food plant selection by the black field cricket.

MULTIPLE-CROP FEEDING INSECTS

Grasshoppers

They are among the most destructive insect pests in Kansas, on grassland and rangeland as well as crops. The Rocky Mountain grasshopper, Melanoplus spretus, now extinct, periodically destroyed plants of much of the Great Plains, including Kansas, from 1846 through 1877, with the worst damage in 1864 and 1874. Many articles appeared in the *Kansas Industrialist*, the College paper, between 1875 and 1877.

In a newspaper clipping, apparently from the *Kansas City Star* or *Times* but trimmed so that there is no name or date, there is an article by Charles Arthur Hawley entitled, "Stricken Kansas Farmers Were Aided in 1890's by the Mother of Harry K. Thaw." I quote, "Among the documents he (Washington Irving) found the first description ever recorded by white men of the visitation of grasshoppers which destroyed all before them. This first description of a grasshopper plague was written in 1820."

In 1874, a Kansas farmer thus described a plague of grasshoppers:

> "There was not a hint of a cloud in the sky that day until along about 4:00 o'clock in the afternoon. Then the sky suddenly became hazy and speedily darkened, until in a matter of a few minutes, it was so dark that it not only frightened me but did something to the chickens. . They hastened to their roosts as fast as they could. Then with a whizzing, whirring sound the grasshoppers came from the northwest and in unbelievable numbers. They lit on everything. I was covered from head to foot. When they hit my face and hands, the impact was like missiles, and at once the insects began to eat. The ground was covered, in some spots to a depth of three or four inches, and trees along the creek were so loaded that large limbs were broken off. The insects fell into the creek and drowned in such numbers that they formed a dam and the water turned brown and our cattle and horses would not drink it. Even fish died in the foul water . . . We had about fifteen acres of corn which old settlers said would make fifty bushels an acre. The hoppers landed about 4:00 o'clock. By dark there wasn't a stalk of that field of corn over a foot high left in the entire field."

Hamlin Garland, who knew the dreary life of the farmer of 'the great American desert', wrote all his life of the hardships that farmers and their families endured. Garland's 'Main-Traveled Roads' gives these pictures in stark realism. The picture of utter desolation that came upon the Haskins family because of the grasshopper plague that drove them out of Kansas is unforgettable. The family came at the end of a cold snowy day seeking shelter of another farmer. "They are leaving Kansas since they've been ate up and drove out by grasshoppers."

"Explorers declared they had seen grasshoppers flying above the top of Pike's Peak, which towers 14,110 feet above sea level. Entomologists and biologists substantiated these reports by describing the biological structure of the pests, pointing out that they have air sacks distributed through their bodies that sustain their flights at high altitudes."

> "With the advent of steam driven locomotives the difficulties increased. Often the hoppers so covered the tracks that trains were delayed until the hoppers could be removed. Sometimes the trains were canceled until the pests had disappeared."

The Rocky Mountain Locust (grasshopper) Commission, of which C. V. Riley was a member, after studying grasshoppers in the 1870's, concluded that there would be fewer problems as more of the land was tilled.

The plow was probably responsible for reduction, but not the extinction, of the Rocky Mountain grasshopper. Conversely, a few other species of grasshoppers profited by cultivation, being able to thrive on wheat, alfalfa, corn, and certain introduced grasses.

Popenoe (1891) reported on an outbreak of *Dissosteira longipennis*, a close relative of *D. carolina*, but larger and limited to the western two-thirds of the state.

Several major outbreaks occurred in 1913 and 1918. The peak of the outbreaks during the dry and hot 1930s was probably in 1937, when 26,822,000 pounds of wet poisoned bait were spread over Kansas, involving 75,000 farmers. Major species destructive to crops included *Melanoplus sanguinipes*, the migratory grasshopper, and *M. differentalis*, the differential grasshopper.

A moderate outbreak occurred in southeastern Kansas in 1953 and moved slowly westward, taking several years to reach the western border. Roger C. Smith, a member of the KSU faculty from 1920 to 1958, summarized grasshopper populations in Kansas during 1854-1954 (see bibliography).

Paris green, one of the first insecticides used in the U.S., was introduced to Kansas in 1860-1870 (Whitman, 1870). By 1868, the usefulness of Paris green was well known. Popenoe (1877-1891, 1904, 1905) published on its effectiveness against grasshoppers. In 1905, the first account of insecticidal grasshopper control in Kansas recommended Paris green bait with sugar and saltpeter.

The first, organized, area control program for grasshoppers occurred in Kansas in 1912. County agents supervised the mixing of the bait, consisting of bran (a filler or holder), white arsenic or Paris green (the poison), molasses and ground oranges to attract the grasshoppers, and water. The Department of Entomology had a major part in developing this nationally known "Kansas Bait" for grasshopper control.

This bait was broadcast in the mornings when the grasshoppers were beginning to move. Dean described how county-wide control campaigns were conducted with good results. In 1913, for example, 4,500 Kansas farmers in 12 counties cooperated in a highly successful control program.

Hunter and Claassen (1914), of the Department of Entomology at the University of Kansas, reported perhaps greater grasshopper control activities, mostly in the southern half of Kansas, and published six articles on grasshoppers. Results of tests and experiments with varied formulas were reported. Photographs accompanying the

articles included one of the hopper dozer in action. The authors stated they had had requests for information about grasshopper control since 1872.

Wilbur described the damage of feeding on the inflorescence of grass (1936), an outbreak of the thistle grasshopper in certain western Kansas areas (1940), and populations in strip cropping of wheat in western Kansas.

Grasshoppers, particularly on grassland and rangeland, were the principal subject of my studies (1972, 1974, 1976, 1977, 1978, and 1979). W. H. Arnett (1972, 1974) recorded the seasonal occurrences of instars and adults of 34 species in rangeland near Manhattan. M. A. Brunsen (1967) recorded the distinguishing characteristics, ecology, and distribution of the various nymphal stages of 23 species of the slantfaced grasshopper of Kansas. I-Wu Chu (1970) determined the feeding preferences of several species of grasshoppers among eight cultivated grasses. J. D. Lambley (1972, 1972, 1974) and J. B. Campbell (1972, 1974, 1976) established the host plant preferences of grasshoppers in six planted pastures. Campbell, Lambley, and O. K. Jantz determined the species of plants ingested by some 40 species of grasshoppers in the Manhattan vicinity, by dissecting the grasshoppers' crops and identifying the plant fragments. Campbell also determined the relationships of grasshoppers to burning, grazing, and range sites (soil types) of the native tallgrass prairie near Manhattan. A. J. Bajoi (1977) reared three species of grasshoppers on each of several host plants common in the grasshoppers' habitats, to determine survival rate when restricted to a single host plant species. I. Javadi (1979) simultaneously exposed second and third instars of five species of grasshoppers to each of three pyrethroid insecticides, using both field plots and glass containers in the laboratory. Mortalities in the field plots and in the glass containers were close. Mortalities among the species often varied greatly for a given insecticide.

Approved and candidate insecticides for grasshopper control have been evaluated in the field for several years.

Harvey and Hackerott (1976) studied grasshopper-resistant alfalfas selected in the field.

Mock and DePew (1979) reported on the grasshoppers on wheat field borders before planting winter wheat. Mock, Johnson, and DePew (1981) studied control of wheat field borders before planting winter wheat.

Studies were started about 1977 on the grasshopper, *Hypochlora alba*, which survives only on Louisiana sagewort in the Manhattan area of grassland-rangeland. Conversely, none of the some 50 species of grasshoppers can survive on this plant. Pubescence is one factor and probably to a lesser degree the various phytochemicals. Coworkers included S. G. F. Smith, T. L. Hopkins, M. H. Blust, and G. L. Kreitner. In 1981, Smith and Kreitner reported on nonglandular trichomes in *Artemisia ludoviciana* and their ingestion by a monophagous grasshopper, *H. alba*.

Knutson (1981) published on development and survival of this grasshopper, polyphagous grasshoppers, and the 2-striped and lesser migratory grasshoppers of *Artemisia*.

Smith and Grodowitz (1983) reported on the effects of trichomes of *A. ludoviciana* on ingestion, assimilation, and growth of *H. alba* and *M. sanguinipes*.

In 1983, Knutson published a bulletin with pictorial keys and colored photographs of the economic species of grasshopper, plus the noneconomic species that feed largely on weeds but look similar to economic species and those that are so striking in appearance and so plentiful that spraying might occur unless they are identified as weed feeders.

Chinch Bug

This insect overwinters in bunch grass, migrates to small grains, and then to young sorghum or corn plants when the grain ripens. It was early demonstrated that scattering diseased chinch bugs to spread a fungus was not effective. this fungus occurs naturally all over the state and propagates to an extent to be effective only in periods of two weeks or more of cool, damp weather.

The first barrier used was a dust furrow, to stop summer migration of the flightless chinch bug nymphs from maturing wheat and oats to corn or sorghum. A special drag made two dust furrows with a ridge between them. These furrows were made on the wheat or oats side of adjacent corn or sorghum fields. They were satisfactory in dry years, but were not when rains occurred during bug migration. In some instances, a gasoline torch was used on the bugs, including those attempting to climb the side of the ridge.

In 1924, a new type of chinch bug barrier was used, consisting of a line of oil-creosote with postholes in the ditch every rod to trap the bugs. It became known as the "creosote posthole barrier." The chemical barrier consisted of about nine parts of "road oil" to one part of creosote, and it became the standard protective barrier throughout the Midwest for many years.

The creosote posthole barrier was later replaced, in part, by a thin line of a yellowish, sticky powder: dinitroorthocresol. The migrating chinch bugs were killed upon contact with this dust.

Sprays and dusts applied in the already infested field did not prove very satisfactory in Kansas until the new chlorinated insecticides appeared. Chlordane, benzene hexachloride, and toxaphene sprays were highly effective when the bugs were clustered on corn and sorghum plants. They were also effective when sprayed as a barrier between ripening wheat or oats and corn or sorghum.

Now that the persistent insecticides are banned, less persistent types are being sprayed directly onto plants. They are more effective when applied as drops from a sprayer wand, which hit the lower leaf sheaths where most of the bugs are concentrated.

Chinch bug resistance by sorghum was developed by Painter and plant breeders and the first publication appeared in 1935. An atlas of forage sorghum resistance was one major accomplishment.

Many of the earlier papers on chinch bugs are listed below.

Popenoe (1882) published a general account of the bug.

Headlee wrote bulletins in 1908, 1910, 1911, and 1913 as knowledge increased. McColloch (1913, 1914) published on the bug and its hibernation and in 1916 on egg parasites. Hayes, with C. O. Johnson, published on the responses of certain grasses to attack. Hayes (1924) also published on barriers.

Painter (1928) described injury to the plants caused by feeding and in 1931 wrote on plant resistance by sorghums (with Snelling and Parker). Painter and Bryson studied hybrid vigor and adaptation in relation to bug resistance (1935).

Wilde (1978) published on insecticide control, economic levels, and plant resistance. In 1980 he wrote on effects of host plant and photoperiod and insecticidal control (also greenbug) on seedling sorghum with seed, planting time, and foliar treatments. In 1982, he published on chinch bug resistance in commercial grain and forage sorghum hybrids and on insecticides applied at planting time or as foliar sprays for control on grain sorghum.

Wilde, T. W. Mize, J. J. Stuart, and R. J. Whitworth (1984) published on comparison of planting time applications of granular or liquid fertilizer-insecticide combinations for control of chinch bugs and greenbugs on seedling sorghum.

Wilde and Mize (1984) published on enhanced microbial degradation of pesticides in soil and its effect on chinch bug and greenbug control in seedling sorghum.

Wilde, Kadoum, and Mize (1984) published on absence of synergism with insecticide combinations used on chinch bug.

Reproduction, development, and feeding preference of chinch bug on various wheat cultivars were studied by Stuart, Wilde, and Hatchett (1984). In 1986, this group investigated reproduction of the chinch bug on selected small grains and genetic sources.

In 1986, Mize and Wilde described new sources in grain sorghum of antibiosis to the chinch bug and discussed reproduction of the insect on these resistant sources.

Greenbug

This aphid was first reported in the U.S. in Virginia in 1882 and was first reported in outbreak numbers on wheat in Kansas in 1907. To a lesser extent, it was also a pest of oats and barley. Periodic, local outbreaks occurred with colonies sometimes overwintering on winter wheat in southern Kansas. The outbreaks were during the early, cold spring before the predators and parasites could warm up, and when it was often too cold for insecticides to be effective.

Many greenbugs were carried by the wind not only over Kansas but several states to the north and east. Prior to 1957, only one biotype was known, subsequently called Biotype A. Biotype A may have been preceded by others but no attempt was made to separate biotypes until after resistance was found in Dickinson selection 28-A wheat. In 1957, a strain in Oklahoma was described that destroyed resistant wheat cultivars, called Biotype B. Biotype B had generally replaced A by 1966, despite very similar reproductive and ecological patterns.

In 1968, large areas of sorghum, including Kansas, were attacked by what was later termed Biotype C. (W. P. Hayes in 1916 had reported greenbug on sorghum but did not consider it a major pest.) Biotype C infests and damages small grains as well as sorghum and is ecologically but not morphologically different from Biotypes A and B. It develops at much higher temperatures than A or B and hence attacks sorghum during the summer from seedling to boot stage and has largely replaced Biotype B in the Great Plains.

It was estimated that 1 ¼ million acres of sorghum were treated in Kansas during 1968 and 1969. The major insecticide used for Biotype A was parathion during 1948-1968. Then Disyston was widely used on both small grains and sorghums. In 1974, about six years after Biotype C appeared, Texas entomologists found a strain resistant to Disyston, which was designated Biotype D. The resistant aphid appeared in Kansas and several other states around 1975, probably brought up by southern wind currents.

L. Roy Taylor led the studies on aphid migrations between 1964 and 1965. He published with Ralph E. Berry (1968) on effects of temperature and light on dispersal in the field of pea aphid and a braconid parasite and of temperature on takeoff of greenbug and corn leaf aphid, factors affecting flight responses of high-altitude migration of aphids in maritime and continental climates, and with Lee Halgren (1968) on factors affecting postflight behavior of the bean aphid and the greenbug.

Harvey and J. A. Wilson reported on injury by the greenbug to resistant and susceptible winter wheat in the field. Harvey and Hackerott published in 1969 on greenbug resistance in sorghums. R. W. Livers and Harvey in 1969 reported on resistance in rye. In 1970, Hackerott and Harvey wrote on resistance to greenbug in three millet species, and Harvey and Hackerott published on chemical control on sorghum and effect on yield.

In 1971, Harvey and Hackerott reported further on injury to resistant and susceptible sorghum in the field and also wrote a general report on greenbugs and resistance in sorghums. In 1974, Harvey and Hackerott reported on the effects of the greenbug on resistant and susceptible sorghum seedlings in the field. In 1976, Hackerott and Harvey reported on progress in breeding resistant sorghums and evaluation of greenbug resistance and also registered a greenbug-resistant sorghum.

Wilde in 1979 wrote on resistance of sorghum seedlings to greenbug, and DePew (1979) discussed greenbug resistant grain sorghums and (1976) evaluated resistance in S_2 progenies of grain sorghum. In 1976, DePew published on greenbug resistance to grain sorghum. In 1977, T. L. Walter, Wilde, Hackerott, Harvey, J. Lawless, M. Witt, DePew, M. Lundquist, W. Moore, R. Sloan, R. Raney, K. Kelly, and G. A. Milliken reported on 1976 field tests with greenbug resistant sorghum. Harvey, T. J. Martin, and Livers reported on resistance to Biotype C in synthetic hexaploid wheats derived from *Triticum tauschii*. Harvey (1982) wrote on the dispersal of Biotype C.

Greenbug was the principal insect studied by DePew from 1975-89. The first large-scale marketing of grain sorghum hybrid seed resistant to Biotype C occurred in 1976. Research by DePew indicated that greenbug-resistant hybrids provided good, but not complete, protection and that insecticidal control is warranted when resistant hybrids are subjected to severe greenbug pressure (collaborators were M. D. Witt and T. L. Walter).

In 1979 Biotype E was discovered, which destroyed sorghum hybrids and wheat formerly resistant to Biotype C.

Harvey and plant breeders H. L. Hackerott and T. J. Martin have released the following greenbug-resistant breeding lines: Sorghum - KS30, 41, 42, 43, 44, 56, 57, 65, 66, KP6BR; Sudangrass - KS73-28; and Wheat - KS8H64OGB (C1 17959).

L. A. Halgren, working under and with Rettenmeyer, studied takeoff behavior, flight behavior, and postflight behavior (1968).

Wilde's initial work was on soybean insects, but subsequently was changed to pests of corn (mostly corn rootworm and black cutworm) and sorghum (greenbug and chinch bug). Recent work on greenbug has dealt with the effects of temperature and plant nutrient availability on the expression of greenbug resistance in sorghum and a comparison of the economic injury level of greenbugs on greenbug susceptible and resistant sorghum hybrids. Other studies have included behavior of the parasite, Aphelinus asychis, in relation to greenbug and certain other hosts (1971); planting time applications of systemic insecticides in grain sorghum; interactions with herbicides and effect on predators (1975); resistance in commercial sorghum hybrids in the seedling stage (1979); in 1978: temperature influence on greenbug resistance of crops in the seedling stage, temperature and plant nutrient effects on resistance of seedling stage, and predistribution and nonpreference for certain cultivars.

DePew (1970) reported on systemic insecticides for control on spring-planted barley and the evaluation of foliar and soil treatments for control on sorghum. In 1972, he further evaluated insecticides on grain sorghum and greenbug-resistant grain sorghum hybrids.

Harvey and Hackerott (1970) reported on resistance of three species of millet to greenbug.

Harvey, Hackerott, and Martin (1981) reported on dispersal of alate Biotype C greenbugs and (1982) current status of Biotype E greenbugs in Kansas, Nebraska, Oklahoma, and northern Texas.

Bauernfeind (1982) reported on the effects of certain insecticide sprays at low temperatures on Biotype greenbugs and control of Biotype E with insecticide sprays at low temperature (1983).

The status of Biotype E greenbugs in Kansas, Nebraska, Oklahoma, and northern Texas was updated by S. D. Kindler, S. M. Spomer, Harvey, R. L. Burton, and K. J. Starks (1984).

Wilde, Mize, Stuart, and Whitworth (1984) published on comparison of planting time applications of granular or liquid fertilizer-insecticide combinations for control of chinch bugs and greenbugs on seedling sorghum.

Wilde and Mize (1984) published on enhanced microbial degradation of pesticides in soil and its effect on chinch bug and greenbug control in seedling sorghum.

DePew (1984) reported on further control studies. He updated information on control of Biotype E with foliar-applied insecticides (1985 and 1986).

Wilde, Russ, and Mize (1986) compared effects of tillage, cropping, and insecticide use on planting-time treatments to control greenbug and chinch bug in sorghum. In 1987, DePew and M. L. Hooker studied the effect of insecticide placement at planting on greenbug control in grain sorghum. Harvey and C. A. Thompson in 1988 investigated the effects of sorghum density and resistance on infestation by greenbugs.

Reese, Harvey, and agronomists (1986) studied new approaches to the identification and development of sorghum resistant to greenbug Biotype E.

SOIL INSECTS

Insects that spend most of their life in the soil are more difficult to study and less has been published on them. This summary is limited to specific soil insect studies; other accounts involving soil insects appear under the host plant and economic species.

McColloch (1917) published on underground insect rearing and (1918-1919) on false wireworm.

H. R. Bryson, often in association with Hays and McColloch, studied the hibernation of wireworms (1924), soil deterioration and insects (1925), underground insects (with Hayes, 1924-1929), interchange of soil and subsoil among burrowing insects (1931), effects of water on soil-inhabiting insects (1931), feeding habits of wireworms and false wireworms and identifying insects by their burrows (1939). He did general, biological, and behavioral studies of wireworms (1930), false wireworms (1939), white grubs, and corn seed beetle (1936). He also did extensive work on seed treatments.

STORED PRODUCT INSECTS

Popenoe wrote about germination of weevil-infested peas in 1891 and on grain weevils in 1901. Dean (early 1900s) published on control, including super heating, freezing, and improved cyanide gas fumigation of infested flour mills and the sources of infestations in mills, railway cars, bakeries, warehouses, and steamships. Headlee reported on insects of grain bins and granaries in 1908.

Investigations on insects attacking stored products were assumed by Wilbur about 1950. He conducted fumigant and grain protectant studies. Early emphasis was on insect problems in grain stored on the farm. Later, he shifted largely to laboratory controlled studies of the environmental factors that affect the insects' behavior and survival and relative susceptibility of grain varieties to stored grain

pests.

Wilbur's studies included teosinte as a host for stored product insects (1954); relative susceptibility of the life history stages of the rice weevil to certain fumigants (1957); effects of ronnel on adults (1960); susceptibility of certain stages of the rice weevil in wheat fumigation at various moistures (1960); dosage-time relationship of 80:20 ($CC1_4CS_2$) for treating adults (1963); determining sexual maturity as indicated by sperm transfer and viable eggs (1963); size and weight differences of three geographic rice weevil populations (1964); radiographic studies of a parasite, *Cheotospia elegans*, of the maize weevil (1972); behavior of angoumois grain moth on several strains of corn at two moisture levels (1956); irradiation of early instars (1970); two species of flour beetle in wheat at three moisture levels: damage and reproduction (1956); effect of germination in wheat (1954); effect of fumigation on number of test insects, exposure period, and posttreatment interval on release of fumigant bioassays (with W. K. Whitney and P. Harein); subsampling evaluation (1960); loss of wheat weight by feeding of the lesser grain borer (1964); development and habits of the granary weevil (1965); resistance of corn to laboratory infestations of the larger rice weevil; grain fumigation types and condition of grain (1959); detecting hidden infestations in grain (1960); modification of cultures for sampling respiratory environments (1966); respiratory environments of grain-infesting weevils (1968); stink bug damage using tests for early detection (1969); association of green stink bug and the yeast-spot disease organism on soybeans; and effects on quality (1970).

In 1959-1960, he studied grain storage insects and conducted research in Mexico for the Rockefeller Foundation. In 1967, he was called to Guyana by the AID to evaluate grain storage insect problems in Georgetown. His study resulted in effective use of aluminum phosphide for control of insects in bagged rice.

In 1953, P. A. Dahm, in cooperation with several coworkers, studied insect fragment production in milling, using radioactive rice weevils.

In 1958, Whitney conducted research on toxicology and control, with emphasis on physical, chemical, and biological effects of fumigants.

In 1964, C. C. Roan published on effects of fumigants on wheat, the significance of sorption and dissipation of diazinon on wheat.

Robert B. Mills joined the stored products unit in 1963, replacing Wilbur upon his retirement in 1970. Mills has expanded the program in both depth and diversity. He has also conducted short courses and technical visits both in the U.S. and many parts of the world.

Some of his publications, often written with his graduate students or colleagues, have included:

Angoumois grain moth's general biology (1964); early germ feeding and larval development (1964); radiographic studies on development in wheat, corn, and sorghum kernels by Mills and Wilbur (1966); sub-lethal gamma radiation effects on prepupae, pupae, and adults by Z. A. Quershi, Mills, and Wilbur (1968); demonstration and extraction of a sex attractant for females by B. P. Khare and Mills (1967); and with R. L. Keys, development in wheat, sorghum, and corn as affected by site of feeding (1967). With the maize weevil, susceptibility of gelatinized wheat product, bulgur, also with lesser grain borer (1969); radiographic studies on wheat kernels (1971); development of WURLD wheat (1973); development in maize kernels and pellets of maize kernel fractions (1974); resistance in corn kernels (1972); evaluation of world sorghum collection for resistance (1974); breeding for resistance in corn kernels (1975); reactions of sorghum varieties to maize weevil infestation under three relative humidities (1974); conditions modifying expression of resistance in kernels (1976); effect of gamma radiation, influence of medium and physical disturbances during rearing on development and number of progeny (1979); influence of rearing medium on size and weight of adults of four *Sitophilus* populations and weight loss of host kernels; development of maize weevil and red flour beetle in whole, cracked, and ground pearl millet (1981); effects of diurnal rhythm, light, photoperiod and temperature, and effect of age, sex, and geographical populations of *Sitophilus* (1982).

Rice weevil investigations included studies of developmental activities and behavior inside wheat kernels (1970); comparison of techniques for screening sorghum grain varieties for resistance; feeding and mortality of adults during simulated winter farm-bin temperatures (1981); development of oviposition on seven species of fungi by foreign grain beetle and development of oviposition and longevity (1965); attachment mechanism of *Trogoderma hastisetae* that makes possible their defensive function (1976); susceptibilities of 13 stored-product insect species to entanglement (1980); effect on mating frequency and delayed maturity of males; induced sterility-recovery of fertility of the almond moth during five generations after gamma radiation (1978); and gamma radiation effects on mating frequency and development of male almond moth (1977).

A. Ungsunantwiwat, John R. Pedersen and Mills (1982) published on laboratory flight activities of *Sitophilus*: effect of age, sex, and geographical population, and effects of diurnal rhythm, light, photoperiod, and temperatures.

General reports have included food-infesting pests by Wilbur, Mills, and H. Paul Boles (1978); potential limitations of the use of low temperatures to prevent insect damage in stored grain (1979); effects of low temperature accumulation on developmental stages of stored product insects (1977); and host resistance to stored product insects (1979).

Serological comparisons of antigenic extracts from three species of *Sitophilus* by A. E. R. Downe showed that the rice weevil and the maize weevil are more closely related to each other than to the granary weevil (with B. F. McLaurin, Jr.). In 1978, he published on potential effects and limitations of low temperature on stored product insects.

T. A. Granovsky and Mills (1984) published on low temperature survival of acclimated granary weevils and

red flour beetles.

Y. E. Seifelnasr, Hopkins, and Mills (1982) reported on olfactory responses of adult red flour beetles to volatiles of wheat and millet kernels, milled fractions, and extracts. In 1984, Seifelnasr and Mills published on varietal pearl millet grain resistance to angoumois grain moth, rice weevil, and the lesser grain borer.

Mills and coworkers compared (1986) a pneumatic probe and a manual probe for sampling stored grain sorghum.

Greogry B. Partida's research (1971-1975) included cooperative efforts on effects of *Bacillus thuringiensis* on certain insects attacking stored grain sensitivity of almond moth pupae to gamma radiation.

In 1972, Horber published on development of maize weevil in kernels of two nearly isogenic, inbred lines of corn. In 1975, he wrote about evidence of ovipositional preference of the cowpea weevil for cowpea varieties; in 1974, on how seed size affects the occurrence of "active" and "miniature" forms of the weevil in laboratory populations; and in 1976, how seed coats of cowpeas affect oviposition and larval development. In 1984, Brewer and Horber reported on resistance to this weevil in different seed legumes.

A. Fadlelmula and Horber in 1984 reported on resistance of sorghum varieties to rice weevil and angoumois grain moth.

Several papers were presented by staff members at the 3rd International Conference on Stored Product Entomology in 1984. Horber and coworkers reported on insect resistance in seed legumes and sorghum. Horber also gave a general presentation on host resistance to stored-grain insects.

Mills and C. T. Asanga (1985) determined changes in environment, grain quality, and insect populations in pearl millet stored in underground pits. In 1986, they conducted laboratory studies of pearl millet in hermetic storage.

Howard and D. D. Mueller (1987) studied the defensive chemistry of the flour beetle, specifically the presence of prostaglandin synthetase inhibitors.

Many short courses, conferences, and workshops have been conducted on such subjects as fumigation safety in cooperation with the Kansas State Board of Health and Labor; on sanitation, with the Association of Operative Millers, and the National Pest Control Association. Many scores of international visiting scientists have visited the laboratory. During recent years, Mills and colleagues, especially Valerie F. Wright, have participated in the KSU Food and Feed Grain Institute's AID project, which provides training and technical assistance on grain storage and marketing to developing countries. Mills has participated in short courses or had technical assignments in eight foreign countries on four continents and participates in the annual grain storage short courses at KSU for participants from developing countries.

John R. Pedersen, who is on the staff of the Department of Grain Science and Industry, works closely with this Department, on various aspects of stored product insects and has given considerable technical assistance and training in grain storage and preservation locally and overseas.

Wright's research has been primarily on the feeding value of fungal- and insect-deteriorated grain sorghum for ruminants; estimating stored-product insect populations; and determining biology and losses in grains resulting from insect attack. Thirteen of her publications of studies at the University of Minnesota appeared in print after her arrival here in 1979. Wright and R. Burrows (1982) reported on mold damaged grain sorghum as a diet for other stored-grain insects. In 1983, N. D. G. White, Wright, F. L. Watters, and Mills wrote on future directions and current problems for stored-product entomology; in 1983, Wright and T. J. Spillman prepared an annotated bibliography on the larger grain borer; in 1984, on the world distribution of this borer; in 1984, N. B. Osman, Wright, and Mills wrote on the effect of rearing temperature on certain aspects of the biology of the rice moth; and in 1984, with Mills, on the estimation of stored products insect populations in small bins using two sampling techniques. In 1986, Wright contributed a chapter on use of pesticides to control insects in farm storage, in a book on pesticides and humid tropical storage systems.

Among the international training courses Wright has conducted are two in the Philippines (1979, 1981) for SEARCA (Southeast Asia Cooperative Post-harvest Research & Development Programme); two in Tanzania for the Peace Corps (1981, 1982); one in Ouagadougou, Upper Volta (1982); and some locally for international visitors to KSU. Technical assistance has included a seminar in Tanzania (1982); a workshop in Slough, England (1983); and project design development in Pakistan (1983).

Cooperation has been productive between the Department of Entomology and the Stored Products Insects Laboratory, the Department of Grain Science and Industry, and with the Biological Research Unit (stored products insects) of the U.S. Grain Marketing Research Laboratory, USDA, located in Manhattan. Contributions of current USGMRL collaborators are listed below.

William H. McGaughey's research has been concerned primarily with the use of *Bacillus thuringiensis* (B. t.) for controlling insects in stored grain. These studies established the effectiveness and stability of B. t. as a moth control agent for stored grain and led to the registration of B. t. by EPA in 1979. The studies have been continued to evaluate effectiveness of B. t. in relation to formulation, application method, spray volume, management practices, and insect population susceptibility. Also, more basic studies have been conducted to develop a better understanding of the interaction between B. t. and the grain storage environment, and of the susceptibility of storage pests to different isolates of B. t. Additionally, McGaughey has been involved in some fumigant evaluation, preparation of USDA extension bulletins, and conference organization.

In 1974, Kinsinger and McGaughey wrote on the susceptibility of Indian meal moth and almond moth to B. t.; and Kinsinger, McGaughey, and E. B. Dicke on susceptibilities of these two moths to eight B. t. isolates; Kinsinger and McGaughey on the histopathological effects of

B. t. on larvae of these two moths; and B. t. for moth control on wheat.

In 1975, McGaughey, Kinsinger, and E. B. Dicke wrote on the disposal of B. t. spores by nonsusceptible species of stored grain insects. Kinsinger and McGaughey (1976) published on B. t. and a granulosis virus of Indian meal moth.

McGaughey (1978) published on moth control in stored grain: efficacy of B. t. on corn and method of evaluation by using small bins and on the susceptibility of angoumois grain moth to B. t.

In 1982, McGaughey wrote on a laboratory evaluation of commercial formulations of B. t. for moth control in stored inshell nuts.

K. J. Kramer, R. W. Beeman, W. C. Speirs, W. E. Burkholder, and T. P. McGovern (1983) wrote on susceptibility of stored product insects to alkyl ketones and analogs; toxicity of 2-tridecanol.

Beeman, Speirs, and Barbara A. Schmidt (1982) reported on resistance by Indian meal moth infesting stored corn and wheat.

Jonathan P. Halisack and Beeman (1983) published on status of malathion against five genera of beetles infesting farm stored corn, wheat, oats in the U.S.

Beeman and W. E. Speirs (1984) published on toxicity, persistence, and antagonism of avermectin B against stored products insects.

Kramer, Beeman, and others wrote about susceptibility of stored-product insects to alkyl ketones in 1985. Beeman and Nanis (1986) reported on malathion resistance in the red flour beetle. Also in 1986, Beeman and collaborators studied chromosome rearrangement in *Tribolium castaneum*.

Anderegg and L. J. Madisen (1982) published on the effect of dockage on the degradation of ^{14}C malathion in stored wheat, on degradation of ^{14}C malathion in stored corn and wheat inoculated with *Aspergillus glauca*, and on the effect of insecticide distribution and storage time on the degradation of ^{14}C malathion in stored wheat.

Past USDA Collaborators in Stored-Product Insects

The following list has been taken largely from papers, letters, and notes by the late R. T. Cotton, Donald A. Wilbur, Gailen D. White, and Roger C. Smith.

Gilbert Schenk maintained a laboratory at Manhattan during the 1920s and cooperated with George A. Dean on stored grain and mill insect problems. After Schenk's resignation in 1929, research was continued by George B. Wagner, who worked out of Kansas City until 1934. Then he moved to Manhattan to become associated with R. T. Cotton, who was delegated from Washington, DC. Because of the interest of Southwest millers, they initiated research on the problems of the insect pests of stored grain and milled cereal products in Kansas and other grain growing and processing areas in the United States.

From 1934 to 1940, Wagner acted as first assistant in the operation of the Manhattan Laboratory. During this time T. F. Winburn, N. E. Good, and H. D. Young (Chemist) joined the organization.

One of the earliest undertakings was the preparation, in cooperation with Dean, of USDA Circular 390, "Flour Mill Insects and Their Control." Advice and encouragement of Dean and his staff through the early years of the laboratory were most useful.

With the cooperation of the milling industry, intensive studies were made of the insect populations of flour mills over a wide area of the southwest. Research on mill insect control was conducted with the help of C. O. Swanson, E. G. Bayfield, Royce Pence, John A. Shellenberger, and Max Milner of Kansas State University, in addition to the Operative Millers as a group.

Research was conducted on fumigants in flour mills and grain storage areas, vacuum fumigation, infestation in transit, insect resistant bags and packages, the use of grain protectants, and many other related problems.

With the passage of the Agricultural Adjustment Act of 1938, providing an Ever-Normal Granary Program, interest rose regarding the insect hazard to grain in farm-type storage in all parts of the country. A research grain storage site was established at Hutchinson, Kansas, among other grain growing areas, with funds and facilities supplied by the Commodity Credit Corporation.

Winburn was assigned to coordinate and lead research activity in the field, but in 1941 he resigned to enter military service.

Wagner took over the field work temporarily, but resigned a short time later to join the Millers National Foundation.

Herbert H. Walkden was assigned to take over the field work on grain storage problems in Hutchinson, Kansas in 1941. New men, including R. B. Schwitzgebel, Carl Bartholomai, Gailen D. White, were pressed into field research work. Extensive studies were conducted at Hutchinson to evaluate the effects of treating the walls of grain bins with insecticidal materials prior to harvest. Grain protectant treatments were initiated. Fumigation dosages and application techniques were developed. Most of this work was done on Kansas farms.

From 1934 to 1940, Wagner acted as first assistant.

From 1940 to 1950, J. C. Frankenfeld took over the first assistant duties of field and laboratory experimental work at Manhattan. He participated in the "Crossroads Experiment" of the Joint Task Force No. One for duty with the Naval Medical Research Section and was the entomologist responsible for exposing stored grain insects to the radiation of the atomic bomb in the Bikini Atoll test.

In compliance with a program of USDA research facilities consolidation in 1951, Walkden and White were transferred to the Manhattan station and the Hutchinson station was closed. R. T. Cotton was promoted to section leader with Howard D. Nelson his assistant. Later both were reassigned to Washington, DC, J. C. Frankenfeld left government service, and Walkden became project leader, directing the research of the USDA Manhattan Station, Division of Stored Product Insect Investigations, Bureau of Entomology and Plant Quarantine.

The program of research at Manhattan continued to develop and improve the chemical, physical, and biological methods for preventing and controlling insect infestations in facilities in which grain and grain products are handled, stored, processed, packaged, and transported.

The following entomologists of the Manhattan station engaged in research, which added to the current wealth of information regarding stored grain insects and their control.

Walter T. Emery, 1941 to retirement in 1949, conducted experiments on the identity, biology, abundance, and control of stored grain insects in farm and commercial storages, freight cars, and mills.

Leonard M. Redlinger conducted commercial-scale tests of insecticidal sprays in mills and insect control in Commodity Credit Corporation storages and farm bins from 1948 to 1952.

Norman M. Dennis (1948 to 1960) evaluated insecticides and fumigants, resistant packaging of cereal products, studied methods of detection of hidden insect infestation in grain, and the effects of gamma and cathode ray irradiation on stored product insects.

James K. Quinlan (1954-1960 and 1964-1969) conducted field-scale research studies with grain protectants and fumigants and worked to develop aerosol treatment of stored grain.

W. Keith Whitney's research (1956-1958) dealt with fumigant evaluations under controlled laboratory conditions and studies on the effects of high-frequency electrical fields on stored-grain insects.

Albert C. Apt's research (1953-1956) was primarily on the development of insect control measures for Commodity Credit Corporation stored corn and the development and evaluation of grain protectants.

Garth H. Spitler (1952-1954) field-tested grain protectants in Commodity Credit Corporation stored corn. In 1954, he set up a new branch station for Khapra beetle research in Mesa, Arizona.

Griffin L. Phillips (1954-1956) conducted both laboratory and field grain fumigation studies. Much of his research employed gas thermal conductivity as a means of gas analysis, especially methyl bromide.

John H. Schesser (1956-1960) conducted research on grain protectants. From 1960 through 1963 he served as assistant to L. S. Henderson, Chief, Stored-Product Insects Branch, AMS, USDA, in Washington, DC. In 1963 he returned to Manhattan, where his major field of research was freight sanitation.

Charles E. Storey, starting in 1956, conducted basic and applied research on the distributional behavior and effectiveness of grain fumigants, with emphasis on the development of improved methods of grain fumigant application.

Harrison E. McGregor's early research (1956) was directed toward chemical control of the dermestid, Trogoderma glabrum (Herbst), in stored grain. He conducted the first field-scale grain fumigation tests with aluminum phosphide tablets in 1958, which led to the registration of Phostoxin by the USDA.

Howard D. Nelson returned to Manhattan and served as Assistant Station Leader from 1957 to 1961.

Wayne L. Berndt (1957-1964) had as a primary field of research the evaluation of stored-grain insect repellent materials. He conducted field research tests with inert dusts applied as grain protectants.

Stanley D. Carlson (1959-1964) conducted field work in line elevators, laboratory research on diatomaceous earths as grain protectant materials, laboratory studies of atmospheric gases on stored-grain insect respiration and mortality, and atmospheric gas preconditioning of insects prior to fumigation.

Gailen D. White (1951-1969) conducted insect control studies in farm-stored grain, Commodity Credit Corporation binsite storages of wheat and corn, and in grain elevators. In 1958, he was assigned leadership of the technical administration and direction of the research of the station.

Delmon W. LaHue, who transferred from the Tifton, Georgia station in 1960, conducted research on the chemical control of the insect pests of stored grains through laboratory screening of insecticidal materials and intermediate-type bin studies with new materials.

Hobart P. Boles transferred from the Savannah, Georgia station in 1965. His research in Kansas was devoted to the field of stored-grain insect ecology.

There have been hundreds of publications documenting the research of the station, but undoubtedly, the best known is Dr. R. T. Cotton's book titled, "Pests of Stored Grain and Grain Products."

The Manhattan station has had several name changes through the years. It was one of seven stations of the Stored-Product Insects Research Branch of the Market Quality Research Division, Agricultural Research Service, United States Department of Agriculture, and known as Mid-West Grain Insects Investigations. It is now part of the U.S. Grain Marketing Research Laboratory.

INSECTS OF MEDICAL AND VETERINARY IMPORTANCE

Popenoe published (1892) a brief account of the horse fly.

P. J. Parrott reported on horn fly trapping and control (1899-1900).

Painter wrote on bot flies in 1930. In 1939, an annotated list of local mosquitoes was compiled by DeLoss. R. C. Smith and coworkers conducted evaluations of oils, rotenone, and other available materials for fly control during the late 1930s and into the 1940s. In 1942, they reported on fly control in barns and also evaluated effects of fly repellents and sprays on diary cattle.

Dean (1950) published on the effectiveness of various insecticides on horn flies.

A. E. R. Downe (1969-1970) studied feeding habits of Kansas mosquitoes (sometimes with J. D. Edman), showing that they attacked larger, more abundant animals

(cattle and sheep) most often.

W. W. Young, under my direction, assembled records of biting flies in Kansas, with ecological, distributional, and behavioral notes (1950).

Laboratory studies were conducted by Harvey (1960) and later by me (with Hillard Knapp, 1963) using systematic insecticides for control of fleas on rats, to determine the proper dosage of insecticides to add to food to kill the fleas but not the rats. This reduced the spread of plague, murine typhus, and other, rat- and flea-borne diseases. J. P. Poorbaugh and H. Gier (1960) obtained data on field occurrence of fleas, lice, and mites of wild rodents in eastern Kansas.

In the 1950s, most of my studies and those of my graduate students involved determining the effects of one or more exposures of larval or adult house flies to various concentrations of malathion or dieldrin, at lethal and sublethal levels, upon reproductive potential, longevity, and weight. Substantial differences in reproductive potentials also were found in house flies collected in various isolated areas where DDT and other chlorinated compounds had not been used and between these populations and a laboratory strain of DDT-susceptible house flies.

J. M. Hite studied the ecology, feeding, behavior, and life history of the brown recluse spider (1966). Results were published after she left KSU. Later, Elzinga wrote on the longevity of this spider (1977).

C. W. Pitts studied various medical insects from 1965-1978, and earlier as a graduate student. Among his publications, some with graduate students, were (1962) fly control in feces of cattle fed CoRal, toxicological studies on DDVP feed additive formulations to control house fly and face fly oviposition in cattle feces (with Hopkins, 1963), development in feces of six species of animals and influence of moisture content (1968), response of adults to relative humidities (1970), sensory organs of the fly (1971), olfactory responses to bovine feces, antennal olfactory sensilla (1976), and communal oviposition (1977). Other studies included feed additives for control of flies in poultry manure (1976). Stable fly studies included humidity responses, early embryogenesis, and factors affecting membrane feeding (1976).

Paul A. Dahm came in 1947 to work mainly on medical insects and left in 1953. When he arrived there were very poor laboratory equipment and facilities. His studies on toxicology, physiology, metabolism, mode of action of insecticides, and use of radioactive tracers produced a fresh and valuable addition to the Department. Publications determined poisonous effects of certain insecticides to livestock (1950-1953) in cooperation with F. C. Fountaine, J. E. Pankaskie, Roger C. Smith, and F. W. Atkinson. In 1955, he published on lice control on chickens. Dahm's contribution also extended into the teaching of pest control technology and postwar concepts of medical entomology.

Clifford C. Roan followed Dahm in 1954. In 1956, he published on synthesis of diazinon using P^{32}; he also studied the effect of different temperatures and piperonyl butoxide (p.b.) and DDT-resistant strains of house flies and effects of p.b. on the cholinesterase activities of some organic phosphorous insecticides on the house fly.

In 1957, he published on systemic insecticides and cattle grubs and, with Harvey, on field evaluation of increased resistance of cattle to the cattle grub and the interaction of p.b. with malathion on mode of action in cockroaches. In 1958, larvicides were studied in both field and laboratory. In 1959, the penetration of p.b. as a synergist and as an antagonist in house flies and effect of malathion on EPN on mice were studied, and in 1960, the effects of three miticides on the northern fowl mite. In 1960, he published on systemic insecticides for cattle grub control and chemical changes occurring in malathion residues. In 1961, he published on effects of malathion and p.b. combinations on rate of oxygen consumption on house flies. He also studied the distribution and excretion of P^{32}-labeled diazinon in guinea pigs and house fly genetics and malathion. In 1963, he reported on effects of route of administration to house flies on the interactions of malathion and p.b. and in 1964, published on the effects of incremental dosages of malathion applied topically to adult house flies.

In 1961, Harvey and Brethour published on the effect of Ruelene and Ronnel for ear tick and cattle grub control.

Harvey, with animal science associates, Brethour and Launchbaugh at Fort Hays Branch Station, studied feed additives for control of horn fly larvae in feces of cattle, ear tick control (1961), and back rubbers and cattle grubs (1962). In 1968, Harvey and D. G. Ely reported on the relation of ration to the short-nosed cattle louse and control of the louse by dichlorvos resin strips. In 1969, Harvey published on studies of wax-bar applications for horn fly control and partial herd treatment for this fly with crotoxyphos in wax bars. With Brethour, he tested dichlorvos-impregnated strips. Of special significance was the development of the first insecticide-impregnated ear tags (1960), which had widespread use during the next 10 years.

In 1979, Harvey reported on treatments of one beef animal per herd with permethrin for horn fly control and measured the effect of horn flies on weight gains by cattle. He investigated (1980) horn fly control with fenvalerate-impregnated ear tags and effect of horn fly on cattle behavior. Studies in 1982 investigated control of cattle with impregnated ear tags attached to back rubbers and dust bags (with Brethour and Broce) and controlling the fly in cow-calf herds with insecticide ear tags on nursing calves (with Brethour).

Harvey and Brethour (1983) published on chin-ball application of permethrin to cows for horn fly control. These authors with Broce reported (1984) loss of effectiveness of insecticide ear tags for horn fly control.

In 1985, Harvey and Brethour investigated use of dust bags and backrubbers to apply insecticides for control of pyrethroid-resistant horn flies.

Harvey and Brethour (1986) evaluated insecticide-impregnated tags attached to chains and used as backrubbers to control horn fly in cattle. They also developed a pellet-pistol method to apply insecticides to cattle for horn fly control. In 1988, they published a further account of control of horn fly with insecticide pellets fired from a

CO_2-operated pistol.

In 1987, Broce and collaborators surveyed dispersal of horn flies among cattle herds. Harvey, Brethour, and other animal scientists in 1987 investigated the effect of cattle breed and flucythrinate-impregnated ear tags on horn fly control in yearling heifers.

M. J. Grodowitz and Broce (1983) reported on calcium storage in face fly larvae for puparium formation. Broce and Elzinga (1984) published on comparison of prestomal teeth in the face fly. T. Van Geem, Broce and R. D. Moon (1983) reported on a system for physiological age-grading of females.

V. G. Gonzaga and Broce (1984) published on effects of substituted benzylphenols and some insect growth regulation on the reproduction of the face fly.

Van Geem and Broce (1984) wrote on the significance of cattle discharges and secretions as protein sources for ovarian development of the face fly and on fluctuations of crop protein and carbohydrate content correlated to periodicities in ovarian development.

In 1987, Broce and Gonzaga studied the effects of chemicals on reproduction of the face fly. Grodowitz, Broce, and L. H. Harbers (1987) determined characteristics of dung that affect survival and puparial mineralization of face fly larvae.

P. Ajidagha, C. W. Pitts, and D. E. Bay (1983) reported on early embryogenesis of the stable fly.

In 1986, Berry, Nelson, and Broce wrote about the effects of weather on the capture of stable flies with fiberglass traps. Greene and Broce (1986) contributed to the proceedings of a meeting held at Garden City to discuss stable fly biology and control in cattle feedlots.

J. S. Pontius (1983) published on population density, growth, and development time of house fly larvae. Elzinga and Broce (1988) characterized the presence of hypopi on house flies as a case of "detrimental phoresy."

M. J. Grodowitz, J. Krchma, and Broce (1982) reported a method for preparing soft bodied larval Diptera for scanning electron microscopy.

K. C. Stafford, Pitts, and T. L. Webb (1984) reported on olfactometer studies of host-seeking by the parasitoid *Spolangia endius*.

C. R. Roseland, M. J. Grodowitz, K. J. Kramer, T. L. Hopkins, and Broce (1984) published on participation of minerals and catecholamines in the stabilization of mineralized and sclerotized puparial cuticle of muscoid flies.

Beginning in the summer of 1984, Mock conducted a trapping program to bolster our knowledge of Ceratopogonidae in Kansas, especially *Culicoides variipennis*, the well known vector of bluetongue virus.

Broce and researchers in Veterinary Medicine and Animal Sciences cooperated in a study (1986) of the effect of sarcoptic mange on growth and lymphocyte proliferative responses in pigs. This work continued in 1987, with a report on growth and behavior of pigs infested with scarcoptic mites.

BIOLOGICAL CONTROL

William A. Ramoska came in 1977 and initiated studies in insect pathology, at a time when the first laboratories were equipped and assigned specifically for these studies.

Previously, biocontrol research had been limited to general laboratory and field studies, mostly as portions of overall work on such insects as house flies, European corn borer, chinch bug, grasshoppers, alfalfa weevil, and certain aphids. These are discussed above under the various crops or pest species.

Popenoe (1897) listed some "natural agents" for possible control of noxious insects and, in 1880, wrote on destroying insects by fungal disease.

Hesder and McColloch (1913) published on pathogenic fungi and chinch bugs.

Hayes (1917, 1925) wrote on the hibernation of certain scarabs and *Tiphia* wasp parasites.

In 1932, Smith wrote on fungal and bacterial diseases of grasshoppers and chinch bugs. Biocontrol of these insects is discussed in detail under the appropriate sections above. He also listed some insects attacking bindweed.

Marshall (1936) published some observations on a pirate bug, *Orius incidiosis*. Dean and Kelly wrote on the practical use of insects to control insect pests and noxious weeds.

Painter did pioneering work on plant resistance to insects, which is considered part of biological control in the broad sense. He published a review article in 1958.

In 1973, David and Wilde reported on the susceptibility of the convergent lady beetle to parasitism by a braconid, *Perelitus coccinellae*.

In 1979, Ramoska and Pacey wrote about food availability and period of exposure as factors of *Bacillus sphaericus* efficacy on mosquitoes. Toxicity of parasporal crystals in *Bacillus thuringiensis* subsp. *israelensis* was reported (1979) by D. J. Tyrell, L. A. Bulla, L. I. Davidson, and Ramoska.

In 1980, Ramoska, Pacey, and S. Watts published on tests of pathogenicity and parasitism of B. t. var. *israelensis* (Serotype H-19) and B. *sphaericus* against larvae of *Culex restuans*. M. E. Wilson and Ramoska reported on a cytoplasmic polyhedrosis virus isolated from the variegated cutworm. Also in 1980, Hopkins and Ramoska published a radiotracer method for determining ingestion of *B. sphaericus* by mosquito larvae and wrote about feeding behavior of mosquito larvae related to *B. s.* efficacy.

In 1981, Ramoska, S. Watts, and H. A. Watts reported on effects of sand-formulated *Metarhizium anisopliae* spores on larvae of three species of mosquitoes. Ramoska and Sweet studied predation of mosquitoes in tires by a spider and Ramoska, Watts, and R. E. Rodriguez wrote on the efficacy of suspended particles of formulated and unformulated *B. thuringiensis* Serotype H-14 on mosquito larvae. Ramoska also published on the long-term epizootic potential of various introduced pathogens of mosquito larvae.

In 1982, Ramoska and Bulla reported on the comparative toxicity of five strains of *B. sphaericus* to the mosquito, *Culex pipiens*. Also, Ramoska, W. A. McCollum, K. L. Quickenden, and A. Seekinger published on field tests of two commercial formulations of *B. t.* Serotype H-14 against *Aedes* mosquito larvae in a Montana pastureland.

In 1983, Ramoska published on the influence of relative humidity on *Beauveria bassiana* infectivity and replication in the chinch bug.

Poston and Welch reported on IPM crop management and biological control and on managing arthropods in corn via biological control at an international symposium on pest management in 1984.

In 1984, James R. Nechols joined the faculty with research responsibilities in biological control. In 1985 and 1986, Nechols found nine species of naturally occurring egg parasitoids that attack the squash bug.

In 1985, Krueger and Ramoska studied the purification and infectivity of *Entomophaga grylli* against *Melanoplus differentialis*. Ramoska and Todd reported on variation in the efficacy and viability of *Beauveria bassiana* in the chinch bug.

Reese and C. W. Holyoke, Jr. (1987) wrote chapters on allelochemics affecting insect growth and development and on acute insect toxicants from plants for the Handbook of Natural Pesticides.

J. L. Tracy and J. R. Nechols compared two parasitoids on squash bug eggs in the laboratory. In 1987, they studied development, survival, and sex ratio in relation to temperature. In 1988, they compared thermal responses, reproductive biology, and population growth.

Weed Control

The musk thistle head weevil, *Rhinocyllus conicus*, has been established and monitored by Horber since 1973 on 35 release sites in nine counties of eastern and central Kansas. Assistance was given to the Kansas State Board of Agriculture, Weed and Pesticide Division and various County Weed Directors in 1979 to release 175,000 weevils in 53 Kansas counties. A suppression effect of musk thistle populations became apparent in several sites where weevils had been released between 1975 and 1978. The musk thistle rosette weevil, *Trichosirocalus horridus*, was released between 1977 and 1981 on four sites and was recovered in 1982 from one site.

INSECT PHYSIOLOGY AND BEHAVIOR

Research in this area has been carried out by T. L. Hopkins and coworkers.

In 1967, R. E. Monroe, Hopkins, and S. A. Valder studied metabolism and utilization of cholesterol for growth and reproduction of aseptically reared houseflies.

In 1972, Hopkins and B. B. L. Srivastava reported on factors affecting rectal water transport in a cockroach. K. C. D. Urs and Hopkins published on the effect of moisture on the lipid content and composition of two strains of *Tenebrio molitor*.

In 1974, R. A. Wirtz and Hopkins reported on tyrosine and phenylalanine in the haemolymph and tissues of the American cockroach during metamorphosis. This was followed in 1975 (Srivastava and Hopkins) by work on bursicon release and activity in the haemolymph during metamorphosis.

In 1977, Wirtz and Hopkins published on tyrosine, phenylalanine, and DOPA concentrations in two kinds of cockroaches in relation to cuticle formation.

Hopkins and coworkers (1982) reported that N-ß-alanyldopamine plays a major role in insect cuticle tanning. Also in 1982, Ahmed and Hopkins worked out the synthesis, properties, and titer of ß-D-glucopyranosyl-O-L-tyrosine during insect development. Ahmed, Hopkins, and Kramer published on tyrosine and tyrosine glucoside titers during development of the tobacco hornworm and the effect of 20-hydroxyecdysone on tyrosine glucoside hydrolase activity.

In 1983, Kramer, Hopkins, and coworkers studied electrochemical and enzymatic oxidation of catecholamines involved in sclerotization and melanization of insect cuticle. This group reported in 1984 on the roles of catecholamines and ß-alanine in cuticle sclerotization and melanization in the red flour beetle. They also investigated the properties of tyrosine and dopa quinone imine conversion factors from the pharate pupal cuticle of *Manduca sexta*.

This was followed in 1984 by a publication of catecholamines in haemolymph and cuticle of *M. sexta* during its development (Hopkins, Morgan, and Kramer). Then Kramer, Morgan, Roseland, Hopkins, and Beeman discussed regulation of cuticle pigmentation and sclerotization in the red flour beetle at an international meeting in 1984.

In 1985, Aso, Kramer, Hopkins, and Lookhart published on the characterization of haemolymph protyrosinase and a cuticular activator from *Manduca sexta*. Roseland, Grodowitz, Kramer, Hopkins, and Broce reported on stabilization of mineralized and sclerotized puparial cuticle of muscid flies. Also, Ahmed, Hopkins, and Kramer published on the role of juvenile hormones in regulating tyrosine glycoside synthesis in *M. sexta*. Then, Hopkins, Morgan, and coworkers reported on the roles of dopa decarboxylase and phenoloxidase in the melanization of tobacco cutworm.

Several publications appeared in 1987 on insect cuticle research. Kramer and Hopkins described tyrosine metabolism for insect cuticle tanning. These authors plus other collaborators reported on the use of solid state ^{13}C and ^{15}N nuclear magnetic resonance to detect aromatic crosslinks in insect cuticle. Roseland, Kramer, and Hopkins studied cuticular strength and pigmentation in red and black strains of *Tribolium castaneum*. Morgan, Hopkins, and others discussed the biosynthesis of N-ß-alanylnorepinephrine in insect cuticle and its possible role in sclerotization. Hopkins and others contributed a chapter on mechanisms of cuticle stabilization in tobacco horn-

worms to a book on Molecular Entomology. Broce and collaborators wrote on the mechanical properties of mineralized and sclerotized puparial cuticles of *Musca autumnalis* and *M. domestica*.

In 1988, Czapla, Hopkins, and others identified diphenols in the hemolymph and cuticle during development and cuticle tanning of cockroaches.

Reese and Schmidt (1986) published on the physiological aspects of plant-insect relationships. These authors plus Mize in 1987 investigated physiological interactions between phytophagous insects and their hosts.

Schmidt and Reese (1988) reported on effects of physiological stress on growth and food utilization by larvae of black cutworms.

M. H. Blust and Hopkins (1987) studied olfactory responses of a specialist and a generalist grasshopper to volatiles from *Artemisia ludoviciana* and then reported on gustatory responses of these grasshoppers to terpenoids in that plant.

Nechols and others (1987) investigated geographical variability in ecophysiological traits controlling dormancy in *Chrysopa oculata*.

M. O. Harris (1987) reported on responses of ovipositing onion flies to authentic and surrogate onions in the proceedings of an international meeting. With J. R. Miller (1987), she studied host acceptance behavior in the onion fly.

Broce, Grodowitz, and Kramer (1987) described the morphological and biochemical composition of mineralized granules from the Malpighian tubules of *M. autumnalis*. With Krueger and Hopkins in 1987, he reported on the dissolution of these granules during mineralization of the puparium.

INSECTICIDAL RESIDUES

Some of the relevant studies are listed under specific crops and species.

Few papers on residues were published as numbered contributions prior to the chlorinated insecticides. Leaflets and other publications included results of evaluations of the available insecticides such as the arsenicals, oils, derris, rotenone, and pyrethrum, without much concern for residues.

In 1964, C. C. Roan published on effects of fumigants on wheat and the significance of sorption and description of diazinon on wheat.

Burkhardt (1957) published on effects of alfalfa dehydration on residues of malathion.

Knutson, Kadoum, Hopkins, G. F. Swoyer, and Harvey (1971) conducted a 5-year study on persistence of several soil and foliar insecticides applied to irrigated corn and sorghum, downstream from the Cedar Bluff Reservoir. Recommended dosages were applied in soil and by air and subsequent samples taken of soil, groundwater, surface water, foliage, and grain, and carryover in the soil into the next season. A previous 10-year history of pesticides used in the study areas was reported by Harvey, Knutson, Hopkins, and Swoyer (1971).

In 1978, Kadoum and Mock reported on herbicide and insecticide residues in tail water pits.

Kadoum (1977) published on wheat protectants and metabolism breakdown on wheat and in milling infestations; and effects on emulsifiable and encapsulated formulations of certain insecticides on adult stored-product insects. In 1978, he wrote about the effect of grain moisture on degradation of several insecticides on corn, sorghum, and wheat. In 1979, Kadoum reported on effects of baking temperatures on insecticide residues in cakes. Also, he published on differential degradation of malathion as affected by plant hybrid, moisture content, and temperature. In 1981, Alnaji and Kadoum reported on effects of baking temperature on residues in bread.

Kadoum worked with researchers in Clothing, Textiles, and Interior Design (1988) studying insecticide removal during laundering from cotton and polyester fabrics.

In 1983, B. N. Anderegg and L. J. Madisen published on the effects of dockage, insecticide distribution, and storage time on the degradation of malathion in stored wheat.

This is an incomplete summary of research. Many samples of plants were shipped to other laboratories for analysis to determine labeling precautions before marketing of insecticides.

SYSTEMATICS

Publications on Kansas insects by Popenoe have included Coleoptera of Kansas (1878), beetle fauna of Kansas (1881), Hemiptera of Kansas (1885), handbook of butterflies of eastern U.S. (1885), and insects of farm crops and scale insects of Kansas (1919).

In 1920, W. P. Hayes (assisted by McColloch) prepared a well illustrated bulletin reporting on the separation of the species of May beetles (June bugs), including male and female genitalia. Hayes also published (up to 1929) on larval identification and on an extensive study of the wheat white grub, *Phyllophaga lanceolata*.

R. C. Smith's publications on Neuroptera were largely during his first three years here , 1920-1923. He wrote on the identification of species of the lace wing and spongilla fly families.

In 1930, C. W. Sabrosky published on the Chloripidae of Kansas.

R. H. Painter published extensively on Bombyliidae and on a smaller family, Apioceridae, from about 1930 until his death in 1968, revising many genera and describing many new species. He also studied and described type specimens in Europe.

F. A. Lawson (1954) wrote on structural features of cockroach egg capsules. In 1956, he published on variation in the ovipositor of a wingless cockroach. In 1958, G. B. Mulkern and Lawson reported on the transplantation of integumental tissue in several species of cockroaches. He also provided morphological descriptions of developmental stages of roaches. In 1959, he published a key to the nymphs of common families of Hemiptera. Marks and Lawson (1962) reported on a comparative study of the Dictyopterian ovipositor. In 1963, Lawson and E. R.

Quiaoit reported on gonad degeneration in the Oriental cockroach and other species.

C. W. Rettenmeyer published extensively on the behavior of army ants (1964, 1966, 1967) and other arthropods associated with them: *Thysanura* (1963, 1964), rove beetles (1966), and phorid flies (1967). He also worked with western harvester ants (1964, 1966, 1973), carpenter ants, and pattern-recognition recruiting dances of the honey bee (1967).

R. J. Elzinga's research during the first 15 years (1961-1976) concerned mites associated with neotropical ants, in collaboration with C. W. Rettenmeyer. During this time, four genera of mites were revised and 28 new species were described. Later (1978-1984) he published six more papers on mites, describing four new species. In 1984, he and Blocker published on the distribution of army ant mites and leafhoppers of Paraguay.

Since 1980, comparative morphology of the labellum of fly mouthparts has been Elzinga's primary area of emphasis (with A. Broce). Over 28 families and 100 genera of flies have been examined in detail, using the scanning electron microscope. In 1986, these two authors published descriptions and SEM illustrations of the labellar modifications in muscomorpha flies.

Since joining the staff in 1965, H. D. Blocker has collected extensively in the U.S., Canada, Mexico, and Paraguay. He has been a participant in the NSF-sponsored Summer Institute of Systematics at the Smithsonian Institution and in the 2nd Seminar-Workshop on Range Science in Adelaide, Australia. He has published several, major, taxonomic revisions of leafhoppers and presently is addressing phylogenetic analysis of these groups, in addition to classification. Publications appeared in 1966, 1967, 1970, 1971, 1975, 1976, 1978, and 1979 to 1984. He is coauthor of a volume on The True Prairie Ecosystem, which is the culmination of an extensive International Biological Program project, funded by NSF. In 1985, Blocker and Wesley published on the distribution of *Anthysanella* in Canada and Alaska and described a new subgenus and six new species from Mexico. Also in 1985, Blocker and Triplehorn wrote a book chapter on the external morphology of leafhoppers.

In 1987, Blocker and J. E. Lowry described three new species of *Flexamia* from the Great Plains. In the same year, Blocker and Johnson described the subgenera of the genus *Anthysanella* and proposed a phylogeny for the group.

Harvey, on an NSF grant, studied the interrelationships of dodder, its plant hosts, and aphids (1966).

H. G. Spangler, under Rettenmeyer's guidance, studied ant stridulations and their synchronizations with abdominal movement in certain ants (1966).

P. S. Welch was primarily a teacher, but he published (1969) on *Hydromyza confluens*, on aquatic Lepidoptera, and on larval habits of *Bellura melanopyga*.

J. W. Johnson wrote a revision of the North American species of *Praon*, a parasite of aphids (1984).

M. E. Rice (1985) described the male of *Neoclytus torquatus*. In 1987, he described morphological variation in *Plega dactylota* and the status of its subspecies. R. Urrelo, Rice, and Blocker (1987) published a new Kansas record for Zoraptera.

APICULTURE

Tanquary published a short paper on the honey bee in 1919.

J. H. Merrill conducted numerous studies between 1918 and 1924 on brood diseases, winter protection, available honey plants, queen introduction, relation of stores to brood rearing, and winter consumption of stores.

After E. L. Eshbaugh went to the Northeast Kansas Experiment Field, R. L. Parker's studies changed toward apiculture. A popular bulletin on the subject was published in 1953 (and revised by N. M. Kauffeld and me in 1976).

Parker also published in many areas: beekeeping and orchards (1956); major pollen sources and influence of weather factors in pollen collecting, pollen as a limiting factor in honey production, winter protection of colonies (1958); honey grading (with Tilton, 1958); and foraging behavior related to different alfalfa clones (with R. Boren and Sorensen, 1962).

Part of W. Franklin's work at the Fort Hays Branch Station was the use of honey bees in connection with alfalfa and production experiments. He also studied *Nosema apis* and other bee diseases.

Kauffeld (working with Horber and Sorensen) was concerned with attractiveness of various alfalfa clones to bees at various locations, during different seasons and years (up to 1980). They also published (1971) on the relative attraction of flower color, aroma, nectar volume, and sugar content.

There has been no apiculturist in the Department since Kauffeld's departure.

SILKWORM

An editorial appeared in the Kansas Farmer in 1871 (August 15, p. 53): "It may be news to some of our readers that we have a silk factory in successful operation in this State. Mr. Boissiere, a wealthy French gentleman, established a factory in Franklin County, Kansas, some two or three years ago, which is now turning out several hundred yards of silk ribbon per day, from the raw material. This gentleman is also planting large groves of mulberry and ailanthus to feed the silkworms; and will gradually increase his facilities, as circumstances permit."

"The silk factory was located at Silkville, near Williamsburg, and was operated by Mr. E. V. Boissiere. Mr. Boissiere described his factory and its operation in a letter written October 26, 1872, to A. M. Blair, secretary of the Franklin County Agricultural Society, that read in part as follows: 'I commenced the weaving of silk velvet ribbon in 1869 but with very inadequate accommodations. In

the following year I erected a factory, 28' x 85', one story high, with walls of stone, which gives me ample room. I have now two looms, constantly employed: one capable of turning out 112 yards of ribbon one-half inch wide per day; the other, 72 yards, one inch wide. These looms employ two men and three women, and part of the time, a young girl. I shall soon have a third loom completed and set up, for weaving ribbon three inches wide, which will be capable of turning out 40 yards per day . . . I planted a quantity of white mulberry seed procured from France, for the sole purpose of rearing silkworms. They produced an abundance of trees.'" (Trans. Kans. St. Bd. Agric., 1872, p. 221)

"Professor Whitman was in touch with these operations. He visited Silkville in the summer of 1875. In his report to the Regents in 1874 he wrote: 'I was enabled to make some interesting experiments with native and foreign silk-spinning insects. Five native and three foreign species were successfully raised at the College.'" (Whitman, J. S., Fourteenth Ann. Rep. Dept. Public Instr. Kans., 1874, p. 131)

"Professor Whitman also acknowledged the receipt from Silkville of specimens of raw and manufactured silk raised and manufactured on the Silkville plantation, also of Chinese mulberry plants. This silk- manufacturing venture did not prove successful but mulberry trees were still to be found growing on the plantation site at Silkville.'" (Call, L. E., Agricultural Research at Kansas State Agricultural College before Enactment of the Hatch Act. Kans. Agric. Exp. Stn. Bull. 441, 1961.)

Further details on this silkworm venture were published by B. Vining, Kansas Farmer, February 2, 1890, and a detailed, illustrated account appeared in the Kansas City Star (on file in the Farrell Library at Kansas State University) but, unfortunately, is undated.

EXTENSION

The first extension entomologist in the U.S. was T. H. Parks, appointed in 1913 in the State of Idaho, largely because of problems with the alfalfa weevil.

Kansas was the second State to appoint a full-time extension entomologist: T. L. Talbert in 1914. When Talbert resigned in 1916, T. H. Parks replaced him. Parks resigned in 1918 and was replaced by E. G. Kelly who was here from 1918-1949. Kelly had joined the U.S. Bureau of Entomology at Washington, D.C. but frequently made summer trips to Kansas, with headquarters at the Bureau of Entomology Laboratory at Wellington.

Kelly was one of several men who accomplished so much that it cannot be fairly condensed here. Copies of several of his speeches and his annual plans and reports are in the files. As expected, virtually all of his publications are extension bulletins and leaflets rather than research articles. Hessian fly and chinch bug were the most commonly mentioned insects. The Colorado potato beetle was discussed when potatoes were extensively grown in the Kansas River valley east of Manhattan. There are only two publications with AES contribution numbers: one on grasshopper control in 1920, and one on cooperation between high schools and colleges (1922).

Kelly was dynamic, energetic, productive, and well known both by Kansas citizens and by his peers throughout the country. His yearly plans and year-end reports demonstrated his ability to plan, organize, and carry out insect control programs. They appear much like present day documents, except that television and other sophisticated procedures brought about by computers were not available during his time.

Among the items that stand out in his speeches are his efforts and successes in interesting young people in insects and associated disciplines. I am told that a typical trip might be to Garden City, with several stops along the way to obtain pertinent information. He would have facts ready for the news media the same day or the next morning, although seeking publicity was not his goal.

In his early years of Extension work, he realized the importance of cooperating with well-organized institutions, including the State Bankers Association, State Livestock Association, State Board of Agriculture, State Seed Growers' Association, state and local Chambers of Commerce, the National Livestock Loss Prevention Board, and the research and control divisions of the United States Department of Agriculture, Bureau of Entomology.

A number of highly successful statewide campaigns for insect control was organized by him. These included campaigns for the control of chinch bugs, Hessian fly, grasshoppers, and garden insects.

For more than 25 years, he was interested in livestock insect control. Although progress was slow during many of these years, his active interest made it possible for him to take the lead in demonstrating in Kansas the value of insecticides and sanitation in the successful control of livestock insects.

Kelly was replaced by Dell E. Gates in 1949. Some of Gates' projects and accomplishments are discussed below.

Abundant wheat crops during the late 1940s produced excess wheat that was placed in storage. The 1948 harvest season was very wet, resulting in much high-moisture, insect-infested grain. Food and Drug regulations became more restrictive on what was acceptable as human food. To aid an accelerated campaign for clean grain, Leaflet 30 "Stored Grain Insects and the Clean Grain Program" was produced by Gates and Whitehair, Grain Marketing specialist. The leaflet illustrated life stages and damage by stored grain insects, as well as insect control for grain on the farm. The leaflet became a regional source for the extension service in Kansas, Nebraska, Oklahoma, Missouri, Texas, and Colorado. In subsequent years, the leaflet was revised and reissued many times and is still being used.

The book, *Insects in Kansas*, was published in 1943 by the Kansas State Board of Agriculture, one of a series of publications on topics of importance to agriculture. The original authors were R. C. Smith, E. G. Kelly, G. A.

Dean, H. R. Bryson, and R. L. Parker. It was revised in 1962 by Gates and L. L. Peters.

Since Gates' time in the early 1950s, a newsletter of insect conditions has been prepared weekly by Extension entomologists during the growing season. Information from State Board of Agriculture survey entomologists, county agents, and university entomologists is relayed weekly to county agents, insecticide applicators, and insecticide handlers.

H. L. Brooks became the second Extension entomologist in 1965. He specializes in wheat and sorghum insects and safe use of insecticides.

Donald C. Cress joined the Extension staff in 1978, as Pesticide Coordinator and chairman of the Chemical Task Force. His primary responsibilities are pesticide applicator training and pesticide impact assessment. His work involves publishing the Kansas Pesticide Newsletter and miscellaneous publications on pesticide use. He also has revised and published the Private Pesticide Applicator Certification Manual and about 18 commercial manuals. As a result of the efforts of the Chemical Task Force, Kansas has one of the best, most efficient, and cost-effective applicator training programs in the U.S.

Donald E. Mock joined the department in June, 1973, as the first Area Extension Specialist, Crop Protection.

In 1978, his title was changed to Area Extension Specialist, Entomology. When the new position of Extension Integrated Pest Management Coordinator was created in 1980, he moved to the main campus. With Gates' retirement early in 1982, Mock assumed a part-time role as Extension Livestock Entomologist, while continuing with IPM program coordination.

Mock's position in Garden City was created in response to requests in southwest Kansas, which boomed in the 1960s when plentiful natural gas supplies were coupled with the bountiful Ogallala Aquifer to create a vast increase in agricultural productivity. Irrigated acreage in the 22-county Southwest Kansas Extension Area climbed from .5 million acres to over 2 million by 1975. The complexity of irrigated agriculture, interspersed with dryland farming and noncropland, created many niches wherein familiar insect pests assumed unusual importance.

While Mock's assignments from 1973 to 1980 carried no research responsibilities, he managed to conduct some related research on widely varying subjects. With Kadoum he published on pesticide residues found in tailwater pits during the pilot pest management project. For a number of winters in the mid-1970s, he conducted exhaustive surveys of southwestern corn borer survival, supplementing work by Jay Stone and K. O. Bell's personnel in the State Board of Agriculture, and documented the multimillion dollar annual crop loss from that pest. With Stone, Jeff Whitworth (one of Poston's graduate students), and W. P. Morrison of Texas A & M, he coauthored an annotated bibliography of the southwestern corn borer (1976).

During the grasshopper outbreak of 1977-1981, Mock necessarily devoted considerable time advising on grasshopper control. In 1979, he cooperated with Johnson, DePew, and M. Shuman of the Department of Entomology, Kansas State Board of Agriculture, in conducting efficacy tests of several insecticides with new Special Local Needs Registration for grasshopper control and was responsible for publishing the results in Insecticides and Acaricide Tests.

From 1981 through 1983, he worked cooperatively with Alberto Broce on a number of range cattle, fly-control demonstrations.

Mock was senior author of a widely used color-illustrated bulletin: Insect Pest Management for Corn in the Western Great Plains.

Phillip E. Sloderbeck, stationed at Garden City, has a major responsibility of providing educational programs in insect pest management for county agents, farmers, and crop consultants. One of the programs emphasized is the use of the southwestern corn borer model to time insecticide applications. This model was developed by S. Welch and F. Poston.

During 1982, he cooperated with G. L. Greene on a chemical efficacy test for ant control on turf; with Buschman on a miticide efficacy test and testing effects of pyrethroids on mite populations; and with Greene, Buschman, and Broce on a survey of parasites of fly pupae around cattle feedlots in southwest Kansas.

In 1985, he published with Buschman, F. R. Lamm, and G. L. Dick on effects of nonemulsifiable oils and sprinkler package on the efficacy of corn borer insecticides applied by chemigation.

From 1986 to 1988, he collaborated with Buschman in testing the efficacy of miticides for corn spider mites and of insecticides for corn borers. Another study in 1988 was with W. P. Morrison, C. D. Patrick, and Buschman, on seasonal shifts in species of spider mites on corn in the western Great Plains. He also published with DePew (1988) on control of the Russian wheat aphid: preliminary evaluation of insecticides and field tests of selected insecticides on winter wheat (with Harvey as additional author).

Robert J. Bauernfeind's demonstration projects include: chinch bug furadan-barrier treatments; chinch bug planting-time barrier treatments; insecticidal control of alfalfa weevil, grasshoppers in alfalfa, and chinch bug; effect of various white grub populations on wheat stands; sticky traps to detect greenbug movements; control of greenbugs in sorghum with planting-time insecticide applications; effectiveness of aerial applications of parathion in controlling chinch bug in wheat; and control of greenbug in wheat with insecticides applied at low temperatures.

Integrated Insect Pest Management Programs in Kansas

In 1972, the Federal Extension Service launched an expanded integrated pest management (IPM) program, encouraging state Cooperative Extension Services to test and develop IPM practices in crops other than cotton. Hence, an extension entomologist was needed in southwest Kansas to take the lead in developing a joint proposal with Agronomy and Plant Pathology cooperating. The Kansas proposal was coordinated with those of Texas,

Nebraska, and Oklahoma as the Great Plains Sorghum Pest Management Proposal, although interstate coordination was minimal.

The Kansas project consisted of a 3-year pilot project of pest management and provided for the employment of an Area Extension Specialist in Crop Protection to be stationed at Garden City. Provision was made for this to be a permanent position, with the university assuming funding responsibilities during a 3-year phase-in term. Mock secured this Area position.

Mock supervised nine scouts serving 27,000 acres in Haskell, Meade, and Stevens Counties. By 1975, there were 13 scouts serving 54,500 acres in Kiowa, Scott, Wichita, Greeley, and Nemaha Counties, in addition to the original three. The primary target pest for this IPM demonstration was greenbug biotype C on sorghum. The project gradually shifted heavily toward corn insect scouting as center-pivot irrigation of corn increased. Weed and plant disease scouting, soil sampling for plant nutrients and pesticide residues, and irrigation tailwater analyses were also included in the project.

While L. Brooks and other campus-based personnel helped direct the project, the 300-mile distance between campus and the project epicenter called for Mock to shoulder the majority of the responsibility for detail and execution.

The establishment of field crop consulting as a major agribusiness in western Kansas developed largely out of this pilot project. When the pilot project began, Schuster and Associates of Liberal, Kansas was the only firm scouting Kansas fields, handling about 25,000 acres. By 1976, there were nine firms employing 36 fieldmen and providing pest management services to 370,000 acres. By 1980, the scope of this new field of agribusiness had plateaued with some 80 or 90 consulting personnel serving about 1.1 million acres throughout western Kansas.

In 1976, this area position in Garden City had provided a positive example for the Kansas Legislature in funding a Crop Protection proposal. The proposal was the brainchild of Lindsay Faulkner, then Department Head of Plant Pathology, and was actively promoted by R. J. Sauer in Entomology and Roger L. Mitchell, who was then Vice President for Agriculture. This funded proposal created 11 new faculty positions -- one in each Area Extension unit and one in each of six departments on campus. This was the background for the addition of Lynne C. Thompson (urban entomology), Bauernfeind (South Central), and Lippert (Southeast Kansas) to the entomology faculty.

By the late 1970s, the extension IPM program had grown to involve all parts of the state and at least five departments on campus. Problems such as competition, lack of communication, and redirecting of IPM funds by administrators also had developed. Finally, in 1980, the position of Extension Integrated Pest Management Coordinator was created to help unify the IPM program and rectify those of the above-named problems that were within his power. Urged by fellow Area specialists in the crop protection disciplines, Mock was appointed and became a part of the faculty on campus.

Although Mock was officed in and maintained membership in the Department of Entomology, his duties as IPM Coordinator were interdisciplinary and provided liaison among virtually all of the departments in the agricultural production and natural resources disciplines.

ENTOMOLOGICAL HUMOR

A hoax perpetrated more than a half century ago is still being recalled.

A reporter from the old Manhattan (Kansas) Chronicle, in the Sunday issue of September 4, 1932, apparently bored with the lack of news, concocted a tale of the "Siberian Concrete Moth," which theoretically had been brought into the community by a Siberian student.

Wrote the reporter: "Baffling evidence of an insect which destroys concrete and certain types of rock and which has escaped isolation by scientists may have been found in the vicinity of the college."

The reporter hypothesized that part of the moth's 5-year life cycle was spent on the human body "in much the fashion of a ringworm or the itch, hence, it could easily have been brought to this locality by the Siberian student and have been deposited in a certain type of rock near the college to which it was especially adapted."

There was further speculation in the article that "Heavy damage to streets and buildings might result if the Siberian moth were to find its way to the concrete pavement on Highway 40 and creep toward the city (Topeka)."

The reporter offered some clues for those who would like to look for a Siberian Concrete Moth. "The habits of the pest are as peculiar and interesting as they are mystifying. The first evidence of its presence usually noted is a disintegration of the rock or the concrete which it attacks. The stone turns to powder when it comes under even slight pressure after being attacked by the Siberian moth."

One of the senior staff members, then one of the newest members of the department, recalled that "everyone thought it great fun--except the head of the department, George A. Dean, who wasn't happy with good-natured jibes from colleagues and former students who implied in communications with Dean that there was substance to the Chronicle report." Dean took the story to be downgrading to the entomological profession.

The article was widely copied, and numerous letters were received at the time of its release.

The News Bureau at the University recounted the story in 1982, and it was picked up by a national news service. Phone calls from at least 25 radio stations and newspapers came in, including Guam and Australia. The news service had apparently rewritten our News Bureau release, implying I was writing an entire book on entomological jokes and the most often asked questions were (1) did any of the readers believe the story and (2) what are some other entomological jokes? At least the equivalent of two days was spent on the phone!

When E. G. Kelly applied for an appointment in the U.S. Department of Agriculture, he wrote the E of his name with a flourish. So he was appointed as E. O. G.

Kelly and that was his official name in USDA matters. His government publications list E. O. G. Kelly as the author, e.g., E. O. G. Kelly and T. S. Nelson, Controlling Garden Webworm, USDA Farmers Bulletin 944, 7 pages, 1914.

Newspapers, at least in 1926, actually printed retractions! A report under the misleading heading "Bugs Big as Cows" was printed by the KSAC *Industrialist*, covering a lecture by the great Australian entomologist, Dr. R. J. Tillyard. He had lectured on the campus on some fossil insects that attained a length of 18 inches. The next week a correction of the headline exaggeration appeared in the *Industrialist* (April 14-21, 1926).

BIOGRAPHIES OF FORMER DEPARTMENT MEMBERS

Barbara N. Anderegg

She received an M.S. (1976) and a Ph.D. (1979) from the University of Wisconsin. She was a research scientist with the U.S. Grain Marketing Research Laboratory in Manhattan and her research was on the degradation of insecticide residue in stored grain. She resigned in 1984.

Judy K. Bertholf

She had an M.S. from Texas Technical University (1979) and a Ph.D. from Purdue University (1983). She came to KSU as Residential Extension Specialist to replace Lynne C. Thompaon. She resigned in 1985.

H. Paul Boles

Boles received an M.S. in 1947 and a Ph.D. in 1967, both from Kansas State University. He was a research scientist with the U.S. Grain Marketing Research Laboratory and worked on fumigation of grain and biological factors affecting it, grain resistance to insect attack, and moth-proofing. He retired in 1983.

John C. Boling

He received an M.S. (1968) and a Ph.D. (1976) from Mississippi State University. He served as specialist in fruit and vegetable insects from 1970-1972 and assisted in designing the Horticultural Research Center at Wichita. He resigned in 1972 to start a consulting firm in Texas.

Philip Bonhag

Dr. Bonhag was on the faculty from 1948 to 1951 with a specialty in insect embryology and morphology. He then went to Iowa State and later to the University of California. He died at an early age. I can find no records of him in our files, but know that he was a scholarly man.

Harry R. Bryson

Bryson was on the staff from 1924 to 1956. After receiving the B.S. degree in 1917 and the M.S. degree in 1924 at KSAC, he joined the faculty, with research emphasis on underground insects. He received his early training under J. W. McColloch.

Many of his earlier studies involved accurate identification of the immature stages of white grubs and wireworms, control of these insects on extensive cropping areas where crop rotation was not a feasible method of control, and treatment applied to planted seeds to protect them from underground attack until soil conditions were suitable for rapid germination. He also studied chinch bug hibernation and summer behavior of the corn leaf aphid.

His underground insect research was helped by the construction of a cave below the insectary west of Sunset Avenue near the old stadium.

He also wrote a laboratory manual on old-fashioned insect ecology, with emphasis on underground insects.

He was physically handicapped during his later years and suffered from chronic diseases. However, he continued his research and teaching whenever possible. R. L. Parker and I, as well as others, gladly took over his classes if necessary.

As members of the Department traveled around the country, they received many inquiries about Professor Bryson from former students, who always praised him as a teacher.

Bryson died in 1956. His tombstone at Sunset Cemetery in Manhattan has excellent carvings in granite of a scarab beetle and a noctuid moth.

Lee A. Bulla, Jr.

He received a Ph.D. from Oregon State University and then worked in a USDA laboratory at Peoria, Illinois. He came here in 1976 with the U.S. Grain Marketing Research Laboratory with an adjunct appointment with the Division of Biology, but several of his publications bear numbers from the Entomology Department. He left in 1982 to take an administrative position at the University of Idaho and then became Dean of Agriculture at the University of Wyoming.

Christian C. Burkhardt

He received an M.S. here in 1950 and subsequently went to the University of Missouri for his Ph.D. Then he moved to the University of Wyoming. While here, he did extensive research on insects of various field crops.

R. C. Connin

He received an M.S. from Ohio State in 1949. He served here as a USDA entomologist from 1951 to 1954. His studies mainly concerned a search for the vector of wheat streak mosaic virus. Later he studied transmission by the wheat curl mite, including host plant range, oversummering on volunteer wheat, epidemiology of the disease, and other possible vectors. He left to join the USDA staff in Bozeman, Montana.

Paul A. Dahm

Dahm received a Ph.D. from the University of Illinois and came here in 1947. He moved to Iowa State University in 1953, where he was later made a Distinguished Professor.

When Dahm arrived here, there were no laboratory facilities for research in insect toxicology. The major remodelling is described under "Facilities" above. He was one of the pioneers in using radioactive tracers in insecticide toxicology. He also made major contributions to the post-World War II adjustments and progress in entomology.

George A. Dean

Dean received his B.S. degree from KSAC in 1895. After two years managing his father's farm, he realized that he was destined to teach and entered Kansas State Normal College at Emporia (now Emporia State University). After receiving a teacher's certificate, he became principal of a grade school in Topeka.

In 1901, he commenced graduate work and received an M.S. in entomology at KSAC in 1905. For several years, he taught entomology and studied primarily chinch bug, Hessian fly, and San Jose scale.

Large losses from insects infesting flour mills and stored grain resulted in investigations under Dean's supervision. He inspected flour mills and elevators, railway cars, warehouses at seaports, and steamships on which flour and grain were shipped. Assisted by several workers, Dean developed the best method at the time for controlling insects in flour and grain.

In 1913, he became head of the department. Also in that year, he demonstrated a practical method for control of grasshopper outbreaks by broadcasting poisoned bran mash, an idea that had been developed in the department in 1911 and 1912. He also first suggested use of poisoned mash against cutworms and armyworms.

He served as a consultant on stored grain insects throughout the U.S. and parts of Europe and collaborated in investigations in several states on cereal and forage insects, including European corn borer, chinch bug, Hessian fly, wireworms, cutworms, grasshoppers, greenbug, and later Mediterranean fruit fly.

Dean was known as an excellent administrator. He continued as department head until age 73. He died in 1956, after a prolonged illness.

Lester J. DePew

He came to KSU in 1954, after receiving an M.S. from the University of Minnesota. He worked at the Southwest Kansas Branch Station in Garden City and studied primarily the biology and control of arthropods on wheat, sorghum, alfalfa, and minor crops in that area. He retired on December 31, 1989.

A. E. R. Downe

He received his Ph.D. from Queen's University, Canada and had worked with the Entomology Research Institute, Ottawa, Canada. Downe came here in 1961 and studied feeding habits of Kansas mosquitoes, including serological precipitin tests to determine host-blood sources. He returned to Canada in 1964, to the University of Saskatchewan and later to Queen's University in Ontario.

Elbert L. Eshbaugh

He received his M.S. from Kansas State University. From 1946 to 1966, he was at the Northeast Experiment Field near Wathena, studying particularly insects attacking apples and strawberries. He then served as Plant Protection Advisor in India from 1967-1971, working in extension and research for control of insects, rodents, and plant diseases. then he returned to Manhattan to study alfalfa weevil until his retirement in 1975.

Howard E. Evans

He received an M.S. and a Ph.D. from Cornell University. During 1949-1952, while at Kansas State, he taught General Entomology, Immature Insects, and Morphology and curated the insect collection. His research was primarily on wasp behavior. After leaving here, he worked at Cornell, Harvard University, and then Colorado State University.

Ernest E. Faville

Faville came to KSAC from Nova Scotia, where he had been director of the Nova Scotia School of Horticulture. He had great experience in the provinces of eastern Canada, appearing before audiences of farmers. He also was a regular contributor to Canadian agricultural journals. During vacation periods, he visited the leading fruit-growing areas of the eastern U.S. and Canada.

He was engaged as professor of horticulture and entomology in 1897. He was highly recommended in letters published in the *Industrialist*. For example in February, 1899: "In his work here in the development of the cold storage idea, fertilization, and the destruction of insect pests, he has given the department an impetus which will be lasting."

He resigned in December, 1898 to become president of the (Jewish) National Farm School near Philadelphia. He later founded the publication *Successful Farming* at Des Moines and was the principal stockholder of the *Farmers' Tribune* of Sioux City, Iowa.

Woodrow W. Franklin

He received his B.S. from McPherson College in 1942 and his Ph.D. from Kansas State University in 1950.

After several years of teaching high school, he was appointed to the staff of the Fort Hays Branch Station. From 1948 to 1953 he worked primarily on insects attacking alfalfa and the false wireworm. He also studied honey bees, bee diseases, wild bees, and seed production in alfalfa.

During 1953-1954, he was headquartered at the Central Agricultural Experiment Station at Suakoro, Liberia. There he studied insects attacking coffee, cocoa, and vegetable and citrus crops.

During 1956-1957, he was on the staff at KSU in Manhattan and Assistant State Apiarist with the Kansas Entomological Commission.

From 1957 to 1964, he was Entomology Advisor with AID, headquartered in the Somali Republic. There he helped establish various research programs, including

other phases of agriculture. Special emphasis in entomology included tse-tse fly surveys and sorghum insects. He also worked in Liberia.

He was head of the Department of Biology, Sterling College, Sterling, Kansas, from 1964 until at least 1970. I have been unable to obtain any information of him since that time.

Dell E. Gates

He received his M.S. from Kansas State and was Extension Entomologist here from 1949 until his retirement in 1982. Until Leroy Brooks was appointed in 1967, Gates was the only entomologist in Extension. It is remarkable how much he accomplished during these years, working in such a large state with such diversified crops.

William P. Hayes

He obtained his B.S. degree in 1913 and his M.S. in 1918, both from KSAC. His studies included such pests as thief ant, maize billbug, Hessian fly, and sorghum insects.

He resigned in 1924 to go to the University of Illinois, where he was head of the Department of Entomology, 1948-1955.

He died at Champaign, Illinois in 1970.

Thomas J. Headlee

Dr. Headlee succeeded Popenoe in 1907. In 1910, he remodeled the old greenhouse, primarily for greenbug studies, and perfected a constant temperature and moisture incubator. Later, he moved his equipment into sections of the "new greenhouse," for chinch bug and greenbug research.

He resigned to go to Rutgers University in 1912. I recall his fine work in New Jersey in connection with mosquito control in the 1940s.

Robert G. Helgesen

He obtained an M.S. in 1967 from North Dakota State University and a Ph.D. in 1969 from Michigan State University. He was on the staff of Cornell University from 1969 to 1980.

In 1980, he became professor and Head of the department here. His special interests include insect pest management, insect population ecology, forage crop entomology, and taxonomy of the Scarabaeidae. He took a leave in 1987-1988 to serve as Associate Director of Cooperative Extension. He resigned in August 1989 to become Dean of the College of Food and Natural Resources at the University of Massachusetts.

Significant progress is evident during his years here. Included are long-range planning, effective use of committees, faculty recruiting, resource distribution, encouragement of new programs and facilities, and microcomputer and audio-visual support.

Marshall W. Johnson

He obtained his M.S. from North Carolina State University and a Ph.D. from the University of California, Riverside. He joined the department in 1979 and was assigned to the Garden City Branch Station, to do research on arthropod pests of that area.

His major interests were insect pest management, biological control, and insect ecology. He evaluated acaricides, studied the distribution of spider mites within fields and on plants, and investigated the relationship between corn yields and spider mite densities per plant. He resigned in 1981.

Louis Keifert

He received his Ph.D. from the University of Kansas. He was on the staff here from 1947-1948, primarily as a teacher. He then went to the University of Florida.

E. G. Kelly

He was born and reared on a farm in western Kentucky, graduated from the University of Kentucky in 1903, and received his M.S. degree the following year. Later, he took advanced work at Kansas State College, the University of Minnesota, and Iowa State College, which granted him a Ph.D. in 1927.

From 1904 to 1907, he was assistant to S. A. Forbes in the Illinois State Natural History Survey.

In 1907, he joined the United States Bureau of Entomology, working in the Forage Insect Division. He was assigned to research projects in southern Kansas on chinch bug, Hessian fly, and grasshoppers. He became entomologist for the Kansas Extension Service in 1918 and remained in that capacity until his death in 1952.

Warren Knaus

He was born in Indiana in 1858 and died in McPherson, Kansas in 1937.

At the age of 12, he moved with his parents to a farm near Roper, in Wilson County, Kansas. He graduated from KSAC in 1882. During 1882-1886, he taught school in Dickinson County and worked for the Salina Herald. In 1885, he received an M.S. degree at KSAC.

He became interested in insects in 1880-1881, when he took courses in entomology taught by Popenoe. Although Knaus was a printer and publisher by profession, his hobby was insects. For about 50 years, he spent most of his spare time collecting beetles in Kansas, Oklahoma, and several western states. He maintained contact with other coleopterists throughout the world. In 1902, he was visited by Walter Horn. His collection of nearly 90,000 specimens and his library were transferred to KSAC in 1937.

He received an honorary Doctor of Science degree from KSAC in 1927. McPherson College also awarded him the same honorary degree. He was a member of the Kansas Academy of Science for 56 years and served as president in 1929. He was one of the founders of the Kansas Entomological Society and was its president in 1937.

Herbert C. Knutson

Dr. Knutson received his M.S. from Southern Methodist University in 1937 and his Ph.D. from the University of Minnesota in 1941.

He was on the faculty at the University of Rhode Island.

After serving in World War II, he became head of the Department of Zoology there and also Administrator of the Bureau of Entomology and Plant Industry for the Rhode Island Department of Agriculture.

He was appointed head of the Department of Entomology at KSU in 1953 and remained in that capacity until 1976. Then he returned to teaching and research until his retirement in 1983. He died in 1986.

He was an authority on medical and veterinary entomology, field crops insects, and the biology and management of mosquitoes and grasshoppers. Although he did significant research in these areas, Dr. Knutson felt that the training of graduate students was his most important accomplishment. After his retirement, he devoted much of his time to compiling this history of the department.

Paul G. Lamerson

He received an M.S. at KSAC in 1932 and was appointed temporarily to work on the apple and plum curculio in the Wathena area in northeastern Kansas. He published with R. L. Parker on strawberry leafroller and many other insects of fruits and vegetables. I was unable to locate further information on Lamerson.

Fred A. Lawson

He obtained his Ph.D. from Ohio State University and was on the staff here from 1946 to 1962. His main duty was teaching, but he conducted research to describe egg cases and nymphs of cockroaches and general cockroach morphology. He resigned to join the staff of Colorado State University, then moved to the University of Wyoming.

Charles L. Marlatt

Marlatt, who graduated from KSAC in 1884, was an Assistant in the department until he joined the USDA in 1889. He received an honorary degree from KSAC in 1922.

His work for USDA centered on the control of introduced insects. The first step was the passage of the Insect Pest Act in 1905. This prohibited shipping live insects into this country, mailing them, or sending them from state to state. In 1912, the Plant Quarantine Act, which Marlatt prepared, became a reality. Also in that year, he became chairman of the Federal Horticultural Board, which investigated insect pests before proposing quarantines. In 1928, this board became the Plant Quarantine and Control Administration.

David L. Matthew, Jr.

After receiving an M.S. here in 1954, he became the first Survey Entomologist for Kansas. He worked under the Division of Entomology of the State Board of Agriculture and maintained an office in the department. In 1958, he resigned to become an Extension Entomologist at Purdue University.

J. W. McColloch

During his undergraduate studies at KSAC in 1910 and 1911, McColloch was a special field agent and began his investigations on chinch bug, Hessian fly, and corn earworm. He received his B.S. degree in 1912 and his M.S. in 1923, both from KSAC. He was on the staff of the department from 1912 to 1925. He died in 1929.

I have been told by several colleagues that McColloch would have been one of the nation's outstanding entomologists had he not died of cancer at an early age. According to George Dean and others, he exhibited a rare ability to quickly analyze an insect outbreak and "he seldom erred in his judgment."

He pioneered work in this department on resistance of plants to insects (later taken over and expanded by Painter), and he studied relations of kinds and varieties of small grains to Hessian fly.

Joseph H. Merrill

Merrill received his B.A. degree from Dartmouth College in 1905 and his Ph.D. in 1914 from Massachusetts State College (now University of Massachusetts).

He joined the department in 1912, working mainly with garden and orchard insects and apiculture. His poor physical condition necessitated his retirement in 1925, but he was mentally alert and continued to publish numerous articles, mainly on apiculture, until 1941. He died in 1946.

Robert B. Mills

He obtained a M. Ed. from the University of Colorado in 1953 and a Ph.D. from Kansas State in 1964. He joined our faculty in 1963, later taking over leadership of the stored-product insects laboratory when Wilbur retired. He was also on the staff of the Food and Feed Grains Institute. He retired in 1987.

His research concerned the biology, behavior, and ecology of stored-product insects; farm bin infestations; and resistance of stored grain to insects. In 1976, he studied stored-product insects and their damage to maize in Yucatan. He conducted short courses here and abroad and acted as a consultant in Korea, Ethiopia, Costa Rica, Pakistan, and Venezuela.

Benjamin F. Mudge

Mudge graduated from Wesleyan University in 1840 and received his M.A. "several years later." In 1844, he entered the legal profession and practiced law for 16 years. However, he spent his spare time collecting and studying fossils, minerals, insects, and plants.

After moving to Wyandotte County, Kansas, he delivered many lectures on geology and was named State Geologist. He also was appointed Professor of Natural History and Natural Science at KSAC in 1865. During the early 1870s, he taught such diverse courses as botany, ecology, physiology, astronomy, mineralogy, meteorology, physical geography, physics, zoology, and entomology

In 1874, he was dismissed from the faculty by the Regents for "insubordination and gross misconduct." Students presented him with a gold watch, but President Anderson refused to permit the use of the college chapel for the occasion. The presentation was made off campus.

He then was employed by Yale College as a field geologist.

J. D. Parker (1879-1880) stated that his visits with Mudge lead to the formation of the Kansas Natural History Society, which later became the Kansas Academy of Science. Mudge served as the first president of the organization in 1868. Parker summed up Mudge's contributions: "As long as science has a name and place in the great central plains of the North American continent, Professor Mudge will not be forgotten as a scientific explorer and discoverer."

Dean (1938) wrote that one of Mudge's students was Samuel Wendell Williston, who became a world authority in paleontology and on the insect order Diptera. He frequently praised Professor Mudge as an inspiring teacher and accompanied him on collecting trips to Kansas fossil beds.

Mudge died in 1879. The Kansas Academy of Science collected funds to erect the monument that stands at his grave in Manhattan's Sunset Cemetery.

Reginald H. Painter

Painter came to this department in 1926, after receiving his Ph.D. from Ohio State University. He later received an honorary L.L.D. from the University of Arkansas.

Painter was in charge of the entomological aspects of cooperative projects with plant breeders in the Departments of Agronomy and Horticulture and the USDA, to develop plants with resistance to insects. When begun in 1926, this was the first experiment station project in this field. Many of today's entomologists received their training and education under the direction of Painter.

Among the areas studied, generally with graduate students, were various aspects of resistance to Hessian fly; corn rootworms on corn; corn leaf aphid on sorghums; greenbugs on alfalfa; spotted alfalfa aphid, pea aphid, lygus bug, and potato leafhopper on alfalfa; squash bug on squash; cucumber beetle on cucurbits; fall armyworm on corn; and chinch bug on sorghum.

Among insect-resistant varieties distributed or approved as a result of studies in which Painter collaborated were: Atlas Sorgo, resistant to chinch bug; Cody alfalfa, resistant to spotted alfalfa aphid; and Pawnee, Ponca, Ottawa, and other wheats, resistant to Hessian fly.

He presented the first evidence of the presence of biological strains in Hessian fly and the corn leaf aphid. As a result, their characteristics are probably better known than those of any other insect biotypes.

Early in his career, he described and named 10 new species of Apioceridae, which then constituted more than half of the known North American species and more than a third of the species in the world. For many years, he studied Bombyliidae, in collaboration with his wife, Elizabeth. They collected in Central America and extensively in the southwestern U.S. and Mexico. He described and named five new genera or subgenera and 96 new species or subspecies.

Painter died unexpectedly in 1968, while on sabbatical leave as a special staff member of the Rockefeller Foundation assigned to the International Center for the Improvement of Maize and Wheat, in Mexico City.

Ralph L. Parker

He came to KSU from Iowa State University in 1925 and took medical retirement in 1958. He died in 1968.

Parker was involved in teaching, research, and extension activities in bee culture and fruit and shade tree investigations. He was State Apiarist of the Kansas Entomological Commission and had charge of apiary inspection in Kansas. He was a nationally known judge of bee and honey exhibits and once served as consulting entomologist for the Bermuda Department of Agriculture.

Some beekeepers found American Foul Brood in colonies that had been treated with sulfa drugs. Parker maintained that, if the sulfa has been effective, there would have been no AFB at the time of inspection, so this was evidence of the failure of sulfa drugs and burning was the only remedy. I recall that when one irate beekeeper argued use of sulfa rather than burning his hives, Parker simply stated his reasoning in one sentence and then ignored him. Another beekeeper wanted the Kansas Entomological Commission to discharge Parker. Later this beekeeper, while fishing, fell from a rock and was badly injured. When he finally recovered, he wrote Parker a letter of apology.

Parker developed the apiary building and bee yard with cherry trees galore. He kept it in excellent shape, and it was gorgeous when the trees were in bloom. During his tenure, the department sold honey. Many townsfolk came to the office to buy honey from educated bees.

Percival J. Parrott

He was an Assistant Entomologist, starting in 1907. He was in charge of entomology for a short time after the resignation of Popenoe.

"Parrott, after 3 years of excellent work, went to the faculty of Cornell University, in which he had a distinguished career." (Willard, 1940)

George B. Partida

He received his Ph.D. in 1971 from University of California, Riverside. He was on the staff here from 1971 to 1975, with substantial teaching duties. His research concerned stored-product insects. He resigned to take a position at California Polytechnic University.

Leonard M. Peairs

Peairs was born in Lawrence, Kansas in 1886. He graduated from KSAC in 1905 and was a graduate assistant from 1905-1907. He received his M.S. in 1907, then served at the University of Illinois, the University of Maryland, and Cornell University.

He returned to KSAC in early 1910 and was an assistant professor until 1912. He spent the remainder of his career at the University of West Virginia and died in 1956.

Many of his studies were on the relationships of temperature to insect development. He collaborated with Sanderson on the revision of a textbook "Insects of Farm,

Garden, and Orchard."

Leroy L. Peters

He received his M.S. here in 1956 and his Ph.D. from the University of Missouri in 1971. He served as Survey Entomologist from 1958 to 1965 with the Kansas State Board of Agriculture and maintained an office in the department. He left to take a job with the South Central Research Extension Center of the University of Nebraska, Clay Center.

Charles W. Pitts

Pitts received his Ph.D. here in 1964 and was appointed to the staff in 1965. He left in 1978 to become Head of the Department of Entomology at Pennsylvania State University.

His studies included muscoid flies, mainly face fly, but also stable fly and house fly. The research centered on behavior and biocontrol, along with the usual insecticide control. He also worked with L. R. Taylor, a visiting professor, on aphid migrations and finished this research when Taylor returned to England. Pitts followed Roan as the unofficial Head of the department. He wrote . . "it proved to be a valuable experience for me. I would not change a thing along these lines."

Edwin A. Popenoe

Popenoe entered Lincoln Academy in Topeka, Kansas, in 1869 and received his A.B. degree from Washburn College in 1876, majoring in classical literature. He taught in public schools until 1879 and received an M.S. from Washburn in 1880.

Then he came to KSAC to teach and do research in entomology, horticulture, zoology, and botany.

In 1894, he was transferred from the chair of Horticulture and Entomology to that of Entomology and Zoology. He applied for reappointment after the general dismissal of faculty in 1897, but did not receive it. However, he was reappointed in 1899.

During his professorship, Popenoe also was superintendent of the college grounds, including planning and planting of trees and orchards. Like other entomologists of his time, he had a broad range of interests and knowledge, especially horticulture and geology.

For 10 years, he was secretary, and for one term was president, of the Kansas Academy of Science. Her was Entomologist with the Kansas State Board of Agriculture from 1874 until at least 1882 and also state inspector of nurseries.

He wrote an entomological column in the *Kansas Farmer* and was designated by the American Association of Land Grant Colleges and Experiment Stations to supervise the horticulture exhibit at the Columbian Exposition in 1893.

The Regents dismissed him again in 1906, but rescinded their action shortly thereafter. He was reprimanded for "inactivity and failure to publish anything." Except for these cold, terse minutes of the Board of Regents, all writings and evidence of Popenoe's ability and success are positive. However, his resignation was accepted in 1907.

He retired to his farm south of Topeka, specializing in iris and peony culture. He died in 1913.

Fred L. Poston

He received his M.S. in 1973 and his Ph.D. in 1975, both from Iowa State University. He came to this department in 1975 and was responsible for insect ecology and developing management programs for the southwestern and European corn borers. He resigned in 1984 to become Associate Director of the Cooperative Extension Service.

Lallan Rai

He received his M.S. from Agra University, India and his Ph.D. here in 1956. While at Kansas State, his research was on fumigation and pesticidal chemistry. He returned to India and eventually became head of a university department.

William A. Ramoska

He received his M.S. in 1973 and his Ph.D. in 1975 from Ohio State University. He worked for the Lee County (Florida) Mosquito Abatement District for one year.

After joining our staff in 1977, Ramoska began research on insect pathology, biological control, and tissue culture.

He developed a way to kill mosquito larvae with bacteria. Other studies involved the use of a fungus to control chinch bug and a virus to control southwestern corn borer. In 1985-1986 he was on sabbatical at Boyce Thompson Institute, New York, to study fungal pathogens of the leafhopper genus, *Empoasca*.

This promising research was cut short by his early death from cancer in 1986.

Charles V. Riley

Riley was born in London in 1843 and studied in France and Germany. He came to the U.S. at age 17. He worked for three years on a farm in Illinois and spent his Sundays collecting insects.

Then he went to Chicago as a writer for *Prairie Farmer*, emphasizing entomology. During 1864-1876 he was State Entomologist of Missouri, issuing nine famous reports on noxious and beneficial insects of that state.

Riley was a lecturer and member of the faculty of KSAC from 1870 to 1872. He again lectured in 1876, when Professor Whitcomb left. We have more than 90 of his hand-drawn teaching charts, many in color.

In 1877, the first Entomological Commission, consisting of three members, was established and funded for the purpose of studying the "Rocky Mountain Locust." It was attached to the Department of the Interior; $10,000 was appropriated for its use in 1878 and again in 1879. Riley was chairman and members were A. S. Packard, Secretary and Cyrus Thomas, Treasurer.

From 1876 until his death in 1894, he served with distinction as Chief of the U.S. Division of Entomology, USDA.

Riley was called the Father of American Economic Entomology, but he is known more for his research and

administration than for his teaching. A detailed account of his career is presented by Meiners (1977).

Clifford C. Roan

He received his M.S. in 1947 and his Ph.D. in 1950, both from the University of Illinois. He worked on Oriental fruit fly in Hawaii and then on insecticide studies at the USDA in Beltsville, Maryland. He joined our staff in 1954 and served as unofficial department head until his resignation in 1965. In 1960-1961, he received a Fulbright Award to work in New Zealand. His special interests were toxicology and insecticide residues. He was very effective in getting outside funding in the department. He resigned to take a position with the Geigy Company in Australia.

Carl W. Rettenmeyer

He obtained a B.A. from Swarthmore College in 1963 and a Ph.D. from the University of Kansas in 1962. He came here in 1960 to expand the insect behavior studies and specialized in army ant behavior. In 1971, he left to join the staff of the University of Connecticut.

Richard J. Sauer

Sauer received his M.S. from the University of Michigan in 1964 and his Ph.D. from North Dakota State University in 1967. He served as Acting Associate Director of the Michigan Agricultural Experiment Station and a faculty member in entomology at Michigan State University. From 1976 to 1980, he was professor and head of our department. With his innate administrative ability and increased financial support, he was able to expand and improve the department in several areas. He resigned to accept the position of Director of the Minnesota Agricultural Experiment Station.

John H. Simpson

He received a M.S. from Rutgers University in 1965 and served as the Survey Entomologist in Kansas from 1965 to 1970.

Roger C. Smith

Smith came to this department in 1920 (replacing Tanquary) from the Bureau of Entomology, USDA, Charlottesville, VA. He became head of the department in 1943. After reaching mandatory retirement age for administrators in 1953, he continued on as professor until 1955, when he helped arrange for the University's first U.S. Agency for International Development (AID) technical assistance program with India. He was one of two members of the initial survey team and then became a member of the house staff team, until his retirement in 1970.

Smith's research between 1920 and 1950 dealt primarily with the relationship of insects and climate, particularly those attacking alfalfa. To some extent, this encompassed nearly all phases of entomology, with broad, fundamental work on basic biology of insects. He also did insect control studies.

A publication in *Science* by an institution in a nearby state claimed that castor beans were lethal to grasshoppers, but based this conclusion on four individuals! Smith immediately ran tests and dispelled this claim (J. Econ. Entomol. 32:749-758, 1940).

For a while, he continued his studies on the Neuroptera, especially the lace wings and the spongilla flies. He was also highly effective in getting termite and pest control operators organized and legislation passed to regulate their work.

However, Smith emphasized and practiced good teaching. He taught at one time or another most of the courses offered by the department and prepared several teaching manuals. In 1972, he established the Roger C. Smith Scholarships, to be given yearly to an undergraduate major and a graduate student.

Among his favorite sayings was "It's a wise man who knows what to throw away." In this one case, he was not wise, because when I replaced him as department head, Dr. Smith had not thrown away anything!

Jay D. Stone

He obtained a Ph.D. from Iowa State University and worked at the Garden City Branch Experiment Station. His primary duty was to develop a full-time research program on insects and mites of corn, with emphasis on Banks grass mite. He left in 1976 to become Project Leader for Entomology at Texas A & M University Research Center.

Harry W. Somsen

He received an M.S. from North Dakota State University in 1949 and worked in Montana on wheat stem sawfly. He came here in 1954 as a USDA employee and studied Hessian fly and wheat curl mite, including surveys and screening of wheat varieties. He retired in 1976.

Maurice C. Tanquary

He came to KSAC in 1912, after receiving a Ph.D. from University of Illinois. In 1913, he received a leave of absence to join the Crocker Land Expedition in the Arctic as a zoologist. He returned in 1916 and resigned in 1919 to go to Texas A & M University.

His work here was principally teaching and research on honey bees.

I am told he had an excellent ability to translate the wording of scientific research into practical results. I knew him while I was a graduate student at the University of Minnesota but, unfortunately, did not take his course in beekeeping.

L. Roy Taylor

He was in the department as an NSF Senior Foreign Scientist Fellow in 1964-1965. He came from the Rothamsted Experiment Station in England and was the first entomologist to receive such an appointment, shortly after the program was started. He helped guide and participated in a Regional Technical Project with emphasis on migration of aphids. The project included trapping migrating aphids in several states with Johnson-Taylor suction traps and yellow pan traps. In 1977, Taylor received the Gold

Medal Award from the Royal Agricultural Society of England for his research in agriculture.

Hugh E. Thompson

He received a Ph.D. from Cornell University in 1954. For two years, he worked as an entomologist with the Pennsylvania Department of Agriculture, specializing in oak wilt transmission. He came to this department in 1956, initially specializing in transmission of Dutch elm disease. He also taught and did research on insects attacking forests and ornamental plants. He retired in 1986.

Lynne C. Thompson

He received his Ph.D. in 1976 from the University of Minnesota and joined our staff the same year. He was an Extension Entomologist, responsible for horticultural and urban insect activities. He resigned in 1980 to work on forest insects at the University of Arkansas.

Paul S. Welch

He was appointed to the staff in 1913 and resigned to go to the University of Michigan. His research included Lepidoptera of Michigan and the biology of certain aquatic Lepidoptera, Oligochaeta from any parts of the U.S. and Western Hemisphere, and certain nematodes. His role at KSAC was mainly teaching.

Stephen M. Welch

He received his Ph.D. from Michigan State University in 1977 and came to our department that year. He had charge of modeling agricultural production systems and developed many of the models now used in pest management in Kansas. In 1984, he became Technical Development Coordinator for the Cooperative Extension Service.

J. S. Whitman

He was previously employed in the city schools of Lyndon (Osage County), Kansas. He also had been professor of Geology at Pennsylvania State College for about nine years.

He was first offered the chair of Agriculture and Agricultural Science at KSAC in 1867, but rejected it. He was considered again in 1873, but was made instead professor of Botany and Entomology and a college librarian.

He spent the summer of 1874 collecting geological, entomological, and botanical specimens. He taught botany, entomology, physiology, geology, drawing and German at various times. He was also interested in developing silkworm culture in Kansas.

In 1876, the Regents set up a separate Department of Botany and provided that "the services of J. S. Whitman be dispensed with at the end of the year." He failed to get re-employment at the university.

He died in Lyndon, KS in 1904.

W. Keith Whitney

He received his M.S. in 1958 and his Ph.D. in 1962 from Kansas State University. He was on our staff from 1958 to 1962, as a Research Entomologist at the USDA laboratory. He left to work for Dow Chemical Company, then had a Ford Foundation appointment in Nigeria, and later joined American Cyanamid Company as Principal Scientist in Insecticide Discovery.

H. F. Wickham

He became professor in the department in 1907. I was unable to locate further information about him.

Donald A. Wilbur

He earned an M.S. from Ohio State University and joined our staff in 1928.

Wilbur was one of the important workers with grassland insects and the southwestern corn borer during the 1930s and 1940s. About 1950, his research pemphasis shifted to stored-product insects. This interest began when he was assigned to help with mill inspections to provide "certificates of cleanliness" to millers.

In the 1950s, Wilbur pioneered extensive farm testing of chemicals applied directly to grain as "protectants." These are still used widely for control of stored-grain insects.

He and his graduate students made an extensive survey of conditions on Kansas farms conducive to insect infestations in grain. Later research dealt with biology and behavior of stored-grain insects and postharvest resistance in varieties of sorghum and corn.

In 1959-1960, he studied grain storage and conducted research in Mexico for the Rockefeller Foundation. At various times, he served as a consultant to industry on stored-product insect problems. In 1967, he was called to Guyana by AID to evaluate grain storage insects in Georgetown. His study resulted in the effective use of aluminum phosphide for control of insects in bagged rice.

He retired in 1970 and died in 1989.

Valerie F. Wright

She received an M.S. in 1973 and a Ph.D. in 1979 from the University of Minnesota. Then she joined our department and the staff of the Food and Feed Grains Institute. Her research has included the feeding value for ruminants of fungal- and insect-deteriorated grain sorghum, estimating stored-product insect populations, and determining losses in millet resulting from insect attack.

She has conducted international training courses here and in the Philippines, Tanzania, Upper Volta, and other countries. Technical assistance assignments have taken her to Tanzania, England, Pakistan, and several countries in central Africa.

She resigned her position in 1990 to join the faculty at the Escuela Agricola Panamerica in Honduras.

BIOGRAPHIES OF PRESENT DEPARTMENT MEMBERS*

Robert J. Bauernfeind

He came from the University of Wisconsin, where he received his M.S. in 1976 and his Ph.D. in 1978. He was appointed in 1978 as Extension Entomologist for the South Central Area of 19 counties, with headquarters in Hutchinson, KS.

Richard W. Beeman**

He obtained an M.S. in 1974 and a Ph.D. in 1977 from the University of Wisconsin. He joined the staff as a Research Entomologist at the U.S. Grain Marketing Research Laboratory in 1979. His investigations include the identification and description of genes that confer resistance to insecticides in the red flour beetle. He also studies a region of chromosome 2 of this species that controls the development and differentiation of body segments.

Kermit O. Bell, Jr.**

He received an M.S. from the University of Arkansas in 1965 and a Ph.D. from Kansas State University in 1971. He joined the Kansas State Board of Agriculture in 1970 as Survey Entomologist.

He maintains an office in the department and is of considerable help by furnishing current information on pest severity and loss estimates for our extension personnel. He also locates fields with pest infestations suitable for carrying out experiments and obtains live pests from the field for use in research and teaching.

William C. Black IV

He received an M.S. in Forest Entomology from Duke University in 1981 and a Ph.D. in Entomology from Iowa State University in 1985. Before he joined our staff in 1988, he had a postdoctoral appointment at Notre Dame.

He teaches a course on insect genetics and does research on the evolutionary genetics of insect biotypes.

H. Derrick Blocker

He received an M.S. in 1950 from Clemson University and a Ph.D. in 1965 from North Carolina State University.

He joined our department in 1965 and teaches courses in taxonomy of insects and principles of systematics and morphology. His research is on taxonomy of leafhoppers, and he curates the insect collections.

Alberto B. Broce

He obtained an M.S. in 1967 and a Ph.D. in 1971 from the University of Florida. He spent one year of postdoctoral research on community ecology in Florida, three years in Mexico (partly studying remote sensing of screwworms), about one year at the Johnson Space Center in Houston, and three years with the USDA laboratory in Mission, Texas.

He joined our department in 1979 and conducts research on livestock insects, as well as teaching an introductory course in livestock entomology.

H. Leroy Brooks

He received his M.S. in 1963 at the University of Arkansas and a Ph.D. in 1967 from Kansas State University. He joined the staff as an Extension entomologist in 1965. Until 1976 he and Gates worked as a team to cover the wide range of Extension responsibilities. Initially, Brooks focused on corn insects, pesticide education, and IPM implementation. Later he concentrated on sorghum and wheat insects, provided interim assistance in ornamental and residential entomology and was active in 4-H and school enrichment programs.

Lawrent L. Buschman

He received an M.S. from Emporia State University in 1968 and a Ph.D. from the University of Florida in 1977. Before joining our department in 1971, he was at Mississippi State University and Sterling College in Kansas.

He is assigned to the Southwest Kansas Branch Station in Garden City. His research involves arthropod pest management in corn. Currently, he is developing biological, ecological, and population management data for the spider mite complex in corn.

Donald C. Cress

Cress obtained an M.S. from the University of Wyoming in 1966 and a Ph.D. from Oklahoma State University in 1969. After a year of postdoctoral research, he served as Extension Specialist at Michigan State University from 1970-1977.

From 1977-1978, he was a Research Entomologist at the Garden City Branch Station, where he conducted research mainly on mites attacking corn. He came to Manhattan in 1978 as an Extension staff member. During 1982-1983, he was on leave at Purdue University, where he served as User's Services Manager for the early implementation stages of the National Pesticide Information Retrieval System.

Barry A. Dover

Dover received his M.S. from Clemson University in 1983 and a Ph.D. from Texas A&M University in 1987. After serving as a visiting Assistant Professor at Clemson University in 1988, he joined the Department in 1989. He heads up the stored products insects program and serves as coordinator for the interdepartmental program of Pest Science and Management. His research specialty deals with the physiology of insect parasite-host interactions.

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* These biographies are brief because research and publication of present staff members are discussed in appropriate sections above.

** Adjunct appointment.

Richard J. Elzinga

He received an M.S. in 1956 and a Ph.D. in 1960, both from the University of Utah. He came here in 1961, after completing a one-year postdoctoral fellowship at the U.S. Army Biological Warfare Laboratories. His original activity at KSU was teaching, but his research involvement has expanded in recent years.

He has taught courses in general entomology, morphology, arachnology, and taxonomy and has been responsible (with H. D. Blocker) since 1980 for Insect and Arachnid Identification. During his first four years at the university, he assisted in teaching biology courses, until the Division of Biology was formed. He taught Field Entomology at Lake Itasca for the University of Minnesota during the summers of 1980 to 1983.

In 1980, he was awarded a Distinguished Achievement Award in Teaching by the Entomological Society of America.

Paul W. Flinn**

He received an M.S. in 1981 and the Ph.D. in 1984 from The Pennsylvania State University. He is a Research Entomologist with the U.S. Grain Marketing Research Laboratory, ARS, USDA.

His research deals with modeling the stored grain system and environmental factors influencing insect pest species. The development of an expert system for management of stored grain and the biological control of stored grain insect pests are also research activities.

Gerald L. Greene

He received an M.S. from Kansas State University in 1961 and then a Ph.D. from Oregon State University. He worked at the University of Kentucky and then the University of Florida. He developed one of the first usable pest management systems, for velvetbean caterpillar in the soybean ecosystem in Florida.

He came to KSU in 1976 to be Superintendent of the Garden City Branch Station until 1982. Then he began a long-term research project to develop means of reducing losses to biting flies in large feedlots of western Kansas, concentrating on parasites, predators, and feedlot management.

David W. Hagstrum**

He received an M.S. and a Ph.D. from University of California and joined the staff in 1983, as a Research Entomologist with the U.S. Grain Marketing Research Laboratory. He studies the biology, behavior, and population dynamics of stored-product insects under field conditions in four diverse ecosystems.

Marion O. Harris

She received her degrees from Michigan State University, an M.S. in 1982 and a Ph.D. in 1986, and joined the department that year. Her research involves sensory aspects of insect behavior, specifically host-plant recognition in the Hessian fly and visual and odor learning in the stable fly and face fly.

Tommy L. Harvey

He received an M.S. from Kansas State University in 1951, then served as an entomologist at New Mexico State University. He joined the department in 1954 and obtained his Ph.D. from Oklahoma State University in 1963. His position at the Fort Hays Branch Station involves full-time research on insect pests of crops and livestock, and he serves regularly on Ph.D. committees.

The emphasis of his research is plant resistance to insects. He has been involved in the development of several cultivars and germ plasm sources of alfalfa, sorghum, and wheat with resistance to insects and mites. In 1974, Harvey received an Agricultural Recognition (CIBA-GEIGY) Award from the Entomological Society of America for his research on resistance to greenbug in sorghum.

Jimmy H. Hatchett**

He received his M.S. from Oklahoma State University in 1961 and a Ph.D. from Purdue University in 1968. After a previous assignment in Mississippi, he joined our staff with an adjunct appointment with USDA-ARS.

He works on insect resistance in small grains and on insect genetics, particularly the Hessian fly.

Randall A. Higgins

He received a dual Ph.D. in 1982 from Iowa State University, in Entomology (insect pest management) and Agronomy (crop production and physiology). He became Extension specialist here in that same year.

His primary areas of responsibility are insects attacking field crops (corn, soybeans, and alfalfa); stored grains; and non-commercial horticulture. He is particularly interested in advanced crop/pest management practices, such as interpretation of plant responses to stresses, damage/loss assessment, and determining economic injury levels.

Theodore L. Hopkins

He received an M.S. from Oregon State University in 1956 and a Ph.D. from Kansas State University in 1960. He joined the staff then to do research on the metabolism and environmental fate of pesticides, the biochemistry and physiology of insect development and reproduction, and insect-plant chemical interactions. For the past few years, he has investigated the hormonal regulation and central role of aromatic amino acids (particularly tyrosine) in insect cuticle tanning and melanization and the chemical ecology of grasshoppers.

He has served as Acting Head of the Department of Entomology in 1980, 1987-1988, and again in 1989-1990.

Ernst K. Horber

He received a Dr. Sci. Technology from the Swiss Federal Institute of Technology, Zurich in 1951 and a Ph.D. from Kansas State University in 1954. He returned to Switzerland to work until 1970, when he joined our department.

His special interests include insect resistance in alfalfa, stored grain insects, biological weed control, pollination

of alfalfa, and management of wild bees.

Ralph W. Howard**

He obtained an M.S. in 1973 and a Ph.D. in 1976 from the University of Arkansas. He worked with the USDA Forest Service in Mississippi, where he studied the chemical ecology of termites.

He joined our staff in 1985, as a Research Entomologist with the U.S. Grain Marketing Research Laboratory. His research is on the role of chemicals in regulating infra- and interspecific interactions in the community ecology of stored-grain insects.

Ahmed M. Kadoum

He received an M.S. and a Ph.D. from the University of Nebraska, and came to Kansas State in 1966. His specialty is toxicology and pesticidal chemistry and he has researched the fate of pesticides in soil and water and also in stored grains and products.

George E. Lippert

He obtained an M.S. from West Virginia University in 1974 and worked as a County Agricultural Agent and a 4-H Agent in West Virginia from 1975 to 1978.

He became an Area Extension Specialist here in 1978, stationed at the Southeast Area Extension Office.

David C. Margolies

He received an M.S. from the University of Massachusetts in 1980 and a Ph.D. from North Carolina State University in 1984. He joined our staff in 1985 as an ecologist. His current research emphasizes the ability of spider mites and greenbugs to adapt to the environment and the competitive interactions of two species of spider mites on corn.

William H. McGaughey**

He received his M.S. in 1965 and his Ph.D. in 1967, both from Iowa State University. He was leader of the USDA Stored Rice Insects Research Laboratory at Beaumont, Texas.

He came to Manhattan in 1972 as a staff member of the U.S. Grain Marketing Research Laboratory. In 1981, he was named acting leader and in 1982, leader of the Biological Research Unit. His research involves integration of microbial insecticides in management systems for stored-grain pests.

Donald E. Mock

He received a Ph.D. from Cornell University in 1974. He joined the staff in 1973 and was stationed at Garden City as the first Area Specialist for Crop Protection. His responsibility was to establish a pilot program for management of insect pests in southwestern Kansas. He moved to Manhattan in 1980 to serve as Extension Integrated Pest Management Specialist and later as Extension Livestock Insect Specialist.

James R. Nechols

He received an M.S. in 1977 and a Ph.D. in 1981 from Cornell University. Then he worked at the University of Guam, specializing in biological control. He came to this department in 1984.

His interests are biological control, biology and ecology of parasitic insects and mites (especially those attacking fruits and vegetables), and horticultural pest management.

John C. Reese

He obtained an M.S. in 1971 from the University of Missouri and a Ph.D. in 1975 from the University of Wisconsin. He went to a USDA laboratory in California for postdoctoral work and then was on the faculty of the University of Delaware.

He joined our staff in 1982. His research is on the physiological aspects of plant-insect interactions. He now concentrates on greenbugs and chinch bugs, but will continue to do some experiments with black cutworms.

Phillip E. Sloderbeck

He received his M.S. from Purdue University in 1971. Then he served as the Survey Entomologist at the University of Kentucky, while completing requirements for his Ph.D. (1981). He then joined our department and became the Area Extension specialist for 22 counties in southwestern Kansas, stationed at Garden City.

C. Michael Smith

Dr. Smith received his B.S. degree from Southwestern Oklahoma State University in 1971 in Biology. His M.S. and Ph.D. degrees were earned at Mississippi State University in 1973 and 1976, respectively. After serving as a postdoctoral research associate at North Carolina State University for two years, Smith joined the faculty at Louisiana State University as an Assistant Professor in 1978. He conducted research and teaching in the area of plant resistance to insects for ten years and obtained the rank of Full Professor. In 1988, Dr. Smith assumed the position of Chairman of the Division of Entomology, Department of Plant, Soil and Entomological Sciences at the University of Idaho. Dr. Smith joined the faculty at Kansas State University as Head of the Department of Entomology in September, 1990.

Gerald E. Wilde

He received his Ph.D. from Cornell University in 1966 and joined our staff the same year. Initially, he worked on soybean insects, but then changed to studies of pests of corn (mostly corn rootworm and black cutworm) and sorghum (greenbug and chinch bug). His research has significant practical applications in providing extension personnel with information and helping growers control chinch bug outbreaks, like those of the 1970s. He did international studies while on sabbatical leaves with CIAT in Colombia in 1975 and with IRRI in the Philippines in 1981.

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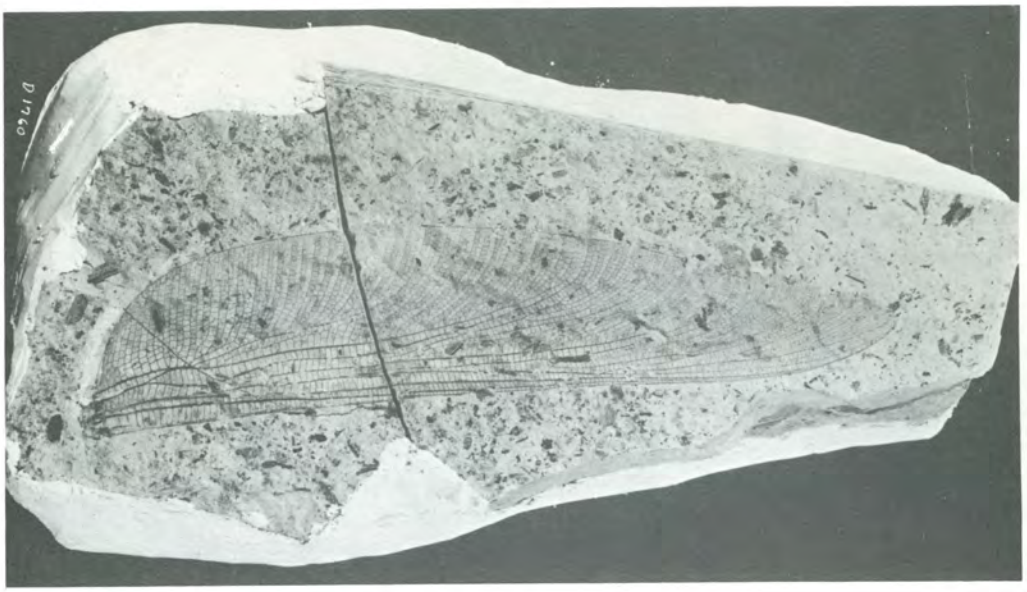
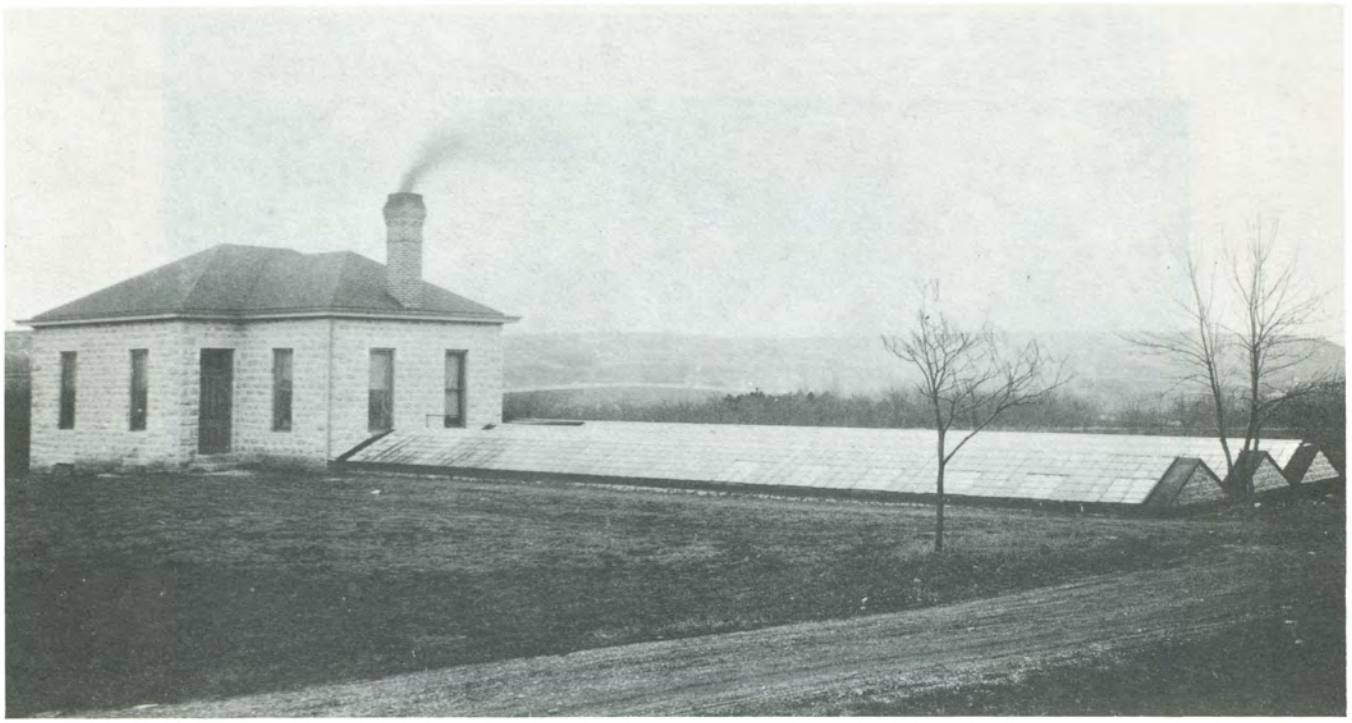
Mixing poison bran mash to control grasshoppers — 1913.

Suction machine for control of pea aphids — 1935.

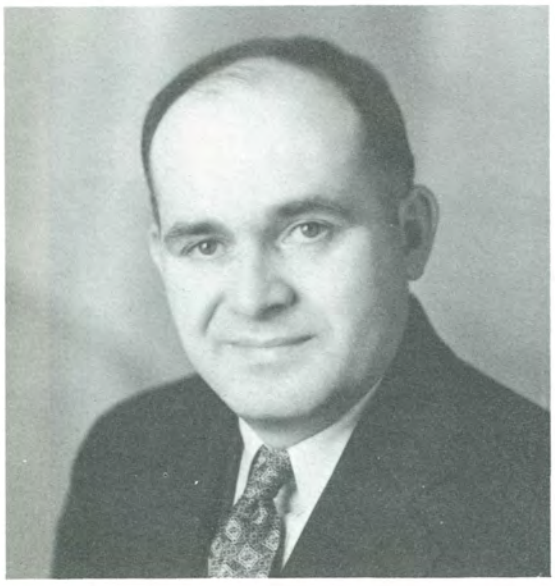


Fossil dragon fly wing, nearly 16 inches long, from Kansas.

Hopper Dozer — 1937. Grasshoppers flew up, hit the board, and dropped into pans of water with kerosene floating on top.



Entomological building and insectary — 1890.



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