A STUDY OF SOME EVENTS IN THE DEVELOPMENT OF ENTOMOLOGY AND ITS APPLICATION IN MICHIGAN

By

WALLACE EUGENE HOUK

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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Since omissions, particularly due to oversight, inevitably occur in an investigation of this type, the writer offers his regrets for those which may occur in this work. The reader is assured that such omissions were not purposeful.

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A STUDY OF SOME EVENTS IN THE

DEVELOPMENT OF ENTOMOLOGY AND ITS APPLICATION

IN MICHIGAN

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AN ABSTRACT

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A study of the development of entomology in Michigan, and some of the implications of that development, was conducted by the following methods:

1. Reviewing literature in Michigan libraries.
2. Consulting literature requested from out-of state libraries, and received by the Michigan State College Library, East Lansing, by inter-library loan.
3. Tabulating data from the correspondence files of the Michigan State College Entomology Department.
4. Consulting records of the Michigan State Department of Agriculture, Lansing; Michigan State Department of Public Health, Lansing; and the United States Bureau of Entomology and Plant Quarantine Forest Insect Laboratory, Milwaukee, Wisconsin.
5. Oral communications and written correspondence with State and Federal agencies, representatives of commercial manufacturers of pesticides and pesticide application equipment, personnel of several Michigan chambers of commerce, contemporaries of former teachers of entomology at the Michigan Agricultural College (presently Michigan State College), present scientific workers at the College, Michigan libraries, the Milwaukee Public Library, Milwaukee, Wisconsin, and other organizations and individuals.

The foundations of the scientific study of entomology in Michigan were established in 1837 when the State Legislature authorized a State Geological and Biological Survey. In 1850, the Michigan State Agricultural Society requested the Legislature to establish an agricultural college and recommended that "insects and their habits" be among the things studied. In 1855, an agricultural college (presently Michigan State College) was established at Lansing and its operation began in 1857. Entomology was first taught at the Michigan Agricultural College in 1858. A chronological account of the teaching of entomology at the Michigan State College since 1858 is presented. The teaching of entomology elsewhere in Michigan is also discussed. An assay of the biographies of former students of entomology at the Michigan State College shows that many of these students have made noteworthy contributions to the field of entomology.

Organized interest in the collection of insects in Michigan began in 1837 with the establishment of the Geological and Biological Survey. Details are given about insect collections and surveys since that time, including the size and content of the collections of some amateur entomologists and the size and content of insect collections in Michigan colleges and museums.

Cooperative pest survey and control programs, undertaken by local, State, and Federal organizations, have played

an important role in the development and application of entomology in Michigan. Extensive programs have been conducted for the Japanese beetle, European corn borer, grasshoppers, chinch bug, Oriental fruit moth, forest insects, flies, Rocky Mountain spotted-fever tick, and mosquitoes.

The first recorded agricultural chemical pest control in Michigan occurred in 1868. Developments in the chemical control of pests in Michigan since that date have been traced. The development of spraying and spray equipment since 1883 is illustrated pictorially. The history of legislation for the regulation, sale, and transportation of pesticides in Michigan, the entomological activities of the Michigan State Bureau of Plant Industry, Lansing, historical notes about some manufacturers of pesticides and application equipment, and miscellaneous notes on entomology in Michigan are included in this work.

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INTRODUCTION

This thesis is a study of the developments, factors, and special events in the growth and application of entomology in Michigan. Heretofore, nothing of this nature has been assembled and recorded for the State. Brief accounts of noteworthy entomological events, personnel, and collections in Michigan, and the contributions in other states of entomologists who once studied or were employed in Michigan, are scattered in general entomological histories by Leland O. Howard (1930), Herbert Osborn (1937 and 1952), E. O. Essig (1931) and Melville H. Hatch (1949). Two unpublished entomological theses at the Oregon State College, Corvallis - one by W. Homer Maris (1918) and another by Daniel E. Bonnell (1942) - deal with historical developments too. The growth of entomology in America from colonial times to the Civil War period, which provided the influence for the origin of entomology in Michigan, has been described by Harry B. Weiss (1936).

The writer's choice of this thesis topic was prompted by: (1) an interest in entomological history and literature; and (2) the fact that the application of entomology in Michigan has been different from that in other states. The latter fact is accounted for by the growth of a larger variety of crops as a result of more heterogeneous soils left by glaciers and a more moderate and variable climate due to Michigan's almost total isolation from other states by the Great Lakes. Since the States' early agricultural history, the varied crops have provided attractive hosts for previously unimportant or foreign insects and other organisms. The control of such pests, some presenting special problems, became one of the primary interests of Michigan agriculture. As a consequence, Michigan was an important pioneer in entomological experimentation and the training of entomologists. Therefore, entomology in Michigan has had extensive effects on the entire field of entomology.

The data for this thesis was compiled by: (1) reviewing much entomological and other literature in various Michigan libraries; (2) tabulating data in the correspondence files of the Michigan State College Entomology Department for the years 1925 to 1954 inclusive; (3) consulting records of the Michigan State Department of Agriculture, Michigan State Department of Public Health, and the United States Bureau of Entomology and Plant Quarantine Forest Insect Laboratory, Milwaukee, Wisconsin; and (4) oral communications and written correspondence with:

(a) relatives, colleagues, and students of deceased teachers of entomology at the Michigan State Agricultural College.

(b) past and present scientific workers at the College.

(c) the United States Department of Agriculture,

Bureau of Entomology and Plant Quarantine, Office of Information, Washington, D.C.

(d) various regional employees of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine.

(e) representatives of numerous commercial manufacturers of pesticides and pesticide application equipment.

(f) personnel of several Michigan chambers of commerce.

(g) registrars and other faculty members of Michigan colleges.

(h) directors of museums in the State.

(i) private individuals having special entomological interests or knowledge of insect surveys, collecting expeditions, and collections.

(j) the Michigan State Department of Public Health, Lansing.

(k) the Michigan State Department of Agriculture, Lansing.

(l) the Milwaukee Public Library, Milwaukee, Wisconsin.

(m) the Detroit Public Library, Detroit.

(n) H. B. Hungerford, Professor of Entomology, University of Kansas, Lawrence.

(o) personnel associated with the university of Michigan Museum of Zoology, Ann Arbor.

CHAPTER I

GEOLOGICAL BACKGROUND OF ENTOMOLOGY IN MICHIGAN

It is not known when insects first inhabited Michigan, for no fossils of insects have been found here.[1] However, evidence indicates that the first arthropod occurred about 445 million years ago. This was the caterpillar - like Onychophora which inhabited the warm seas of the Cambrian Period. By the Silurian Period, about 375 million years ago, saline seas had forced many animals to the land, and arachnids and scorpions appeared on land. Aquatic insects are believed to have appeared in the Devonian Period of approximately 350 million years ago. Spiders, scorpions, and centipedes were quite prevalent on the land then. When Michigan became separated from the ocean in the Pennsylvanian Period, approximately 235 million years ago, insects capable of life on land existed. The Coleoptera, Ephemerida, and Orthoptera were the predominant orders. As Michigan underwent considerable weathering and erosion in the Permian Period and the following 200 million years of the Mesozoic and Cenozoic Eras, the insects of the Paleozoic Era evolved to produce those orders with which we are familiar.[2]

Few recorded studies exist concerning the fauna and flora in Michigan up to the beginning of the nineteenth century. From about 1629 when the first European (Etienne Brulé) is believed to have set foot on Michigan soil to the termination of all foreign reign by the War of 1812, explorers, fur traders, settlers, and soldiers in Michigan could devote little attention to scientific pursuits. If specimens were collected or records thereof made, they were frequently lost or destroyed. No repositories existed; but some specimens were sent to European taxonomists.

Although it cannot be ascertained when and by whom insects were first collected in Michigan for scientific purposes, studies of the natural resources of the State were first provided for by the Michigan Legislature of 1837 which passed a law establishing a State Department of Geology and appropriated funds for a Michigan Geological Survey. Both of these were directed by Dr. Douglass Houghton, Detroit physician, surgeon, naturalist, college professor, and first State Geologist. The first reconnaissances of the Survey were made in 1837 and included zoological and botanical investigations by Dr. Abram Sager and Dr. John Wright, respectively. No insects were studied by Dr. Sager and before the end of 1838, the financial situation of the State necessitated that Dr. Houghton limit the activities of his department to geology. Nevertheless, the foundations of future biological investigations in Michigan had been laid.

CHAPTER II

THE ORIGIN OF THE STATE AGRICULTURAL COLLEGE AND ENTOMOLOGY IN MICHIGAN

With the formal admittance of Michigan to the Union in 1837, there came a rapid and continual influx of native born Americans and European immigrants who settled primarily in the rural areas and became farmers. By 1850, these people had made the raising of crops profitable and agriculture exceeded in value all other industries of the State. Because of the intense interest of the populace in agriculture, a group of citizens met at Lansing in March, 1849 to form the Michigan State Agricultural Society "to promote the improvement of agriculture and its kindred arts throughout the state of Michigan."[1] The Agricultural Society, assuming that the majority of the residents of Michigan were destined to pursue only agriculture extensively for a livelihood, had the instigation of the teaching of agriculture in the public schools as one of their objectives.

At Jackson, in December, 1849, the Michigan Agricultural Society resolved to request the Legislature to establish a central agricultural office to which would be connected an agricultural museum, library, college, and model farm. This request, with emphasis on the establishment of the agricultural college, was made in January, 1850, by Bela

Hubbard, Detroit lawyer, farmer, naturalist, and assistant State Geologist from 1837 to 1841, and chairman of the Agricultural Society Executive Committee in 1850. The Society stated that the studies at the college should consist of:

> agriculture in its details, mathematics and the keeping of accounts, mechanics, natural philosophy and the natural sciences with their applications to agriculture. With these could be profitably associated anatomy, so far as connected with the structure and disease of animals, and the study of insects and their habits.[2]

In March, 1850, the Michigan Legislature favored the Society's request and passed an act establishing a Normal School at Ypsilanti where instruction was to be given to both men and women in agricultural chemistry, husbandry, mechanic arts, and teaching. Prior to this the University of Michigan at Ann Arbor had presented some lectures on agriculture.

In 1852, a group sent from the Agricultural Society to Ypsilanti and Ann Arbor to evaluate the instruction in agriculture, reported that the information dispensed was unsatisfactory for training a student to be a practical and professional farmer; therefore agitation was continued for a school designed especially for the teaching of agriculture. The wishes of the Society were fulfilled on February 12, 1855, when the Legislature, upon the recommendation of Governor Kinsley Bingham, passed an act establishing a school to be called the State Agricultural College of Michigan (Michigan Agricultural College). This name was changed to "Michigan State College of Agriculture and Applied Science" in 1925.

On June 16, 1855, the Agricultural Society selected Lansing as the site of the Agricultural College (now in East Lansing) and on February 15, 1856, a contract was approved for the erection of "College Hall" (on the present site of Beaumont Tower) where classes were to be held, and a dormitory with a boarding hall. Each building was about one-hundred feet long and fifty feet wide, three stories high, and constructed of brick. College Hall contained a library, museum, and three recitation rooms (Figure 1).

On May 13, 1857, the State Agricultural College of Michigan was dedicated by the Michigan Board of Education and became the first school in the United States to offer scientific and practical instruction in agriculture. Its operation began with sixty-one male students to whom was offered a one-year preparatory course and a two-year regular course in chemistry, English Literature, farm economy, horticulture, and mathematics. All the activities of the college were directed by Joseph R. Williams, President and Director of the Farm. This remained the status of the college until 1859, when a reorganization provided a four-year curriculum for which the President had asked the Board of Education for additional faculty members. Among these was a Professor of Animal and Vegetable Physiology and Entomology. Thus began the teaching of entomology at the State Agricultural College of Michigan.

FIGURE 1

COLLEGE HALL (ON THE ~~LEFT~~ RIGHT), FIRST CLASS BUILDING AT THE STATE AGRICULTURAL COLLEGE OF MICHIGAN. THIS PHOTOGRAPH WAS MADE IN 1874.

CHAPTER III

THE TEACHING OF ENTOMOLOGY AT THE STATE COLLEGE OF MICHIGAN, 1858 TO 1894

Henry Goadby,* a physician and surgeon from Detroit, was the first teacher of animal and vegetable physiology and entomology at the Michigan Agricultural College. Dr. Goadby undertook his duties at the beginning of the winter term in December, 1858, and remained at the college until the end of the summer term of 1859 (the term ended in October). His total salary is believed to have been about 1000 dollars.[1] During Dr. Goadby's period of service, and thereafter until 1881, the teaching of entomology was done on the second and third floors of College Hall. From its beginning in 1858 and until 1863, entomology was considered only briefly at the College. A few class periods in zoology or veterinary science were devoted to insect study. Zoology frequently was limited to freshmen and sophomores but considerable variation existed concerning what class of students (freshman, etc.) was permitted to enroll in the course. This variation continued until 1878. The instruction offered by Dr. Goadby consisted of recitations and lectures on the "----- noxious animals and insects which infest fields or crops"[2],

* See biographical sketch in appendix.

and economically important insects were dissected in the laboratory. To supplement his classroom instruction, Dr. Goadby had written a treatise on vegetable and animal tissues called "A Textbook of Vegetable and Animal Physiology."[3] This book was written upon the request of Ira Mayhew, Superintendent of Public Instruction, and after Dr. Goadby's appointment to the faculty. It was one of the first of its kind in America designed for use in seminaries, colleges and other schools. Lessons 37 to 43, pages 128 to 150, deal with insects. The internal anatomy of the alimentary canal, principles of the Linnaean System of Classification, metamorphoses, and the nutrition of larvae and adults of Coleoptera, Hemiptera, Lepidoptera, Odonata, Hymenoptera, and Diptera are discussed. Dr. Goadby's teaching technique with his book was to supply short analyses of the paragraphs rather than follow the practice of providing the student with a list of questions to answer on what he read.

The competency of Dr. Goadby to teach physiology and entomology is borne out by the fact that prior to 1859 (his 54th year of life) he had been a microscopical dissector and demonstrator of anatomy in the Royal College of Surgeons in London, England and upon his coming to the Michigan Agricultural College he brought:

> --a cabinet of preparations, illustrative of Entomology and of animal and vegetable Physiology, which it has taken him thirty years of the most industrious study and severest application to collect and prepare. --- As a thorough practical teacher of the sciences for which he is named, he will be found most efficient.[4]

James H. Gunnison, an Agricultural College Student in 1859 described Professor Goadby in these words:

> Dr. Goadby was a wonderful man, a remarkable teacher; he went out with his students collecting and telling all sorts of interesting things and taught us to observe.[5]

In November 1859, Dr. Manly Miles* was appointed Professor of Zoology and Animal Physiology - the new title given to the department which Professor Goadby had served. Professor Miles, a physician, had gained prominence through his zoological work in Michigan in the position of assistant State Geologist (1859). His collections and observations were so extensive that it was said:

> Dr. Miles did more to develop the general natural history of the State (Michigan) than any other man either before or since he completed his work as State Zoologist.[6]

Dr. Miles was to play an even more important role in Michigan, in furthering the teaching of agriculture at the State College.

Professor Miles was head of the Zoology and Animal Physiology Department from 1860 to 1869. In 1861 and 1862 entomology was included in a course of veterinary medicine and economy of domestic animals taken by seniors. In 1862, Albert John Cook from Owosso, Michigan, was one of the seniors studying entomology at the Agricultural College. Mr. Cook later became well known for entomological work in Michigan and California.

Entomology appears to have been given much consideration by Professor Miles. Evidence for this was that in 1863 entomology became a separate course.[7] The course was called "Entomology"

* See biographical sketch in appendix.

and was taught to freshmen in the second half-year. Professor Miles met one one-hour class each day. A description of the course follows:

> The course in entomology is illustrated by a valuable collection of native and exotic insects. Particular attention is given to the study of species injurious to vegetation; and the best methods of checking their ravages are thoroughly discussed. Students, by collecting and preserving specimens of our native species, become familiar with their habits in their several stages of development.[8]

The students of 1863, by having to turn in a neatly arranged and labeled insect collection at the end of the course, set a precedent which is still followed by students in the introductory course of entomology at Michigan State. In addition to entomology, the freshmen studied trigonometry, surveying, stock breeding, and history.

Entomology and zoology, as taught by Manly Miles, was illustrated with actual specimens. His private collections were frequently used to supplement the meager specimens of the College. Dr. Miles was a popular teacher, for he combined scholarliness with enthusiasm. His enthusiasm and emphasis toward the development of entomology at the State College was verified by the words of Albert John Cook, an 1862 graduate, when he addressed a semi-centennial meeting of the Agricultural College in 1907:

> When he commenced to teach us entomology there were no suitable textbooks, but what cared he? Like Agassiz, whom he so much admired, he taught us to study the things of nature and not what others had said of them. His enthusiasm kindled a quick flame in the minds of his students; and how he loved to dig out the hidden truths of agriculture; and what a superb course he built up in that branch![9]

The success which Professor Miles had in teaching entomology and zoology led to his being given an additional appointment as acting superintendent of the College Farm in 1864, and in 1865 he was given the title of "Professor of Animal Physiology and Practical Agriculture and Superintendent of the Farm." This title distinguished him as being the first professor of agriculture in the first school of scientific and practical agriculture in the world.[10] In 1869 Manly Miles began devoting full time to his agricultural work, and remained Professor of Practical Agriculture until 1875 when he resigned.

Although Manly Miles and others had made extensive contributions to the development and growth of entomology and other agricultural subjects at the Michigan Agricultural College, the actual impetus for the promotion of the teaching of all those subjects pertaining to agriculture occurred through the passage of the Morrill Land Grant Act in Congress on July 2, 1862. This act most actively promoted between 1857 and 1862 by United States Senator Justin Morrill of Vermont, provided public lands in each state for the establishment of at least one agricultural and mechanical college within its boundaries. Besides becoming one of the first Land Grant Colleges, the State Agricultural College of Michigan had the distinction of being cited by Senator Morrill as evidence that such schools in other states would be successful.

Entomology at the Michigan Agricultural College received a tremendous stimulus through the Land Grant Act. The latter actually accounted for the origin of the widespread teaching of economic entomology in the United States.[11] In 1864, entomology at the Michigan Agricultural College was taught for the first time with a textbook devoted entirely to insects.[12]

In 1865, the farmers of Michigan had both the importance of entomology to their welfare and the importance of teaching entomology in the State College impressed upon them by the report that the Colorado potato beetle, Leptinotarsa decemlineata (Say), which had been spreading eastward since 1859, was causing serious losses in Illinois and Wisconsin. The menace of the potato beetle and outbreaks of the armyworm, Cirphis unipuncta (Haw), and cankerworm, Paleacrita sp., in Michigan prompted Manly Miles to investigate the life histories, habits, and controls of these insects.

In 1866, the President of the Michigan Agricultural College, Theophilus C. Abbot, reported to the Superintendent of Public Instruction that the graduates of the college were all occupying honorable positions in society. He said:

> They have contributed to the correspondence of the Department of Agriculture in Washington; have collected and studied entomological specimens ----

In 1867, Albert John Cook, who had received his Master of Science Degree from the Agricultural College in 1865, was put on the faculty as an instructor of mathematics. In addition, he aided Professor Miles by teaching a second half-year

sophomore course in entomology. With reference to this course, one entomological historian had published a paper on the teaching of entomology in the United States in which nothing was said about the Michigan Agricultural College being a pioneer in the teaching of entomology; and in response to the correspondence he received about the error he said, "---- I found that I had overlooked the fact that in 1867, A. J. Cook was really teaching entomology at the Michigan Agricultural College."[14] Evidence already presented in this paper shows that the Michigan State Agricultural College actually pioneered in the teaching of entomology in 1858. Entomology becoming a separate course at the College in 1863, at that time constituting a study of insects injurious to vegetation and their control, is evidence that <u>economic entomology</u> probably was first taught as a college course in the United States, and perhaps in the world, at the State Agricultural College of Michigan. Heretofore, the latter distinction has been given to the Kansas State Agricultural College, Manhattan.[15] Harvard University, Cambridge, Massachusetts, appears to have been the first institution to offer entomological instruction of any kind in the United States, (1837-1842);[16] and the Michigan Agricultural College perhaps was the second to teach academic entomology.

Although Albert John Cook had studied some entomology under Manly Miles, he was " ---- distinctly self-trained and self-educated in entomology."[17] Despite his limited formal entomological training, A. J. Cook was an extremely competent entomologist. He was especially well-versed in bee-keeping. In 1869, A. J. Cook became head of the Department of Zoology and Physiology, and as the Professor of Entomology he began using the newly published text "Guide to the Study of Insects".[18]

How entomology was taught during the first years that Professor Cook was giving the course was stated by Dr. Charles Edwin Bessey - an 1869 graduate of the College and a student of entomology under A. J. Cook - at the 1907 College semi-centennial celebration. Dr. Bessey said:

> Even the subject of entomology was mainly a textbook study. We memorized so many pages and repeated them as nearly as possible verbatim. Here we looked at specimens and now and then a student was seen frantically pawing the air with a "bug net" in his efforts to capture some beetle, bug, or butterfly. But we were under no supervision as to any field work we might undertake. A few of us were fortunate enough to be employed in arranging and labeling the college collections under the supervision of the professor, and here we learned much about insects, their appearance, classification, and the practical work of making a scientific collection. It was laboratory work, but none of us recognized it, nor did we ever use the word "laboratory" in connection with it.[19]

The following comments by various comtemporaries of Professor Cook further illustrate his teaching of zoology and entomology:

> 1. His class in zoology was taught wholly by lecture, and consisted of out-lining the groups of animal life, giving the names of the groups, and their characteristics; when it was done I had the whole system, as he presented it, outlined on a large sheet of paper. In Entomology we had a large textbook, but it was little used. He taught mostly by lecture. He taught how to collect insects and how to preserve them, in both imago and larval forms. But his chief emphasis was on the study of such insects as affect human foods. ---- we had the cabbage worm, tomato worm, and the potato bug down pat. ---- He

had a way of putting students st ease with him if they wanted to learn from him. His markings were high. He would give a ten for what would bring a seven or eight from Dr. Beal. He had little equipment to use in his classes, but he used the blackboard freely to bring out points.[20]

2. Professor Cook was an aggressive teacher who worked hard. He relied heavily on the textbooks for teaching entomology.[21]

3. Professor Cook's lectures consisted mostly of readings from books. Occasionally the lectures were not read. Emphasis was on the economic aspect of entomology, especially the control of insects and beekeeping. Insect specimens from the museum were used to illustrate class work. The first half-hour of class was spent on the lecture (with the students taking notes) and the second half-hour was devoted to either quizzing the students orally, and grading them on a scale of one to ten, or elaborating on topics not too clear to the class. Only rarely did students refer to textbooks to supplement their notes. At the end of the term, essay questions were asked on examinations. Laboratory sessions were used for drawing parts of insects and collecting and labeling insects. Professor Cook believed that if a student had drawn an insect, then something had been learned. Making the required insect collection was easy and considerable fun for most students. Professor Cook enjoyed his classes and the close relationships he had with his students. The average size class consisted of between 18 and 25 students. There were no disciplinary problems, for everyone was so interested in learning from Professor Cook that he was treated with much respect. The lack of work by any student made Professor Cook feel very hurt. His enthusiasm towards entomology was so great that, as he continued to lecture, he continued to raise his voice and individuals outside the building could tell when Professor Cook was lecturing. This enthusiasm aided tremendously in carrying his classes along.[22, 23]

Because of his familiarity with bees, Professor Cook instituted beekeeping in his entomology course in 1868. This was the first instruction in beekeeping ever given in a college in the United States,[24] and it consisted of teaching the principles of apiary management, construction of hives, care of bees, and honey extraction. Practical experience was obtained in the college apiary. The apiary was first located in the vicinity of the present William J. Beal Botanical Garden and the Music Building.[25] Later during Professor Cook's tenure at the Agricultural College, the apiary was moved back of Professor Cook's house in faculty row (about where the present Mary Mayo Residence Hall, West stands) and "next to the woodlot". During the 1880's there were between sixty and eighty hives in the apiary.[26] The apiary, as it was about 1887, is illustrated in Figure 2.

In 1871, the first insect collection was placed in the College Museum (in College Hall). This collection consisted of three groups of specimens designated faunal, scientific, and economic. The collection may have been purchased from the Smithsonian Institution, for in the early days of that organization some of its expeditions were partially financed through the sale of duplicate collected material.[27] Professor Cook and Charles E. Bessy, close friends and companions on field trips, already had collected numerous insects and plants in the Lansing Area.[28] These specimens, and several thousand other insects collected by Professor Cook during his stay at the Agricultural College, were contributed to the College Museum.

A decade of the teaching of agriculture in Land Grant Colleges had created a need for textbooks; and by 1872 Professor Cook and his students had access to the following publications:

1. Bevan, Edward. The Honey Bee, Its Natural History, Physiology, and Management. London: VanVoorst, 1838, 447 pp.

2. Curtis, John. <u>Farm Insects</u>. Glasgow, Edinburgh, and London: Blackie and Son, 1860, 528 pp.

3. Kirby, William and William Spence. <u>An Introduction to Entomology</u> 7th. ed. London: Longman, Brown, Green, Longmans, and Roberts, 1859, 607 pp.

4. Langstroth, Lorenzo L. <u>A Practical Treatise on the Hive and the Honey Bee</u>. 3rd. ed; rev. Philadelphia: J. B. Lippincott and Company, 1870, 409 pp.

5. Westwood, John O. <u>An Introduction to the Modern Classification of Insects</u>. London: Longman, Orme, Brown, Green, and Longmans, 1839-40, 2v; 462 pp. and 587 pp.

In 1872, a "Natural History Society" was organized by the faculty and students of the College. Meetings were held about twice a month, and talks on insects were frequently heard.

Entomology and animal physiology were both taught in the same course in 1874; hence only seven weeks were devoted to entomology. By this year, the details of insect dissections were being drawn on the blackboard by the students in the laboratory. Each student explained the morphology and anatomy of his particular species to the other members of the class. The lectures dealt with insect classification, distribution, transformation and development. Students were rearing insects to study their development; some took rearing cages to their residences to enable them to study their insects more thoroughly.

In 1875, besides continuing to make drawings and explanations of their insects in the laboratory, students met with Professor Cook in groups of two to three for a one-hour lesson each week on the morphology and anatomy

FIGURE 2

THE APIARY AT THE MICHIGAN AGRICULTURAL COLLEGE ABOUT 1887. THE APIARIST IS BELIEVED TO BE PROFESSOR COOK. THIS PHOTOGRAPH WAS LOANED TO THIS WRITER,AND PERMISSION GRANTED FOR ITS REPRODUCTION,BY JESSIE A.PETTIT,FORMER PROFESSOR OF ENTOMOLOGY AT THE MICHIGAN STATE COLLEGE (1906-1934)

of insects. Some charts of insect life-histories were now available in the laboratory. Emphasis was put on the use of the microscope in 1875 too. A microscope was first used at the Michigan Agricultural College in 1872 or 1873 by Dr. William J. Beal, Head of the Botany and Horticulture Department.[29] The construction of this microscope is not known. In 1876, Professor Cook reported to the Michigan State Board of Agriculture, governing body of the College, that "----- we also need at least three and five would be better - of Tolles' hand lenses for use in dissection in entomology. -----"[30] Reverend Henry V. Clark of Clearwater, Kansas, an 1878 graduate of the Michigan Agricultural College and the oldest living alumnus in 1953, mentioned a microscope being used in his physiology course taught by Professor Cook.[31] During this period, the Tolles' Student Microscope may have been the type used in entomology. The Tolles' Microscope was manufactured by R. B. Tolles, Boston, Massachusetts. A microscope bearing the inscription "Botany Department, M.A.C; May 3, 1878, Bausch and Lomb Optical Company. Rochester, New York", probably the oldest at the Michigan State College, is still possessed by the Department of Botany and Plant Pathology.

After 1881, during which six weeks in the winter were spent in studying microscopy at Cornell University, Professor Cook was considered quite an authority on microscopes; and representatives of microscope companies would come to the campus and stay at the Cook residence several days at a time just to quiz the Professor on how they could improve their instruments for better use by zoological students.[32]

Professor Cook continued to emphasize beekeeping and in 1875 the apiary consisted of several hives of German, Italian, and Syrian Bees surrounded with a number of excellent honey plants. "Mysteries of BeeKeeping Explained" was a text.[33] In addition to his teaching duties, which now included rhetoric, bookkeeping, history, and mathematics, Professor Cook was appointed Curator of the Museum. The museum, and the Department of Zoology and Physiology (Professor Cook preferred to call it the Department of Zoology and Entomology, and by 1889 he called it the "Entomological and Apiary Department") still occupied College Hall, and the growth of both was rapidly necessitating more space. In 1876, while reporting to the State Board of Agriculture that the museum was overcrowded, Professor Cook commented that "the question, too, of room beyond the limits of the present apartment is one that must soon call for attention".[34] Futhermore, in an additional report on the Zoology and Entomology Department for the same year, he remarked that:

> owing to a change in the arrangement of the College terms, my instruction has been such as to make the title of my professorship almost a misnomer; the majority of the subjects taught not coming in my department at all. I feel that in view of the increasing duties of my position as Apiarist, and Curator of the Museum, and the disadvantage I labor under in giving instruction in so many subjects entirely foreign to my general thought and study, - Rhetoricals, Book-keeping, History and Mathematics -

that some provision for a change is desirable.[35] Despite his multiplying collegiate responsibilities, Professor Cook managed, in 1875, to write an apiary manual[36] and a report on injurious insects in Michigan.[37] The former consisted of the lectures on beekeeping presented to students prior to 1875 and the latter was the first extensive paper of its kind pertaining to Michigan.

In 1876, the College divided the school year into three terms (fall, winter, and summer). The "term" system shortened entomological instruction from twelve to eight weeks. Entomology was given to juniors in the winter term. (From 1866 to 1876, the school year had started the last of February and extended to the last of November). The lectures were on the anatomy, physiology, and classification of insects, and economic entomology and apiculture. The last two topics were taught with the aid of Professor Cook's newly published treatises on injurious insects and beekeeping, respectively. The beekeeping instruction now included how to divide colonies and introduce queens.

Besides his teaching in 1876, Professor Cook spoke before several State and national agriculture meetings, answered a voluminous number of inquiries about insects, and began research on a kerosene emulsion insecticide and the life history and control of the imported cabbageworm, Pieris rapae (L.), codling moth, Carpocapsa pomonella (L.), Hessian fly, Phytophaga destructor (Say), and other insects.

Beginning in 1877 and continuing through 1892, entomology was taught in the summer term and the students spent five hours a week in class. The term was twelve weeks long. Summer provided the best conditions for the outdoor work in the course. The manner of teaching, throughout this period and up to 1894, remained the same as it had been prior to 1877. In 1891, the summer term entomology course was given the designation "Entomology IV". This was the first entomology course at the Michigan Agricultural College to be designated by number. In 1878, the College accepted donations of a Quimby and a Bingham bee smoker and a Doolittle hive from Michigan residents for apiary instruction. Two bee reference books now available were "A Manual of Bee-Keeping"[38] and "The Apiary".[39] By 1878, the College Museum contained thirty insect cases holding 1100 species of Michigan insects. Most of these had been collected by Professor Cook.

In 1879, all the students at the Agricultural College were required to present an acceptable thesis on some research topic for graduation; thus began the investigation of specific insect problems by entomology students, a method of learning still practiced by graduate students.

In 1882, the Department of Zoology and Physiology moved to the newly constructed Library and Museum Building. This structure is presently known as the Administration Building, but the stone-engraved sign "Library and Museum" at the West entrance still exists. This building is

illustrated in Figure 3. The teaching of entomology was done on the second floor where the facilities consisted of two rooms provided with tables, microscopes, and dissecting apparatus for laboratory work, and a lecture room for eighty students, and a general museum. The lecture room and museum were adjacent to the laboratory but on opposite sides of it. The Library and Museum Building had cost 25,000 dollars and the zoological and museum equipment had cost 16,870 dollars. In 1883, Professor Cook reported to the State Board of Agriculture that the new, large laboratory had enabled the work of his department to be done more satisfactorily than ever before.

In 1881, the entire entomology class exhibited a large collection of injurious insects at the American Horticultural Society Meetings and then presented the collection to the College. One student gave an insect collection to the South Haven Pomological Society, South Haven, Michigan. Another student had come from England especially to study apiculture under Professor Cook.

In 1882, the College began requiring post-graduate students to spend at least one year on the campus to obtain a Masters Degree. A thesis was another requirement for the degree.

In 1887, Congress passed the Hatch Act, vigorously promoted by Representative William Henry Hatch of Missouri, which provided for the establishment of State Agricultural Experiment Stations. With the organization of the Experiment

FIGURE 3

THE LIBRARY AND MUSEUM BUILDING

Stations in 1888, there was a great demand for trained entomologists. Because few men had training in entomology, the demand could not be met immediately. The market created for entomologists led numerous men and women to begin studying entomology to fill the Station positions. Until these people were available, entomology teachers and personnel untrained in entomology carried on the entomological activities of the Experiment Stations. At the Michigan Agriculture Experiment Station, Professor Cook served as "Entomologist" from 1888 to 1893.

After 1888, an increase in student enrollment at the Michigan Agricultural College, a result of the Hatch Act, effected a simultaneous increase in entomology enrollment. Prior to 1888 the enrollment in the Zoology and Entomology Department had ranged from seven to 45 students annually. In 1891 the enrollment was 120. The influx of students in entomology is believed to have been due to the excellent repute of the facilities in the Library and Museum Building and to the continually growing insect collection which was extensively used in teaching. In 1889, the insect collection was enlarged considerably by donations of over 52,000 specimens. The quality of entomology at the Michigan Agricultural College in 1891 is illustrated by the following excerpt from a letter written in 1891 by Charles Fuller Baker, (a student under Professor Cook (1887-1891), an 1891 graduate of the College, and a noted entomologist prior to his death in 1927), to his father, Joseph S. Baker:

> From here I can get to vastly better places than I could from anywhere else ---- no institution in the U.S. affords such facilities for special study in Entomology - as does this.[40]

Between 1888 and 1894, Professor Cook was hoping to increase his staff, and the facilities, to make entomology at the Michigan Agricultural College even better. During this period, he was permitted to hire assistants to aid him in laboratory instruction and to collect insects and work on the insect collection. These assistants, and the period they served, were: (1) Clarence P. Gillette (1887-1888); (2) Arthur B. Cordley (1888-1890); (3) Fred H. Hillman (1890); (4) Charles B. Cook (1889-1890); (5) Frank J. Niswander (1890-1891); (6) Charles F. Baker (1891-1892); and (7) Gager C. Davis (1891-1892). The short tenure of these workers was due to the fact that other colleges enticed them away with higher rates of compensation.

In 1890, Miss M. L. Cummings of Olivet gave the Zoology and Entomology Department considerable aid without accepting compensation.

On November 10, 1893, Professor Cook resigned from the Michigan Agricultural College to accept the Chair of Biology at Pomona College, Claremont, California. Despite Professor Cook's statement that he was leaving:

> principally because of the attractions of California and the fact that my department with the assistants I have had is too large for me to do the work as I desire to do it

several conjectures were made as to why he left the College. Some of these were:

1. The Agricultural College had grown too large. His enjoyment of a small school, small classes, and close relationships with students and faculty could be fulfilled at Pomona.[42]
2. His brother-in-law, Reverend Cyrus G. Baldwin, was President of Pomona College(1890-1897) and was constantly urging Professor Cook to go to Pomona. The Professor had indicated that he might go to California after the graduation of his two children, Albert Baldwin and Katherine, from the Michigan Agricultural College in 1893.[43]
3. He was the only one of the "big three" (the others were Dr. William J. Beal and Dr. Robert C. Kedzie) that failed to receive an advance in salary. Professor Cook's profits from his "Manual of the Apiary" might have been a factor that prevented a raise in pay.
4. Ill health forced his movement to a more suitable climate.
5. Obtaining authority for the erection of the Library and Museum Building from the Legislature after the State Board of Agriculture had denied his request, had wrought ill feelings. The "atmosphere" at the college was just not what it should be.[44] He, himself felt that he had injured his relationship to the State Board of Agriculture by going over their heads to the Legislature to get the Library

and Museum he wanted with the much needed class-room and laboratory space for his department.[45]

Whether it was one or a combination of the above reasons that led Professor Cook to go to California, it is known that he went from the Michigan Agricultural College in good standing. Evidence for this is that the State Board of Agriculture allowed him to take specimens of insects, of which there were duplications, from the College collection, and Professors William J. Beal and Robert C. Kedzie presented him with a letter of commendation signed by all the faculty members. This letter read:

> Whereas Professor A. J. Cook, after twenty-seven years of service in this college, has resigned his position as Professor of Zoology and Entomology and will soon leave us to fill a similar position in a college in a distant state; the faculty of Michigan Agricultural College desire to express their appreciation of his faithful, earnest, and successful work as a teacher in this college and his entire devotion to its interests. Both as teacher and citizen he has been alive to every good word and work. We part from him with sincere regret and invoke for him the large measure of success in another college which he has reached in Michigan Agricultural College. Resolved that this minute be spread upon the records of the faculty and a copy be placed in the hands of Prof. Cook.[46]

At the Michigan Agricultural College, Professor Cook had obtained an excellent reputation as a teacher and an entomologist. His practicl mind and manner of speaking, both in the classroom and at Farmers' Institutes had benefited him and the College enormously. His writings also enhanced him name. His ability as a teacher was reflected in the achievements of those who had their zoological or entomological training under him. The most noteworthy of

these individuals, with their year of graduation, were: (1) James Troop (B.S., 1878; M.S., 1882); (2) Clarence M. Weed (B.S., 1883; M.S. 1884); (3) Clarence P. Gillette (B.S., 1884; M.S., 1888); (4) Edward R. Lake (B.S., 1885; M.S., 1888); (5) Fred H. Hillman (B.S., 1888; M.S., 1891); (6) Charles B. Cook (B.S., 1888; M.S., 1891); (7) Arthur B. Cordley (B.S., 1888; M.S., 1890); (8) Frank J. Niswander (B.S., 1889); (9) Gager C. Davis (B.S., 1889; M.S., 1890); and (10) Charles F. Faker (B.S., 1891). John M. Aldrich was a student in 1889-1890.

CHAPTER IV

THE TEACHING OF ENTOMOLOGY AT THE STATE COLLEGE OF MICHIGAN, 1894 TO 1930

Upon the resignation of Professor Cook, his department was placed in charge of Gager Calvin Davis, Consulting Zoologist of the Experiment Station (1893-1896). Mr Davis directed the activities until February 20, 1894 when Walter Bradford Barrows* was appointed Professor of Zoology and Physiology and head of the department. Professor Barrows came from Washington, D.C. where he had served as first assistant ornithologist in the United States Department of Agriculture and lecturer at the Maryland Agricultural College, College Park.

Although entomology continued to be taught in the same manner as under Professor Cook, the course (Entomology IV) was believed to be improved by decreasing the number of lectures to one a week and increasing the amount of time spent in the laboratory to eight hours a week. The laboratory consisted primarily of studying specimens. The simple magnifying glass appears to have been favored over the microscope for identification. Some laboratory time was devoted to experiments on insecticides. Beekeeping received little

* See biographical sketch in appendix

attention from Professor Barrows and eventually it disappeared from the course. In lecture, Professor Barrows' ornithology interests led him to stress the natural control of insects by birds.[1]

In 1895, an advanced course of entomology was offered to seniors as an elective, if they were prepared to take it. This included systematic and economic work and each student had to make a thorough study of one family of insects. The student could choose the family of most interest to him. The courses related to entomology that could be taken were: (1) Parasitic Fungi; (2) Floriculture, Spraying, and Greenhouse Work; and (3) Economic Zoology.

In 1896, when the Michigan Agricultural College initiated a "Womens Course", the sophomore co-eds were offered entomology in the spring term(in 1896, a regular spring term was instituted; thus making the school year like that familiar to us in 1953). The entomology for women stressed household insects, and consisted of a total of five hours of lecture and laboratory each week. Entomology for men was shifted from the summer term to the winter term, and was taught to sophomores enrolled in a newly created agricultural curriculum. Three hours of lecture and four hours of laboratory were given each week. The first short course in entomology also was taught in the winter term of 1896. It was provided for those who were unable to leave the farm at other times of the year. That year also was the first that insects were exhibited in the classroom

with Denton's butterfly or moth tablets. These were rectangular blocks of white plaster, hollowed out for the insertion of insect bodies. They were covered with glass and sealed with enameled paper.

The following passage illustrates more clearly how Professor Barrows taught entomology between 1894 and 1906:

> In studying entomology, insects are put into the students' hands at the very first, and he learns the relations and names of parts at the same time and fixes these ideas by careful sketches from the real specimens. Field work is taken up at the outset, and a well prepared collection, representing at least eight orders of insects, is required for completion of the course. The student is taken into the field and shown how to find, collect, kill, prepare and mount his specimens, and little by little in the laboratory he learns how to identify and classify them. In this work, as all through the course, particular stress is laid on the species which are markedly beneficial or injurious, and the best methods of avoiding, limiting, or destroying the pests are carefully discussed. If advanced work in entomology is desired, an opportunity is offered in the senior year, and members of this class take up such work as each is individually fitted for, including the systematic study of as many families as practicable, the breeding and rearing of insects, and their parasites, experimental work with insecticides, and the tracing of the life-histories of such imperfectly known forms as are available.[2]

From 1897 to 1905, in addition to the entomology course (now designated 1) which was given to sophomores in the Spring, a course designated 1b was given to juniors who elected horticulture as a major. Entomology 1b consisted of three lectures a week on the life histories and controls of fruit insects. Three credit hours were given for the terms' work. (In 1899, the College began the system of a definite number of credit hours of work per term). In connection with Entomology 1b, field work in spraying was given as a separate

course by the Horticulture Department (Horticulture 6a).

Two noteworthy entomologists studied under Professor Barrows. Their names were: (1) Edward Clarence Green and (2) Ezra Dwight Sanderson. Both of these students graduated in 1897.

While Professor Barrows was in charge of the Zoology and Physiology Department, entomological teaching and investigation was rather academic.[3] The principal entomological activity of the department was the preparation of attractive displays of insects which were distributed to the public schools; most of this was done by Rufus Pettit, Instructor of Zoology and Assistant Entomologist of the Agricultural Experiment Station, who had joined the faculty on January 1, 1897. (In 1902, the State Board of Agriculture had provided funds for the preparation of cases of insects to be placed in each high school in Michigan. In the summer of 1902, over 7000 insects were collected and prepared for such cases). To Mr. Pettit, an economic entomologist, entomology had a fuller meaning of usefulness than that which he was being allowed to practice. In fact when he came to the college, Mr. Pettit had to teach physiology. He vehemently disliked teaching this subject, especially the dissection of cats. Mr. Pettit expressed extreme disappointment after his arrival when he learned he was to teach physiology rather than entomology. His connection with the Experiment Station, enabling him to contact farmers throughout the State, permitted him to learn the farmers' eagerness for knowledge on insect control.

In 1906, a separate Department of Entomology was created at the Michigan Agricultural College. Mr. Pettit was placed in charge of entomology as a full professor. He also was appointed Entomologist of the Experiment Station. The creation of an Entomology Department and Professor Pettit's appointment in the Station had been prompted by his previous efforts to dispense entomological information to farmers and possibly because of differences with Professor Barrows. Although Professor Barrows had little interest in advising farmers about insect control, he did believe that the Experiment Station should have a full time entomologist. The creation of an Entomology Department no doubt also was brought about by the farmers of Michigan. They may have exerted pressure on the State Board of Agriculture to affect the change. Professor Pettit's preparation of bulletins on "Insects of the Year" for the years 1897, 1898, 1899 and 1901, respectively,[5] "Insect life in the Upper Peninsula"[6] for 1900, and the "Codling-moth in Michigan"[7] also served to meet the needs of the farmer and emphasized the necessity for entomology to be a department by itself. In 1906, Professor Pettit gave Entomology 1b the new designation of Entomology 2, and called it economic entomology. It was still taught only to horticulture majors but had to be preceded by Entomology 1. The latter was an introductory course, and required for those in agriculture and forestry. It consisted of three hours of lecture and four hours of laboratory a week, and was worth five credits. In 1907, the following courses (with credit hours and term taught appended), each having Entomology 1 as a prerequisite, were added to the curriculum:

Entomology	3	Farm and Garden Insects,	3,	Fall
"	4	Fruit Insects	2,	Winter
"	5a	Applied Entomology,	3,	Any Term
"	6	Household Insects (for women)	5,	Winter

In 1908, entomology added the following courses:

Entomology	5b	Applied Entomology,	2,	Any Term
"	7	Forest Insects,	5,	Summer (forestry camp)

In 1908-09, a new agricultural building (the present Agricultural Hall) was constructed to house the Experiment Station and such departments as Soil Science, Farm Mechanics, and Farm Crops. An old Agricultural Hall, the building presently occupied by the Conservation Department, became occupied by the Entomology Department which moved from the Library and Museum Building. This newly acquired building, which became known as the Entomology Building, is illustrated in Figure 4. The offices and student lecture and laboratory rooms, in 1909, were all located on the first floor of the new entomological headquarters. At a later date, offices and laboratories were established on the second floor. (In the lecture rooms, a stereopticon was used to illustrate insects on slides. Handmounts were

FIGURE 4

THE ENTOMOLOGY BUILDING

FIGURE 5

A CLASS LECTURE BEING CONDUCTED BY PROFESSOR RUFUS H. PETTIT IN THE ENTOMOLOGY BUILDING.

used too.) Figure 5 illustrates a class lecture being conducted by Professor Pettit in the Entomology Building. The basement contained research and photography laboratories well equipped with microtomes, microscopes, and cameras. Under Professor Pettit, the Entomology Department always had excellent and sufficient equipment. Sometimes it was difficult for Professor Pettit to convince the "Administration" that certain equipment should be purchased.[8] Attached to the building was a twenty by fifty foot greenhouse for the rearing of insects and conducting of experiments.

From 1907 to 1910, Professor Pettit had the following instructors on his staff: (1) Zeno Payne Metcalf (1907-1908) and (2) Merrill A. Yothers (1908-1910). Mr. G. C. Woodin was an instructor in 1913. On April 10, 1910, Miss Eugenia I. McDaniel, a graduate of the University of Kansas, Lawrence, replaced Mr. Yothers. Miss McDaniels was to spend the next 39 years teaching systematic and economic entomology. Dr. George Shafer, Research Entomologist for the Experiment Station (1908-1917), taught classes when Professor Pettit was out of town or ill. He also went to summer forestry camp several years to demonstrate the work of forest insects.

In 1911, a three credit course in systematic parasitology was added for the benefit of senior veterinary students; this was designated entomology 8 and concerned the identification and classification of economically important animal parasites.

In 1913, the inspection of bees in Michigan was placed under the control of the State Board of Agriculture (apiary inspection was transferred to the Michigan State Department of Agriculture in 1921). Beekeepers were anxious to know about bee diseases and more interest was developing in all phases of bee-keeping. It became apparent that apiculture, which had been neglected by Professor Barrows and merely existed through Professor Pettits' interest in keeping the apiary going, should be added to the entomology curriculum. (The apiary was yet in the vicinity of the present Mary Mayo Residence Hall). With the addition of Mr. F. E. Millen, from the Ontario Agricultural College, Ontario, Canada, as State Bee Inspector in 1913, Professor Pettit was quite hopeful that an apiculture course could be offered. In 1914, beekeeping was authorized for instruction. The course was Apiculture 9, and was taught by Mr. Millen. The latter taught beekeeping until 1917. Benjamin F. Kindig and Russell H. Kelty taught beekeeping from 1917 to 1919 and 1919 to 1950, respectively.

Between 1916 and 1917, the following courses were added to the entomology curriculum:

1916:	Entomology	6a	Introductory Entomology, for home economic students	3, Fall
	"	6b	Elementary Morphology,	5, Winter
	"	6c	Systematic Entomology,	5, Spring

1917:	Apiculture	9a	Fall Management,	3,	Fall
	"	9b	Spring Management,	3,	Spring
	"	10a	Introductory Bee-keeping,	3,	Spring
	"	10b	Fall Management,	5,	Fall
	"	10c	Crop Production,	5,	Fall
	"	10d	General Management	5,	Fall
	Entomology	11	Introductory Entomology,	3,	Fall
	"	12	Systematic Entomology,	3,	Any Term

In 1921, the Entomology Department became a part of a new Division of Applied Science, and majors in entomology were expected to take a minimum of thirty-six credits and a maximum of fifty-two credits for a Bachelor of Science Degree. Students were urged to take courses in botany, chemistry, geology, physics, physiology, zoology, mathematics, plant pathology, bacteriology, and foreign languages to supplement their entomological training. Before the close of the sophomore year, a student had to decide upon a major subject to pursue his last two years. Prior to the placement of entomology in the Division of Applied Science in 1921, every student in the agricultural curriculum had to take at least one course in entomology-usually introductory entomology-before graduation. After 1921, this was no longer the case. This situation not only decreased the total enrollment in the Entomology Department but also

marked the beginning of more specialization on the part of students in all the departments on campus. The new courses added in entomology in 1921 were:

Entomology	14	Introductory Parasitology,	3,	Fall
"	15	Medical Entomology,	3,	Fall
"	16	Parasitic Protozoa,	3,	Winter
"	17	Parasitic Helminths,	3,	Spring
Entomology	18a	Systematic Entomology,	3,	Any Term
"	18b	" "		
"	18c	" "		
"	18d	" "		
Entomology	18e	" "		
"	19	Comparative Anatomy,	4,	Fall
"	20	Microscopic Technology,	3,	Winter

In 1924, two new courses were added and made available only to graduate students. These were:

Entomology	100	Investigations in Life Histories and Insect Control; any number of credits, any term.
"	101	Systematic Studies in Some Limited Groups of Insects; any number of credits, any term

From 1925 through 1930, the only significant curricular changes consisted of giving all the entomological courses new number designations (in 1926) which yet exist, and apiculture was transferred to the Department of Horticulture in the School of Agriculture (in 1928). The first binocular microscope was used in the Entomology Department about 1925.[10]

Entomology 1 (Introductory) and Entomology 9a(Apiculture) were taught in the first summer school at the Michigan State College in 1925.

In addition to Professors Pettit and McDaniel, the following new personnel (with their position and period of tenure appended) had been on the entomology staff between 1915 and 1938: (1) Donald Whelan, (first field agent or extension specialist in entomology, 1915-1919); (2) Edwin Ewell (extension specialist in apiculture, 1918-1928); (3) Russell Hain (extension specialist, 1920-1922); (4) L. G. Gentner (instructor, 1920-1925; assistant entomologist in the Experiment Station, 1925-1927); (5) J. H. Harman (extension specialist, 1922-1925); (6) Donald Ries (instructor, 1925-1927); (7) Charles B. Dibble (instructor, 1926-1927; extension entomologist, 1927-1944); (8) Kenneth Arbuthnot (instructor, 1926-1928); (9) Walter F. Morofsky (instructor, 1927-1938; associate professor, 1941-1953; professor, 1953); (10) Goodwin S. Tolles (instructor, 1928-1931);

This writer has obtained the following comments concerning Professor Pettits' teaching and management of the Entomology Department:

1. "He was a popular lecturer at Farmers' Institutes, and in the classroom with his students. He was a man with a great heart."[11]
2. "Professors Pettit and McDaniel cooperated completely on running the department. They were

quite intolerant of any outside ideas which might have disturbed the status quo. They emphasized economic entomology except in scale insect studies. The grasshopper was the principal insect used as the basic form for teaching. Others were not used extensively.[12]

3. He inserted humorous stories in his lectures and kept the attention of his students remarkably well. His students had to do a considerable amount of drawing, for Professor Pettit was quite an illustrator of insects. The insect collection was used for reference but was made available to anyone particularly interested in entomology. Comstock's "Introduction to Entomology,"[13] was preferred by Professor Pettit for teaching entomology.[14]

4. Professor Pettit's mode of teaching his applied and systematic entomology courses was to help a student get started on the study of a group of insects or a particular problem and to say "just keep on going." At the end of the term the students' grade would be given on his progress, the amount of which was left to the interest of the student, and the next term the student could continue the same special study under a new course number, This could continue for numerous terms. If a student had something more than a cursory interest in entomology, his credits appeared to be rather automatic.[15]

5. "He was a popular teacher because of his deep understanding of human nature and because of his ability to present an obscure subject in such a way that the student retained the fundamentals long after the details had faded."[16]

6. "The students enjoyed Professor Pettit's instruction in Entomology. He lived insects and explained their life history in such simple terms for understanding. He told of many experiences that involved certain insects and their control. Students respected his sincerity and integrity. His informality also had an appeal in classes."[17]

7. "He had a way of presenting material that gave you the impression that he was intimately acquainted with the insect, its peculiarities and habits. --- he was always cheerful and illustrated his lectures with interesting stories about insect families. You got the impression that he knew his insects, enjoyed telling about them, wanted his students to understand them and was always willing to share his great knowledge of the insect world."[18]

CHAPTER V

THE TEACHING OF ENTOMOLOGY AT MICHIGAN STATE COLLEGE, 1930 TO 1954

From 1930 through 1945, depression and war caused a small enrollment at the Michigan State College. (During World War II, the enrollment in entomology was so small that Professors Ray Hutson and Walter Morofsky taught physics. Professor Curtis Sabrosky taught chemistry. The enrollment at the College was comprised primarily of United States Army Specialized Training Program Students). After World War II, enrollment began to rise rapidly and in the fall term of 1949 reached a peak of 16,243 students. This fluctuation of students resulted in considerable addition, dropping, or temporary suspension of courses in entomology and other departments. In entomology, those courses which were added (with the year they were added), and which are still offered, were:

Entomology	322	Shade Tree Insects,	3,	Winter	(1931)
"	320	Aquatic Insects,	3,	Fall	(1938)
"	323	Insecticides and Their Uses,	3,	Winter	(1946)

On July 1, 1930, Ray Hutson joined the Entomology Department as an associate professor and divided his time between teaching and the Experiment Station. After Professor Pettit suffered a paralytic stroke in 1933, Professor Hutson became acting head of entomology. In 1934, Professor Hutson was appointed head of the department and received a full professorship. He is still in charge of entomology at the College. The high caliber training and public service given by his predecessor have been continued by Professor Hutson.

In 1948, the Entomology Department moved to a new Natural Science Building (in September, 1944, entomology had become a part of a newly organized School of Science and Arts) where it occupies adequate offices, laboratories and lecture rooms. The facilities include an aquatic insect laboratory,four teaching laboratories, photography darkrooms, a large insect preparation and collection room and an insecticide storage room. The classrooms contain excellent compound and binocular microscopes, and microtomes. New vehicles and various types of spraying and dusting equipment, are available for teaching and research. Sufficient space in a new Plant Science Greenhouse (completed in 1949) exists for research by graduate students and faculty. The entomology facilities in the greenhouse include a large spraying chamber with a revolving turn-table. In 1951, the teaching of apiculture was returned to the Entomology Department. In September, 1950, Ethelbert C. Martin, Provincial Apiarist in the Manitoba Provincial Department of Agriculture, Winnepeg, Canada, joined the entomology staff as an assistant professor, to do apicultural teaching, research, and extension work. An apiary is maintained on the College grounds for beekeeping instruction. The apiary is located in a woodlot adjacent to some dairy barns and cow pastures between Mount Hope Road and Forest Road. Numerous experimental field crop plots in the vicinity provide desirable honey plants.

In 1951, entomology was placed in the Division of Biological Science in the School of Science and Arts, and the following courses were added to the curriculum:

Entomology	415	Medical Entomology,	4,	Winter
"	411	Undergraduate Seminar,	1,	Any Term
"	502	Graduate Seminar,	1,	Any Term
Apiculture	310a	Introductory Beekeeping,	3,	Fall and Spring
"	410b	Fall Management,	4,	Spring
"	410d	Spring Management,	4,	Spring
"	410e	Apicultural Practice	4,	Spring.

In 1952, Apiculture 410 was changed to research on bees for undergraduate students. A course on insect morphology (Entomology 421) was added. "Fruit Insects", "Field Crop Insects", "Insecticides and Their Uses", and "Applied Entomology" also became applicable for graduate credit.

For the 1953-1954 school year, the Entomology

Department teaching schedule consisted of the following courses:

Course Number	Subject	Term	Credits	Hours Lecture and Laboratory Each Week	Entomology Pre-requisites
201	Introductory Entomology	F,S	4	(3 - 4)	
302*	Fruit Insects	S	3	(3 - 0)	201
303*	Farm Crop Insects	F	3	(3 - 0)	201
305a*	Applied Entomology	F,W,S	2	(0 - 6)	201 or 207
305b*	Applied Entomology	F,W,S	2	(0 - 6)	201
307	Forest Insects	S	4	(3 - 2)	Forestry Majors
310a	Introductory Apiculture	F,S	3	(3 - 0)	201
310b	Apiculture	F	4	(3 - 2)	201 and 310a
312	Systematic Entomology	F,W,S	3	(1 - 6)	201 or 307
318a*	Systematic Entomology	F	4	(1 - 9)	201
318b*	Systematic Entomology	W	4	(1 - 9)	201
318c*	Systematic Entomology	S	4	(1 - 9)	201
320*	Aquatic Insects	F	3	(2 - 2)	201
321	Greenhouse Insects	S	3	(3 - 0)	201
322	Shade Tree Insects	F	3	(3 - 0)	201

* Offered for graduate credit

Course Number	Subject	Term	Credits	Hours Lecture and Laboratory Each Week	Entomology Pre-requisites
323	Insecticides and their Uses	W	4	(3 - 0)	201 or 207 or Para-sitology or 306
410*	Apicultural Research	S	4	(0 - 12)	210 and 310a
411*	Seminar	F,W,S	1	(1 - 0)	Entomology Majors
415*	Household, Medical and Veterinary Entomology	W	4	(3 - 2)	201 or 306
421*	Insect Morphology	F	3	(2 - 2)	201
500*	Investigations in Life His-tories and Insect Control	F,W,S	any number		201
501*	Systematic Studies in Some Limited Groups of Insects	F,W,S	any number		201

All the entomology courses listed above, except 305a, 305b, 410, 500, and 501, have at least one lecture each week. Some of the courses consist entirely of lectures. Those in systematic entomology, apicultural research, and investigations of life histories and controls are primarily laboratory subjects, and completing one of these courses or obtaining results on a particular project is left up to the individual student. That is, his progress is supervised by an instructor but the student has to use his own initiative to meet the requirements for credit. The seminar

* Offered for graduate credit

course enables students and faculty members to meet for the presentation of lectures by the individual class members on research projects and a variety of scientific subjects. Besides being a source of knowledge, the seminar enables better friendships or new friendships to be made.

Students in lecture courses are given periodic essay, objective, completion, or true and false examinations over the information they have obtained in the lecture room and from text assignments. In the laboratory sections of lecture courses, and in the laboratory courses themselves, examinations are given on the identification of insects. Laboratory tests often consist of labeling diagrams of insects. Essay and other tests are sometimes given. The laboratory sections of the different courses involve the making of notebooks or drawings (which are accumulated in notebooks) identifying insects, doing spraying or dusting in the field or greenhouse, collecting insects, working in the apiary, or recording data. The most popular course is introductory entomology. The making of an insect collection in this course serves to familiarize the student with actual specimens of insects; hence giving a better appreciation of entomology.

The following list presents the personnel (with their highest rank achieved and tenure dates) that have served the Michigan State College Department of Entomology, since 1930:

1. Rufus H. Pettit (professor, 1897 - 1933)

2. Ray Hutson (professor, 1930 - to date)
3. Eugenia I. McDaniel (associate professor, 1910 - 1949)
4. Goodwin S. Tolles (instructor 1928 - 1932)
5. Franklin T. Sherman, III (associate professor 1930 - to date)
6. James M. Merritt (graduate assistant 1930 - 1934)
7. Merwyn G. Farleman (instructor, 1930 - 1936)
8. Charles B. Dibble (extension entomologist, 1927 - 1944)
9. Curtis W. Sabrosky (assistant professor, 1935 - 1943)
10. Walter F. Morofsky (professor, 1927 - to date)
11. Herbert E. Milliron (graduate assistant, 1936 - 1937)
12. George A. Bradley (graduate assistant, 1937 - 1938)
13. Frank T. Parmelee (graduate assistant, 1939 - 1940)
14. Calvin E. Pederson (instructor, 1940 - 1949)
15. Nelson Ging (graduate assistant, 1942 - 1943)
16. Bruce Wilson (graduate assistant, 1942 - 1943)
17. Herman L. King (associate professor, 1945 - to date)
18. Ryoji Namba (graduate assistant, 1947 - 1949)
19. Ray L. Janes (associate professor and extension entomologist, 1945 - to date)
20. Julius R. Hoffman (assistant professor, 1949 - to date)
21. Leland Merrill,Jr. (assistant professor, 1949 - 1953)
22. Gale R. Gleason, Jr. (graduate assistant, 1950 - 1953)
23. Gordon E. Guyer (graduate assistant,(1950 - 1953; and instructor, April, 1954)
24. George Noland (graduate assistant,(1953 - to date)

25. William S. Cath (graduate assistant, Sept., 1953 - to date)

26. Roland L. Fischer (assistant professor, Sept., 1953 - to date)

27. Russell H. Kelty (assistant professor, 1919 - 1929) In 1929, Professor Kelty continued his tenure with the College as a member of the Horticulture Department. This change was brought about by the transfer of apiculture, the subject he taught, to the Horticulture Department in 1928.

28. Ethelbert C. Martin (assistant professor, 1950 - to date).

An inspection of the foregoing list will reveal that, up to 1945, there were many short term tenures. This was due to individuals being offered more attractive positions elsewhere. Since 1930, the personnel situation in the Entomology Department has been one of continual replacement rather than addition which has been the case in many other departments on campus. The hiring of new staff members in 1945 (Herman L. King); in 1946 (Ray L. Janes); in 1949 (Julius R. Hoffman and Leland G. Merrill, Jr.); and in 1953 (Gordon E. Guyer) provided replacements and not additions to the total number on the entomology staff. Not until September, 1953, was there an actual "addition". This was Roland L. Fischer, a graduate of Kansas State College, Manhattan, and a taxonomist, who holds the position of assistant professor. This addition was the first in almost twenty-five years (since 1930). The list referred to above also indicates that five individuals (Rufus H. Pettit, Ray Hutson, Walter F. Morofsky, Eugenia I. McDaniel, and Franklin T. Sherman) were or have been associated with the Entomology Department for 15 years or longer. Professors Pettit and McDaniel were with the department 37 and 39 years, respectively.

Table 1 presents data comparing numbers of total staff members in the Departments of Botany and Plant Pathology, Entomology, Horticulture, and Zoology for the years 1930 through 1953, and indicates a shortage of personnel in the Entomology Department.

Besides classroom teaching of entomology, the entomology staff presents information on insects to the public in the following ways:

1. weekly radio programs on the Michigan State College Radio Station, WKAR.
2. annual conferences for the commercial pest control operators and the insecticide-fungicide dealers of the State.
3. off-campus college extension and continuing education courses in entomology.

The Entomology Department also has contributed to television programs in the State and plans have been made for entomological programs on WKAR Television in 1954.

In 1953, a survey among 2902 agricultural graduates of the Michigan State College indicated that of a total of

TABLE I

NUMBER OF TOTAL STAFF MEMBERS EACH YEAR IN THE DEPARTMENTS OF BOTANY, ENTOMOLOGY, HORTICULTURE, AND ZOOLOGY FOR THE YEARS 1930 TO 1953

	Botany and Plant Pathology	Entomology	Horticulture	Zoology
1930-31	13	6	10	5
1931-32	13	6	10	6
1932-33	12	6	10	6
1933-34	10	6	10	6
1934-35	10	6	10	7
1935-36	12	7	11	6
1936-37	12	7	11	6
1937-38	12	6	12	9
1938-39	14	6	14	10
1939-40	13	6	13	12
1940-41	14	6	13	14
1941-42	14	6	13	16
1942-43	16	6	12	15
1943-44	15	4	10	9
1944-45	12	4	9	9
1945-46	13	4	10	7
1946-47	19	3	11	7
1947-48	17	4	14	13
1948-49	17	4	14	13
1949-50	23	7	20	11
1950-51	23	7	20	11

TABLE I "continued"

	Botany and Plant Pathology	Entomology	Horticulture	Zoology
1951-52	16	8	28	12
1952-53	26	8	34	13
1953-54	26	9	33	14

1658 who had taken entomology, 84 percent (1362) believed that their entomological training was important in helping them in their jobs. Of 682 graduates who did not take entomology, 59 percent (401) believed that entomology was important and would be helpful to them in their employment. None of the graduates surveyed had majored in entomology, botany, or zoology.[1]

With the centennial anniversary celebration in 1955 of the founding of Michigan State College, the teaching of entomology in Michigan and at the the Michigan State College will be almost one-hundred years old. The teaching of entomology and its application in Michigan has been an immeasurably great factor in the welfare of the residents of Michigan.

A. The Michigan State College Biological Station

In the interest of providing students with the opportunity to study biology under natural conditions, the Michigan State College has endeavored since 1929 to establish a biological station. Between 1929 and 1939, summer instruction in the biological sciences was given at the Gull Lake-farm estate of W(ill) K. Kellogg, manufacturer of cereals and philanthropist who died in 1951. In 1939, this activity was transferred to a former Civilian Conservation Corps Camp at Clear Lake, near Atlanta, Michigan. The studies at Clear Lake were discontinued in 1941 because the United States Coast Guard took possession of the facilities for war-time training exercises. Since 1941, no summer biological station work has been done by the Michigan State College, but establishing a permanent biological station has been one of its goals. That goal will become a reality in June, 1954.

In June, 1954 the Michigan State College will open "The Kellogg Gull Lake Biological Station." This Station is located on the estate of the late Mr. Kellogg at Battle Creek. In 1930, Mr. Kellogg had given Michigan State College 1500 acres of farm and forest land surrounding Gull Lake near Battle Creek, and it has been this property that the College has striven to use for a biological station. Following World War II, the Kellogg Foundation gave Michigan State College Mr. Kellogg's 32-acre summer estate at Gull Lake. With the intensive efforts, since 1952, of Milton E. Muelder, Dean of the School of Science and Arts, and a 45,000 dollar grant from the Kellogg Foundation in 1953, a permanent biological station has been established by the Michigan State College. The monetary value of this Station is estimated to exceed 2,000,000 dollars.

The Kellogg Gull Lake Biological Station of Michigan State College is one of the most scenic and diversified biological stations in America. It will have offices, lecture rooms, laboratories, and residence units on the 32-acre estate. Accommodations will be available for 75 to 100 students. A staff of nine specialists will present courses in entomology, bacteriology, botany, fisheries, parasitology, zoology, and wildlife that will be of particular interest to elementary school teachers, and to undergraduate and graduate college students. Year-round research will be facilitated. The director of the Gull Lake Station is Dr. Henrik J. Stafseth, Director of the Division of Biological Science at the Michigan State College. The Resident-Director is Dr. Walter F. Morofsky, Professor of Entomology at the College. Incidentally, Professor Morofsky was a staff member of the Michigan State College Biological Station when it was in operation between 1929 and 1941. (The other members of the 1929-1941 Station were Dr. Joseph W. Stack, Zoologist, and Dr. Henry T. Darlington, Botanist).

CHAPTER VI

THE TEACHING OF ENTOMOLOGY IN MICHIGAN, OTHER THAN AT THE STATE COLLEGE OF MICHIGAN

Evidence indicates that other colleges in Michigan have placed little emphasis on the teaching of entomology. Among thirty-eight senior and junior colleges and universities in Michigan,[1] excluding the Michigan State College, only eleven appear to have ever offered a course devoted to the subject. These are (1) Adrian College, Adrian; (2) Alma College, Alma; (3) Central Michigan College of Education, Mount Pleasant; (4) Emmanuel Missionary College, Berrien Springs; (5) Hillsdale College, Hillsdale; (6) Marygrove College, Detroit; (7) Northern Michigan College of Education, Marquette; (8) Michigan State Normal College, Ypsilanti; (9) Siena Heights College, Adrian; (10) University of Detroit, Detroit; and (1) University of Michigan, Ann Arbor. Entomology also was taught at Battle Creek College, Battle Creek, which discontinued operations in 1938.[2] The Battle Creek College Biology Department gave its small insect collection to the Emmanuel Missionary College. Entomology at each of the foregoing schools (except at the Universities of Detroit and Michigan) has been limited to a general, introductory course. The

University of Detroit occasionally offers a course in medical entomology. The University of Michigan, in addition to introductory entomology, has offered a course on forest insects since about 1927. From 1920 to about 1950, much of the teaching of entomology at the University of Michigan was done by Dr. Paul S. Welch. He also taught a course of limnology in which he directed the researches of many students interested in aquatic insects. The instruction in forest insects has been given continuously by Dr. Samuel A. Graham. In 1929, Dr. Graham published a textbook on forest entomology[3] that has been quite popular in American colleges. The third edition of the book is used as a text at the Michigan State College.

Besides teaching general entomology at its Ann Arbor campus, the University of Michigan offers the subject at an annual summer camp held at the University of Michigan Biological Station, Cheboygan. This Biological Station has been in operation since 1909. It is situated at Douglas Lake; hence it is frequently referred to as the "Douglas Lake Biological Station". The site has been particularly conducive to the study of aquatic and semi-aquatic insects, especially Hemiptera and Odonata.

The following is a historical summary of the teaching of entomology at the University of Michigan Biological Station:[5] Entomology has been taught as a complete course since 1912. Prior to 1912, insects were included in a course called "Natural History of Invertebrate Animals". This course was taught in 1910 and 1911 by Dr. Arthur Sperry and Dr. Frank Smith, respectively. In 1912, a course called "Natural History of Insects" (this title was retained until 1923) was taught by Professor Smith and Paul Welch. The course was worth two credit-hours. In 1913 the course was taught only by Dr. Welch. From 1914 through 1918, entomology was taught by Dr. M. M. Ellis. The instruction was done in 1919 and 1920 by Mr. D. Stoner, and in 1921 by Mr. Zeno P. Metcalf, and in 1922 by Dr. Robert Matheson. Since 1923, when entomology was made a four credit-hour subject and called "General Entomology", it has been taught by Professor Herbert B. Hungerford every summer except that of 1928. That year, Dr. Clarence H. Kennedy filled Professor Hungerford's position while the latter was in Europe. Besides almost thirty years of teaching at the Douglas Lake summer camp. Professor Hungerford has directed the research of numerous students and done considerable research himself. (Professor Hungerford teaches Entomology at the University of Kansas, Lawrence, during the regular school year). Publications concerning insect research at the station are listed in a "Bibliography of Papers from the Biological Station of the University of Michigan, 1909 - 1945."

At present, besides Michigan State College, only Alma College, Emmanuel Missionary College, Michigan State Normal College, Northern Michigan College of Education, University of Detroit, and the University of Michigan, offer entomology regularly. A number of Michigan colleges

present instruction on insects in biology and invertebrate zoology courses.[6] Some of the schools have done this for many years. Albion College, Albion, had done so since its charter in 1835, and is planning to offer a separate course in entomology at the opening of its 1954 - 55 school year.[7] The course will be taught by Miss Clara Dixon.[8]

The restricted scope of entomology, especially its economic aspects, in other colleges in Michigan is seemingly a result of the following factors:

1. A large variety of entomology courses offered at the Michigan State College - a curriculum that attracts the student interested in majoring in the subject.
2. Low enrollments in small Michigan Colleges. (At Albion College, a course devoted entirely to entomology would probably result in overexpansion.)
3. Concern with medical sciences and related and preparatory subjects in the metropolitan area of Detroit. "At the University of Detroit, entomology does not 'take' even when we design a course called 'Medical Entomology'."[9]
4. Numerous colleges prepare their students primarily for teaching in the elementary grades; a general biology course is most suitable for their needs.[10]
5. Some colleges are religious in character; some of these are only for women.

6. Specialization of colleges in industrial sciences, business, commerce, liberal arts.

7. Small sohools are unable to afford specially trained personnel for entomology only. This is well illustrated by the fact that former or present heads of biology departments or teachers of biology or zoology at Alma College, Battle Creek College, Central Michigan College of Education, Hope College, Michigan State Normal College, Northern Michigan College of Education and perhaps other colleges were actually professional entomologists. The names of some of these workers are:

    1. Jennings R. Hiokman, Alma College,
    2. Luther S. West, Battle Creek College and Northern Michigan College of Education,
    3. LaVerne L. Curry, Central Michigan College of Education,
    4. Richard O. Malcomson, Central Michigan College of Education,
    5. Irene F. Jorae, Central Michigan College of Education,
    6. Oscar E. Thompson, Hope College.

One of the most interesting aspects of the teaching of entomology in Michigan concerns that done at the Cassidy Lake Michigan National Youth Administration Camp near Chelsea (close to Ann Arbor) between 1936 and 1940. Through the combined efforts of the Ann Arbor Rotary Club, the National

Park Service, and the National Youth Administration (a Federal organization instituted in 1930 and continued through the depression and up to 1943, through which monetary aid in the form of scholarships, fellowships, loans, and grants was provided college students throughout the United States) a camp was established at the Waterloo State Forest Preserve, at which young men between the ages of 18 and 21, who were unemployed and not in school, could obtain fundamental training and experience in occupations of their choice. High school and college courses were offered in numerous fields of endeavor. The former courses were offered from the University of Nebraska, Lincoln and the latter courses from the University of Michigan, Ann Arbor. Each youth was paid about 30 dollars a month, and board and room was about 19 dollars a month. The camp was under the direction of Orin W. Kaye, Michigan National Youth Administration Director. The entomology instruction included apiculture and the control of injurious insects. Both of these were a part of an "agricultural curriculum".

CHAPTER VII

AN ASSAY OF THE CONTRIBUTIONS OF FORMER STUDENTS OF ENTOMOLOGY AT THE STATE COLLEGE OF MICHIGAN TO THE FIELD OF ENTOMOLOGY

1. Albert John Cook[1] (Left in 1893)

In addition to his pioneering activities in the field of entomology at the Michigan Agricultural College, which have been or will be discussed in this work, A. J. Cook gained an outstanding reputation for his leadership in entomology in California after going there in 1893. His leadership included the direction of Farmers Institutes, Farmers Clubs, and the Presidency for 18 years of the Claremont Pomological Club. It was through the support of the latter organization that Cook promoted the scientific study of orchard problems and promoted the establishment of co-operatives, insurance, and telephone lines for California farmers. In 1907, he instigated the study of hydrocyanic acid gas fumigation for citrus insects. As Professor of Biology at Pomona College, Claremont between 1894 and 1912, A. J. Cook (and Charles F. Baker, a former student of Cook's at the Michigan Agricultural College) trained a number of students who later became prominent entomologists. In 1911, Professor Cook was appointed California State Commissioner of Horticulture. He served in this position until his death

in 1916. During his tenure as Commissioner, one of his most important accomplishments was that of obtaining a national quarantine law.

2. Clarence P. Gillette[2,3,4] (Left in 1888)

C. P. Gillette was Entomologist of the Iowa State College Experiment Station, Ames, from 1888 to 1890. During those two years, he conducted experiments which showed that when lime was added to either Paris green or London purple, these arsenicals were less injurious to foliage. From 1891 to 1910, he was professor and head of zoology and entomology at the Colorado Agricultural and Mechanical College, Fort Collins. From 1910 to 1932, he was Director of the Colorado State Experiment Station. Professor Gillette gained wide recognition for his systematic work on the Families Aphididae and Cicadellidae and the Order Orthoptera.

3. James Troop[5,6] (Left in 1882)

James Troop became Professor and Head of Horticulture and Entomology at Purdue University, LaFayette, Indiana. He served Purdue from 1884 to 1920. In 1912, he was placed in charge of a separate Department of Entomology at Purdue. From 1899 to 1907, Professor Troop was State Entomologist of Indiana.

4. Edward Ralph Lake[7] (Left in 1888)

E. R. Lake was a teacher of botany at the Oregon State College, Corvallis between the years 1886 to 1888 and

1897 to 1910. In 1910, he joined the United States Department of Agriculture, Washington, D.C., as a botanist.

5. Arthur Burton Cordley[8] (Left in 1890)

A.B. Cordley was an Assistant Entomologist at the University of Vermont, Burlington from 1890 to 1891; an Assistant Entomologist for the United States Bureau of Entomology, Washington, D.C. from 1891 to 1893; a professor of zoology and entomology at the Oregon State College, Corvallis from 1895 to 1907; Dean of Agriculture at the Oregon State College from 1907 to 1914. In 1914, he became Director of the Oregon State Experiment Station.

6. John Merton Aldrich[9] (Left in 1890)

J. M. Aldrich was a professor of zoology at the University of Idaho, Moscow from 1893 to 1913. He also served as Entomologist for the Idaho State Experiment Station from 1893 to 1905. From 1913 to 1918, he served as an Assistant Entomologist for the United States Bureau of Entomology at LaFayette,Indiana where he studied flies that are injurious to grains and grasses. In 1918, the United States National Museum, Washington, D.C. appointed him Custodian of Diptera, and in 1919 was made Associate Curator of the Division of Insects at the Museum. His publications on the Diptera brought him world recognition. The most famous of his works is "A Catalogue of North American Diptera"[10] published in 1905.

7. Clarence M. Weed[11] (Left in 1884)

C. M. Weed served as Assistant State Entomologist of Illinois from 1885 to 1887; Entomologist for the Ohio State Experiment Station, Wooster from 1888 to 1890; professor of zoology and entomology at the New Hampshire Agricultural and Mechanical College, Durham from 1901 to 1904; and Entomologist for the New Hampshire State Experiment Station from 1901 to 1904. He made numerous contributions to the knowledge of insect life-histories and the insecticidal control of insects. The Phalangiidae (Arachnida) of America and the relations of flowers and insects were his favorite subjects of study.

8. Ezra Dwight Sanderson[12] (Left in 1897)

E. D. Sanderson was Assistant State Entomologist of Maryland from 1898 to 1899. In the summer of 1899 he served in the same capacity for the United States Bureau of Entomology, Washington, D.C. From 1899 to 1902, he was employed as Entomologist at the Delaware Agricultural Experiment Station, Dover and associate professor of zoology at Delaware College, Dover. From 1902 to 1904, he was State Entomologist for Texas and professor of entomology at the Texas Agricultural and Mechanical College, College Station. In 1904, Professor Sanderson went to the New Hampshire Agricultural and Mechanical College, Durham as professor of zoology. From 1907 to 1910, he was Director of the New Hampshire Experiment Station. From 1910 to 1915, he was Dean of the College of Agriculture of the West Virginia University, and

from 1912 to 1915 Director of the West Virginia State Experiment Station. While in West Virginia, Professor Sanderson developed an interest in rural sociology, and went to the University of Chicago to study the subject. From Chicago, he went to Cornell University, Ithaca, New York where he attained considerable eminence as a rural sociologist. In 1943, he retired from Cornell as a professor emeritus. He contributed a number of noteworthy publications to both the fields of entomology and sociology.

9. Charles Fuller Baker[13,14,15] (Left in 1891)

C. F. Baker was employed as an entomologist and zoologist by the Colorado Agricultural and Mechanical College, Fort Collins from 1892 to 1897; by the Alabama Polytechnic institute, Auburn, and the Alabama State Experiment Station from 1897 to 1899; by Pomona College, Claremont, California from 1903 to 1904 and 1908 to 1912; by the Cuban Experiment Station, Santiago from 1904 to 1907; and the University of the Philippine Islands, Los Banos, Laguna from 1912 until his death in 1927.

As a teacher of entomology at Pomona College, ---- "he accomplished a remarkable piece of work at that institution----his influence upon students was very unusual and he stimulated the most backward to produce surprising results. Entomology at once forged ahead of all other biological sciences----During his four year stay there he inspired, trained and sent out a fairly large group of biologists in consideration of the small size of the institution at that time".[16]

In the Philippine Islands, Baker's principal activity was the organization and management of a College of Agriculture of the University of the Philippines. From 1918 to 1927, he was Dean and Professor of Tropical Agriculture at that institution. As a hobby, Professor Baker made a mycological and entomological survey of the Philippine Archipelago, North Borneo, Singapore, and Penang. Fieldmen were sent out at his own expense to make collections, and insect specimens were sent to 115 specialists throughout the world for identification. The insect portion of his work was called "Entomologica Malayana". ----"He brought together what is undoubtedly the greatest collection of Malayan insects that has ever been assembled, ----".[17] At his death, Professor Baker had over 300,000 specimens of insects in his personal collection and an unknown number were in the hands of specialists. The Baker insect collection was deposited in the United States National Museum, Washington, D.C., in 1928.

10. Fred H. Hillman (Left in 1891)

F. H. Hillman was a professor of entomology at the Nevada State University, Reno, beginning in 1891.

11. Frank J. Niswander (Left in 1889)

F. J. Niswander was employed at the Wyoming State Experiment Station between 1891 and 1892. He was also a professor of entomology at the University of Wyoming, Cheyenne.

12. Gager C. Davis (Left in 1896)

G. C. Davis was Consulting Zoologist for the Michigan Agricultural College Experiment Station from 1893 to 1896.

13. Edward Clarence Green (Left in 1897)

E. C. Green was employed for some time by the Illinois State Experiment Station, Champaign-Urbana.

Numerous other students who have studied entomology at the Michigan State College have performed important activities in entomology or have made excellent contributions to the field of entomology. Much of this information is difficult to locate. For a list of those students who have obtained advanced degrees in entomology (and the titles of their theses) at the Michigan State College, the reader is referred to the appendix of this work.

CHAPTER VIII

COLLECTORS AND COLLECTING

A. The Beginning of Entomological Collecting in Michigan

Insects probably were first collected in Michigan for scientific purposes by French Jesuits who wrote scattered accounts of Michigan fauna and flora in reports sent to their Canadian superiors.[1] These reports were written between 1632 and 1672 and were titled, "Relation de ce qui s'est passe en la Nouvelle France". Actually, little is known concerning the collection of insects and other natural objects in Michigan prior to 1837 when Michigan was admitted to the Union. European entomologists had received American insects but few labels for these give any information as to the exact collection locality or collector. The famous travelers, Jonathan Carver,[2] Alexander Henry,[3] Peter Kalm,[4] and Isaac Weld,[5] who visited the Great Lakes Region between 1760 and 1800 and recorded valuable information on its fauna and flora, might have been among the first who took insects to Europe. The following evidence indicates that Thomas Say (1787 - 1834), "Father of American Entomology", probably collected insects in Michigan:

1. locality labels for some of his insects bear the following inscriptions:

a. "inhabits near Lake Erie and Indiana",[6]

b. "I obtained this species on the rocky coast of Lake Superior",[7]

c. "found on the coast of Lake Superior" [8]

2. apparently Stephen H. Long's second expedition to find the sources of the Minnesota River in 1823, on which Thomas Say served as zoologist, reconnoitered at Mackinac, Michigan.[9]

Organized interest in the collection of insects and other natural objects in Michigan for scientific purposes appears to have occurred for the first time in 1837 when the first State Legislature authorized the appointment of a State Geologist and appropriated funds for a Michigan Geological Survey.[10] This survey was undertaken immediately by Dr. Douglass Houghton, Detroit physician and naturalist, who was appointed State Geologist in the same year. A Department of Zoology and Botany, directed by Dr. Abram Sager, was a part of the Survey. In 1838, a reorganization of the geological survey instituted a separate Department of Zoology headed by Dr. Sager. In 1840, the zoological and botanical studies of the Survey were abolished by the Legislature. In 1845, after the death of Dr. Houghton, the Geological Survey itself was abolished and was not reactivated until 1859. From 1859 to 1869 the Survey was conducted without remuneration by Dr. Alexander Winchell, Chair of Geology, University of Michigan. In 1869, through the demands of numerous Michigan residents the Survey was put on a permanent basis and it remained in this status until 1921. From 1869 to 1921 it was called the "Michigan Geological and Biological Survey", but few funds were devoted to biological studies. In 1921 the biological survey was absorbed by the Michigan State Department of Conservation which was created that year.

In 1906, A. Franklin Shull, a zoologist at the University of Michigan Museum of Zoology, Ann Arbor, was engaged as an entomologist by the biological survey. In 1908, Dr. Alexander Ruthven, another zoologist at the University of Michigan Museum of Zoology, (1906 - 1929) and later President of the University (1929 - 1951) was appointed chief naturalist of the biological survey to start an inventory of the biota of the State. Dr. Ruthven remained chief naturalist until 1913. Even after 1908, the biological survey received few funds for its studies. It was primarily through private contributions that biology received attention. The following individuals were among those who contributed funds: (1) H. M. Kauffman, Ann Arbor; (2) William B. Mershon, Saginaw; (3) George Shiras, Washington, D.C.; (4) Dr. Bryant Walker, Detroit; and (5) Peter White, Marquette.

Through close cooperation with the biological survey for many years, the University of Michigan Museum of Zoology received all the zoological specimens collected by the Survey. The specimens have been the object of numerous published papers, many of which are in the proceedings of scientific organizations at whose meetings the papers have been presented.

B. Expeditions or Surveys, and Size and Content of Insect Collections

1. By Individuals Having an Official Biological Status

In 1850, Jean Louis Rodolphe Agassiz, Chair of Zoology and Geology of the Lawrence Scientific School at Harvard University, Cambridge, Massachusetts, published an account of the natural history of Lake Superior[11] which contained a catalog on insects collected by himself, John L. LeConte (American Coleopterist) and a party of students and naturalists on the northern and eastern shores of Lake Superior in 1848. The catalog,[12] prepared by John L. LeConte, includes descriptions of new species and a comparison of the distribution of numerous species in the Lake Superior Region and Europe. All the insects had been collected between June 15 and August 25. It is interesting to note that on its way to the Lake Superior Region, the Agassiz party went from Cleveland, Ohio to Detroit, and then proceeded through Lakes St. Clair and Huron to Mackinac Island and Sault Ste. Marie. Perhaps some collecting was done at points in Michigan.

The first extensive collecting of insects in Michigan by a resident of the State was probably that done by Albert John Cook, Professor of Entomology (1867 - 1893) at the Michigan Agricultural College, East Lansing. Professor

Cook's appreciation of systematic entomology and the need for a reference collection of insects for teaching, led to his collecting a considerable number of insects in the vicinity of Lansing. In July and August 1905, beetle collecting was a part of a University of Michigan Museum of Zoology Ecological Survey of Isle Royale, Lake Superior. The collecting was done by Charles C. Adams, Dr. H. A. Gleason, and B. F. Savey. Eighty-nine species of beetles were obtained. A report on the Isle Royale Ecological Survey[13] presents the ecology of the island beetle fauna (a total of 206 species in 1908), notes on the distribution of the beetles in the United States, and a complete catalog of the Isle Royale beetles up to 1908.

In 1906, a survey of aquatic and semi-aquatic insects was made at Walnut Lake, Oakland County, by Professor James G. Needham, Lake Forest University, Illinois, and Dr. A. F. Shull, University of Michigan. The collections of these two workers were a part of a Michigan State Biological Survey of Walnut Lake directed by Thomas L. Hankinson, biology instructor at the Michigan State Normal College, Ypsilanti. The survey was conducted from April 3 to August 30.

In the summers of 1910 and 1911, the University of Michigan Museum of Zoology, in co-operation with the Michigan Geological and Biological Survey, made an investigation of the fauna and flora of the Charity Islands in Saginaw Bay. The funds for this project were provided by William B. Mershon, lumberman and former mayor of Saginaw, (1894 - 95).

The Charity Islands (the largest -650 acres) were of biological interest because they evidently have had no connection with the mainland since glacial times (the biota reaching the Islands over a mass of water 8 - 10 miles wide) and were frequented by a number of species of migratory birds. The personnel surveying the Charity Islands consisted of: (1) W. W. Newcomb (Lepidoptera); (2) A. W. Andrews (Coleoptera); (3) Frederick Gaige (Hymenoptera-ants); (4) N. A. Wood (vertebrates); and C. K. Dodge (plants).

Mr. A. W. Andrews collected from June 19 to 26 and on July 16 and 17, 1910. He obtained about 10,000 specimens and 623 species of beetles and made records of their habitats and hosts.

The Charity Island field work was done without any remuneration except expenses. All the results of the Survey have been published by each author under the common title "Results of the Mershon Expedition to the Charity Islands, Lake Huron".

In the summer of 1913 and 1914, through the financial assistance of George Shiras, former Associate Justice of the United States Supreme Court (1892 - 1903), the University of Michigan Museum of Zoology made a biological reconnaissance of the Whitefish Point Region (Chippewa County) in the Upper Peninsula. The entomological activities of the Shiras Expedition, as the reconnaissance was called, were pursued by A. W. Andrews. In 1913, he collected insects in all orders.

This general collection was made between June 30 and July 2.

In 1914, Mr. Andrews devoted his attention to Coleoptera only. Collections were made between July 19 and August 3, and over 900 species of beetles were obtained.

In 1919, Dr. Theodore H. Hubbell, zoologist of the University of Michigan Museum of Zoology, thoroughly surveyed the Warren Woods Reserve in Berrien County for Orthoptera (a reconnaissance was also made for Orthoptera in Benzie, Calhoun, Washtenaw, Wayne, Oakland, and Jackson counties and in the Hughitt-Rawson Preserve on Thousand Island Lake and around Watersmeet. Over 3,500 Orthoptera were added to the Museum.

In the summer of 1922, Melville H. Hatch, a student at the University of Michigan and presently Professor of Zoology, University of Washington, Seattle, made a beetle survey of Charlevoix County for the Michigan State Department of Conservation, Lansing. This study was part of a land and economic survey, and included Beaver and Garden Islands (the land and economic survey itself was the first ever undertaken in Michigan). The survey was limited to Charlevoix County and was begun in 1922 and terminated in 1923). Between August 22 and September 11, 580 species of Coleoptera were collected.

2. By Individuals Having a Biological Status

In 1874, 1876, and 1877, Messrs. Harvey G. Hubbard and E. A. Schwarz of Detroit made extensive collections of

Coleoptera in Michigan. The 1874 collections were made on the shores of Lake Erie near Monroe and along the shores of the Detroit River and Lake Huron in the vicinity of Detroit. Those of 1876 and 1877 were made along the southern shore of Lake Superior and on Isle Royale, Lake Superior. The southern Michigan collections yielded 1,755 species. One hundred and seventeen species alone were found on Isle Royale.

In 1888, the Hubbard-Schwarz insect collection was "---- unexcelled for its wealth of material in the families containing small species - Clavicornia, Serricornia and some families of Rhynchophora".[14] Messrs. Hubbard and Schwarz were "excellent collectors - perhaps unequaled in this country - and an intimate knowledge of the habits of species, with extreme patience in working out the minute forms have made their collection a valuable one".[15]

The private collecting done by Hubbard and Schwarz has been followed by innumerable private collections and surveys. All of these collectors have contributed enormously to entomology in Michigan and to the whole field. Unfortunately, it is impossible to record the details of each collector's work here.

The following data has been assembled by this writer concerning the entomological collecting of three prominent amateurs in Michigan:

a. Since 1932, Dr. Robert R. Dreisbach, a chemist at the Dow Chemical Company, Midland, has been making a survey of all the insects of Michigan. He also has been listing all the published records on Michigan insects. Dr. Dreisbach has "passed 15,300 as the number of different species found and collected in Michigan".[16] He has about 250,000 insects collected in Michigan, and has collected in every county in the State. "If you take the number of insects listed for each county and add them together, there are now close to 70,000 records".[17]

Dr. Dreisbach also has surveyed the Hymenoptera of Michigan and has 2700 identified species. His beetle collection amounts to about 25,000 specimens. About 8500 species of these beetles are indigenous to Michigan.

Since about 1933, Dr. Dreisbach has collaborated with Mr. Curtis W. Sabrosky, former Assistant Professor of Entomology at the Michigan State College, East Lansing and now an entomologist at the United States National Museum, Washington, D.C., and Mr. George Steyskal (Dipterist), Grosse Ile, Michigan, in a survey of the Diptera of Michigan. Records have been kept for each county and 3300 species have been listed.

b. Another diligent collector of Michigan insects is Mr. J. H. Newman, South Lyons. He has pursued the study of Lepidoptera since 1941 and possesses about 10,000 specimens. The majority of these are from the middle and northern tiers of counties. Mr. Newman is presently compiling an index of individual species. Collection dates and county records are an important part of this index.

c. One of the most prominent students of Diptera in Michigan is George Steyskal, Gross Ile. He started his work on flies in 1933 and in 1938 started specializing in the Acalyptrates. At present he has about 10,000 specimens of Diptera from Michigan and other localities.

C. Insect Collections at Colleges and Museums

1. Michigan State College

a. Personnel, Donations, Content and Size

The insect collection at the Michigan State College had its origin in 1867 when Professor Albert John Cook started teaching entomology at the Michigan Agricultural College. In 1871, Professor Cook placed the first insect cabinets in the college museum and by 1878 he alone had contributed 1158 local species. Throughout his tenure (1867 - 1893), Professor Cook, his students, and friends of the college made noteworthy additions to the insect collection. Students under Professor Cook got so enthusiastic about insect collecting that after they left the College, they sent numerous specimens to the College Collection. Insects were received from all parts of the United States and the world. The student donations were principally from Clarence M. Weed, Howard E. Weed, Clarence P. Gillette, Charles F. Baker, and Gager C. Davis. The largest gift from outside the college was presented in 1889 by Michigan Senator James McMillan of Detroit. This gift consisted of the Fred Tepper Collection of 12,000 Macrolepidoptera and the Austin Collection of 40,000 Coleoptera.

Over 10,000 species were in these two collections. Between 1877 and 1880, Harvey Hubbard, noted Coleopterist of Detroit, had donated a considerable number of Coleoptera to the College. Professor Cook also exchanged specimens with Mr. Hubbard.

In 1890, other gifts made the Michigan Agricultural College collection one of the best college collections in the United States. These additions were:

1. a collection of Hemiptera from the United States National Museum, Washington, D.C. (through the courtesy of Charles V. Riley).
2. a collection of Microlepidoptera from the American Museum of Natural History, New York.
3. a collection of Orthoptera from Dr. Lawrence Bruner of the University of Nebraska, Lincoln.
4. a collection of Lepidoptera from Dr. Eugene Davenport (an 1878 graduate of the College) of the University of Illinois, Champaign-Urbana.

Between 1891 and 1896, Gager C. Davis, as a student (1891 - 1892) and Consulting Zoologist of the Experiment Station deposited numerous specimens of Ichneumonidae (Hymenoptera) in the collection. Many of these were holotypes.

After Professor Cook left the College, little was added or done to the insect collection until Rufus H. Pettit joined the faculty in 1897. After Mr. Pettit became Professor and Head of the Entomology Department in 1906, he stressed the accumulation and classification of economically important insects in Michigan. It has been reported that Professor Pettit, who reared insects extensively, put nothing in the collection that had not been reared.[18] In 1907 an insectary, a greenhouse, was added to the entomology facilities for the rearing of insects. From July 1, 1929 to June 30, 1930, about 4,000 insects which had been reared were added to the collection. Professor Pettit was particularly interested in the Coccidae. His interest in scale insects influenced Miss Eugenia McDaniel, who joined the department in 1910, to study the Coccidae. Miss McDaniel worked on scales with much enthusiasm and gained an excellent reputation throughout the United States for her systematic work on them. A consequence was the addition of numerous species of Coccidae to the collection. Many of these Coccidae were obtained through trades with other colleges.[19] Miss McDaniels' study of forest and ornamental tree insects also resulted in numerous scale insects being added to the collection. In 1949, there were about 400 species of Coccidae in the collection. Through the combined efforts of Professors Pettit, McDaniel and Ray Hutson, considerable numbers of Maybeetles, fleabeetles, and noctuid moths have been placed in the collection. In 1949, there were about 8,000 specimens and about 1100 species of Noctuids in the collection. About 1943, a private collection of Chloropidae (Diptera) was presented by Curtis W. Sabrosky, former Assistant

Professor of Entomology at the College and now an entomologist at the United States National Museum, Washington, D.C. Mr. Sabrosky is a world authority on Chloropidae and, while at Michigan State (1935 - 1943), he spent many hours of his own time identifying Chloropidae sent him from all pasts of the world.

The addition of noctuid moths to the collection resulted primarily from a "cutworm project" undertaken by the College prior to World War II (about 1937 to 1941). This project consisted of rearing cutworm moths from their various life-stages for the purpose of learning how to distinguish species of cutworms without microscopic examinations, and from any life-stage that might be available. Professor McDaniel expended considerable time beyond her regular hours of employment to make the project a success. Professor McDaniel learned to recognize the larval, pupal, and adult stages of at least 20 cutworms.[20] The cutworm project was deemed important because of frequent,serious outbreaks of cutworms in the sandy crop soils of Michigan.

From 1930 to 1942, several National Youth Administration Students (students receiving scholarships, fellowships, loans, grants, or rummerative employment through funds provided American colleges by the Federal Government from 1930 - 1943) collected, mounted and labeled insects for the Entomology Department, and aided in the care of the insect collection. Some recent student collectors of insects, most of whom have collected for theses in the

Entomology Department (and their contributions and date of contribution) are:

1. Dale F. Bray - aquatic insects, 1949.
2. Harold C. Chapman - aquatic and semi-aquatic insects, 1950.
3. Thomas H. Farr - golden-rod (Solidago spp.) insects, 1948.
4. Roland L. Fischer - Cicindelidae (Coleoptera), 1948.
5. Gale R. Gleason, Jr. - insects of Polyporaceous Fungi, 1951.
6. Gordon E. Guyer - Tendipedidae (Diptera), 1952.
7. Cecil Su-Sen Lee - insects of all orders, 1941.
8. Ryoji Namba - Trypetidae (Diptera), 1950.
9. Frank T. Parmelee - wood-borers (Coleoptera), 1940.
10. Calvin E. Pederson - mosquitoes (Diptera) 1947.
11. R. D. Simmons - Agrilus spp. on raspberry (Coleoptera), 1933.
12. Oscar Taboada - Cicadellidae (Homoptera), 1950 - 54.
13. Donald M. Tuttle - insects on cultivated blueberry, Vaccinium corymbosum, 1947.
14. Bruce V. Wilson - butterflies (Lepidoptera), 1943. Mr. Wilson, who teaches biology at a high school in Owosso, Michigan has collected insects of all orders for the Entomology Department in the summer months since 1943. This collecting has been done in a remunerative status.

In October, 1953 the first worker actually designated "Curator of the Insect Collection" by the State Board of Agriculture (governing board of the Michigan State College) joined the Entomology Department. This was Dr. Roland Lee Fischer, a Ph.D. Graduate of the Kansas State College, Manhattan. As an Assistant Professor, he devotes half of his time to the insect collection and half to teaching systematic entomology.

The following data concerning the contents of the insect collection on June 17, 1949 were provided by Miss Eugenia I. McDaniel:[22]

1. "About 350 families"
2. "About 15,000 species"

According to a count in 1949 by Robert L. Gallun, a graduate student in entomology, the insect collection contained slightly over 90,000 specimens.

b. Repositories, Arrangement, and Use

During Professor Cook's tenure (1867 - 1893), the insect collection was housed in the College Museum located in College Hall (until 1880) and in the Library and Museum Building (part of the present Administration Building) after 1880. The insects themselves were kept in wooden boxes about the size of the present Schmitt box and were arranged according to the check-lists of that time. Each insect was given considerable attention in its identification and was well labeled. A few were "type" specimens.

After Professor Cook left the College in 1893, and until 1909, the insect collection continued to be housed in the Library and Museum Building. In 1906 the collection was transferred from the College Museum to the Entomology Department. In 1909 the Entomology Department moved to the old Agricultural Building (the present Conservation Department Building). The insect collection was quartered in this "new" Entomology Building. In 1923, the collection was moved to a brick annex back of the Entomology Building. This new location provided fire-proof storage, more storage space, and more room for the preparation of insects for the collection.

When Professor Pettit took charge of the Entomology Department in 1906, he began transferring the insects in the collection to small, soft blocks of wood. These blocks were placed in "Harvard" insect boxes. This new arrangement at Michigan State followed that at Cornell University, Ithaca, New York, where Professor Pettit studied entomology.

Although Professor Pettits' system permitted the rapid interpolation of new insects in the collection without excessive disturbance to many insects, the loose blocks were responsible for much breakage.

In 1934, when Professor Ray Hutson became head of the Entomology Department, he instituted the use of cardboard pinning trays for the collection. Professor Eugenia McDaniel, with the aid of departmental staff members and students, spent considerable time transferring the insects from the blocks to the trays.

In 1949, the insect collection and the Entomology Department were moved to spacious quarters in the newly constructed Natural Science Building.

During the early years of entomology at the Michigan Agricultural College, the insect collection proper appears to have been used considerably for teaching. Prior to 1889, its small size and its holdings of common, easily replaceable insects adapted it for this purpose. At the present time, it is not used extensively for elementary instruction but functions as a research and reference collection. The age of the specimens has made them fragile and there are numerous "types","holotypes", etc; therefore only the most competent people have access to the collection. This writer does wish to emphasize that the collection is always available for inspection by anyone interested in insects. A decrease in the stress on systematic work done in the department, as compared to the large amount years ago, also accounts for less use of the insect collection proper for teaching now.

At present, elementary instructional work is done with "teaching collections" in which many specimens are frequently replaced. The identifications of replacements are verified by reference to the Michigan State College Insect Collection which has just been discussed.

2. University of Michigan Museum of Zoology

Insects received little attention at the University of Michigan until Dr. Alexander Ruthven became Curator of the Museum of Zoology in 1906 and started building a more complete museum. The insect collection presently numbers over 2,000,000 specimens.[22] The number of species is unknown. Excellent synoptic collections of all orders are present but the Coleoptera, Hemiptera, Lepidoptera, Odonata, Orthoptera, and Tipuloidea are best represented. The Odonata are especially outstanding. The Family Cicadidae and scattered families in the Diptera and Hymenoptera are strong. The size and content of the collection provide excellent opportunities for taxonomic and ecological studies.

The history of the insect collection is extensive and would take considerable time to investigate thoroughly; therefore this writer does not have much to record about it here. It is known that many purchases and gifts of various private collections account considerably for the size of the collection. This writer surmises that the large number of gifts in this collection compared to the few in the Michigan State College Collection may be due to the fact that workers at the University of Michigan seem always to have taken a greater part in the activities of the Michigan Academy of Science than those at the State College; therefore, the close friendships made, the whereabouts of private insect collections learned, and the needs of the

University expressed in Academy meetings may have resulted in purchases and gifts, often of magnificent size and content. Neglect on the part of entomology faculty members at the Michigan State College to attend meetings of the Michigan Academy of Science is believed to be due to the necessity of these workers having to spend considerable time at numerous agricultural meetings to dispense or learn details pertaining to the control of economically important insects.

Some of the most noteworthy contributors to the University of Michigan Insect Collection (with their major contribution, if known to this writer) have been:

1. E. B. Williamson - Odonata
2. F. M. Gaige - Hymenoptera - ants
3. S. A. Graham - Forest insects
4. T. H. Hubbell - Orthoptera and Dermaptera (present Curator of the Division of Insects)
5. J. Speed Rogers - Tipulidae (present Director of the Museum)
6. Ada Olson
7. I. J. Cantrall - Orthoptera and Dermaptera
8. J. J. Friauf - Orthoptera
9. Arthur W. Andrews - Coleoptera
10. C. O. Berg - Aquatic insects (Diptera)
11. Lewis Berner
12. F. Carpentier

13. P. E. Moody

14. Sherman Moore - Lepidoptera

15. John H. Newman - Lepidoptera

16. Paul T. Rihers

17. Sidney Shapiro

18. W. C. Stinson

19. Frank N. Young

20. L. K. Gloyd - Odonata

21. H. K. Gloyd - insects in general

22. A. L. Olson

23. W. F. Blair

24. George Steyskal - Diptera

25. William W. Newcomb - Lepidoptera

26. Melville H. Hatch - Coleoptera

27. Jennings R. Hickman - Coleoptera (Haliplidae)

28. A. Franklin Shull - Coleoptera

29. William Irwin - mosquitoes (Diptera)

30. Alexander Ruthven

31. Carl Obrecht - Culicidae

32. Paul Welch - aquatic Lepidoptera

3. The Grand Rapids Public Museum

This collection consists of about 2,109 species of Lepidoptera, most of which have been collected in the vicinity of Grand Rapids.[23] A few are from foreign countries, especially South America and India. Nothing has been added to the collection since about 1914. A shortage of display

space has resulted in the storage of the collection. Many of the stored insects have been ruined by the lack of care.

The museum does possess several hundred Riker mounts of economically important insects. One important service of the museum, an unusual one for a museum, consists of providing the public with suggestions for insect control.

The Director of the Grand Rapids Public Museum is Dr. Frank L. Du Mond.

4. Michigan State College Museum

This museum, under the directorship of Professor Joseph W. Stack, is preparing a display of colorful "Insects of Michigan".

CHAPTER IX

CO-OPERATIVE SURVEY AND CONTROL PROGRAMS

A. Japanese Beetle - *Popillia japonica* Newman[1]

One of the most determined survey and control programs for an injurious insect in Michigan and numerous other states has been that directed toward the Japanese Beetle, a very serious pest of about 250 kinds of vegetable, field crop, grass, nursery, flower, shrub, and deciduous and small fruit plants. This insect, having entered the United States in shipments of Japanese Iris in the vicinity of Riverton, New Jersey about the summer of 1911, had established itself well throughout a fifty square-mile area of Riverton by 1921, and had begun spreading to various Eastern States. By 1932, despite a strict Federal Quarantine imposed in New Jersey, in 1919, forbidding the interstate transport of uncertified farm produce and nursery stock, important infestations of the beetle occurred in Connecticut, Maryland, Massachusetts, New York, Rhode Island, Virginia and Washington, D.C. Even distant points in Maine, New Hampshire, Vermont, North Carolina, South Carolina, Ohio and Michigan had recorded the presence of the beetle by 1932.

The following is a summary of the survey and control programs for the Japanese Beetle in Michigan:

Surveys for the Japanese Beetle have been conducted annually in Michigan since 1930. Chemical control programs have been undertaken annually since 1936. All survey and control programs have occurred in the Lower Peninsula.[2] Furthermore, they have been persued co-operatively by the Michigan State Bureau of Entomology and Plant Quarantine at Washington, D.C., and numerous communities. This co-operative method of survey and control is believed to be the only one of its kind presently being conducted in the United States.[3] The co-operative program, being of such long duration, "stands as a good example of harmony between local, federal, and state governments."[4]

1. Surveys

The surveys have been done principally by trap scouting. This method consists of setting standard Japanese Beetle Traps[5] at desired trapping sites. Some survey work has been accomplished through the direct observation of beetles or grubs in infested areas. Traps have been set in over twenty-six communities. Detroit has been the only locality to have traps in operation every year. Traps have been placed there since 1932. The number of traps set in any one community has ranged from 50 to 8,000. The latter number of traps were set in Detroit in 1953.

Trapping operations have been undertaken between June 3 and August 31, the average continuous trapping time

being one month. All traps have been provided by the United States Bureau of Entomology and Plant Quarantine. Funds for the setting and removal of traps have always been included with control expenditures. In 1951, 1952, and 1953, total expenditures by the state and communities averaged about 18,000 dollars annually.[6] For the Japanese Beetle surveys (and control programs), the state has been divided into two districts. District 1 covers the area west of the United States Highway 27 and District 2 covers the area east of the same highway. Each district has its own supervisor.

The presence of the Japanese Beetle in Michigan was first recorded in 1932 at Detroit when eight beetles were trapped in the vicinity of the Michigan Central Railroad Depot and the New York Central Railroad Right-of-way.[7,8] Although the first Japanese beetle traps in Michigan had been placed at Dearborn in 1930, no beetles were caught there until 1936. In 1933, 1934, and 1935, traps placed in Detroit on scattered premises in the area of the catches in 1932 attracted four, ten, and twenty-three beetles respectively. All but two of these catches consisted of single beetles. The largest number of beetles trapped in any one community since 1932 has been 3,042. These were caught in Detroit in 1947. This number was 3,114. For a summary of the number of Japanese Beetles trapped in Michigan since 1936, the reader is referred to Table II.

Two of the most interesting items about the Japanese Beetle Survey in Michigan are: (1) Because of a heavy

TABLE II

NUMBER OF JAPANESE BEETLES TRAPPED IN MICHIGAN COMMUNITIES FROM 1936 TO 1954[9]

COMMUNITY	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948*	1949*	1950	1951	1952	1953
BIRMINGHAM				6		2	5											
DEARBORN	1	6	1	5		5	1	2	2			3	-	-	1			
DETROIT	128	67	82	115	252	225	32	86	95	24	12	3042			43	90	54	66
ECORSE										6					1			15
FERNDALE																3	2	
FLINT							80	37	11							1		
GRAND RAPIDS										166	92	39			19	6	17	4
GROSSE POINT FARMS, WOOD, PARK, and CITY				5								25			3	3		
HIGHLAND PARK			2															

* Data not available

TABLE II (CONTINUED)

COMMUNITY	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948 *	1949 *	1950	1951	1952	1953
KALAMAZOO										63	10	4			2		1	2
LINCOLN PARK							2										1	2
MELVINDALE				5	1	2	4	1		1	1						5	6
MUSKEGON											7							1
PONTIAC			1															
RIVER ROUGE							1	24	42	278	15	10			59	7	5	11
WYANDOTTE											1							
TOTAL BEETLES	129	73	86	136	253	234	125	150	150	538	138	3124			128	110	85	107

* Data not available

infestation of beetles at the Erskine Golf Course at South Bend, Indiana in 1952, a concentrated trapping program was instituted in southwestern Michigan in 1953. This resulted in Michigan having more traps set in 1953 than in any previous year. The trapping area included the territory between New Buffalo on the west, Sturgis on the east, and the Indiana Border. (2) At a public hearing on the Federal Japanese Beetle Quarantine at Washington D.C., in 1951, Mr. C. A. Boyer, Chief of the Michigan State Bureau of Plant Industry, was successful in preventing the quarantine from being imposed on Michigan.

2. Controls

Excluding the use of traps for surveys begun in 1930, the first control measure of any kind instituted in Michigan against the Japanese Beetle is believed to have been the placement of a United States Bureau of Entomology and Plant Quarantine Inspector at Detroit in 1935 to do transit inspection for the Japanese Beetle and the European Corn Borer, *Pyrausta nubilalis* Hubner, and to supervise the trapping of Japanese Beetles. Although the Federal Government had released 352 colonies of a hymenopterous parasite, *Tiphia vernalis* Roh., of the Japanese Beetle between 1926 and 1934,[10] it is not known whether any were liberated in Michigan.

The first insecticidal control program in Michigan for the Japanese Beetle was begun in Detroit on April 30, 1936.[11] This program consisted of spraying eighteen tons of lead arsenate, at the rate of 1,000 pounds per acre, on suspected grub-infested soil in the vicinity of the Michigan Central Railroad Depot and the New York Central Railroad Right- of-way. The spraying was completed on June 3. At the height of operations, the spraying involved seventy-six laborers and fourteen spray trucks. The majority of the funds for the lead arsenate, labor, and rental of trucks supplementing those operated by the City of Detroit were furnished by the Federal Works Progress Administration of Detroit. The results of this program, and those of similar programs undertaken in four other states, were described as "Satisfactory treating programs ---- adequately protected non-infested sections from secondary dissemination of the pest from these detached points."[12] The 1936 programs were prompted by the fact that a Federal Quarantine could be avoided by such action; for by 1935, beetle inspection posts had already been established as far west as the Pennsylvania-Ohio Boundary. The necessity of a possible quarantine along the borders of Michigan is illustrated by the fact that in 1935, the soil of a single plant being transported from Philadelphia, Pennsylvania to Inkster, Michigan contained twelve larvae of the Japanese Beetle.[13]

The trapping of 128 Japanese Beetles in the vicinity of the Detroit Produce Terminal in 1936, emphasized the importance of continuing soil treatments. Besides lead arsenate, DDT and Chlordane have been used. DDT was first used in 1944.

The use of DDT, the noted World War II insecticide was begun after experimental evidence indicated that one pound of the insecticide protected peaches from Japanese Beetle injury for six weeks.[14] The use of Chlordane began in 1952. Insecticidal applications have been made in almost all the communities which have had traps set for the Japanese Beetle. Treatments have consisted primarily of soil applications in the vicinity of traps attracting one or more beetles. The largest acreage treated in any one year was 465. This occurred in 1950. Three hundred and one acres were sprayed with a mist blower that year and 164 received soil applications. The community having the largest number of acres treated in any year, and the largest total acres treated, is Detroit. The former occurred in 1950 when 200 acres were sprayed with a mist blower and 35.5 acres were soil treated. The latter totaled about 890 acres. The largest soil treatment project in Detroit any year was 103 acres. This was in 1953. To date the Japanese Beetle in Michigan has been kept under control well by insecticides.

Another control measure for the Japanese Beetle in Michigan, since 1935, has consisted of a road blockade operated at a truck weighing station at Erie, Pennsylvania for the inspection of shipments of farm produce and nursery stock. A member of the Michigan State Bureau of Plant Industry has been posted at Erie annually to do inspection.

Although the United States Bureau of Entomology and

Plant Quarantine had attempted the establishment of milky diseases (caused by the bacteria _Bacillus popilliae_ Dutky and _B. lentimorbus_ Dutky) of larvae of Japanese Beetles at more than 66,000 sites in twelve states by 1944,[16] it is not known whether this biological control measure was used in Michigan.

B. _European Corn Borer - Pyrausta nubilalis Hubner_[17]

The European Corn Borer was observed in Michigan for the first time in 1921.[18] During August of that year, small infestations were found in townships along Lake Erie just south of Detroit, and along the entire southern shore of Lake Erie in New York, Pennsylvania, and Ohio. The Michigan infestation was believed to have resulted from moths being blown across Lake Erie from heavy infestations near London and St. Thomas, Ontario, Canada.[19] The rapid spread of this very destructive insect toward the Great Lakes States and the "Corn Belt" caused considerable alarm among officials of the United States Bureau of Entomology; and in 1921 the Bureau established a field laboratory at Sandusky, Ohio to study means of combating the borer.

Between 1921 and 1924, the corn borer spread throughout southeastern Michigan, northern Ohio, and northwestern Pennsylvania. In 1924, the borer inhabited over 2,000 square miles of Michigan.[20]

On June 2, 1925, in addition to a Federal Quarantine imposed in 1917 to prevent the inter-state transit of borer-infested corn, the Michigan Department of Agriculture initiated an intra-state quarantine.[21] This was pursuant to similar action taken in other states. The quarantine affected all or parts of the following counties: Monroe, Wayne, Macomb, St. Clair, LaPeer, Huron, Sanilac, Oakland, Washtenaw, and Lenawee. In addition, the same year, the Michigan Legislature furthered the efforts of controlling and preventing the spread of the corn borer by passing Act Number 196, Public Acts of 1925 which authorized regulatory and quarantine measures for the insect. This act became effective May 6. Section 6 of the Act provided for an appropriation of 25,000 dollars for each of the fiscal years 1926 and 1927 for corn borer control. By virtue of Act 196, on July 1925, the Bureau of Plant Industry issued the following directive:

> Field or silage cornstalks must be cut as low as possible, not to exceed six inches in height and should be removed from the field soon after, if possible. If impracticable to cut conrnstalks at the before mentioned height, such stalks, must be broken off at a level with the soil surface during the winter, using preferably a heavy pole or metal rail for that purpose, then raked into windrows and burned. Sweet cornstalks must be cut at a height not to exceed two inches, within two weeks after the ears are harvested, removed from the field, and fed direct to live-stock, or made into silage, or shredded, or burned, or plowed under while green. All cornstalks, corn cobs and other corn remnants, not including silage, remaining on premises must be destroyed by burning on or before May 15 of each year; there fore, these cornstalks, corn cobs, and other corn remnants unless finely shredded, should be kept separate from manure piles and away from barnyards.[22]

Recommendations were also set forth for the cutting of corn before September 20, plowing under of corn stubble prior to May 15, and burning of stalks and cobs.

Continued spread of the corn borer prompted the United States Bureau of Entomology to establish a field station, a sub-laboratory of the corn borer headquarters at Arlington, Massachusetts, at Monroe, Michigan in 1926. This field station had its offices in a two story, wooden-frame house located at 308 West Elm Street. The corn borer laboratory remained at Monroe until July 1, 1932. Its activities were directed by Mr. Phillip Luginbill. The work done by the Monroe laboratory, all of which was done in co-operation with the Michigan State College, consisted of conducting educational programs among the public concerning the life history, habits and control (by sanitation and other cultural practices) of the corn borer, breeding varieties of hybrid corn resistant or tolerant to the borer, conducting surveys for borers, and liberating insect parasites for the biological control of corn borers. The personnel from Michigan State College who conducted studies for the Monroe Laboratory were:[23] (1) Charles B. Dibble, extension specialist in entomology, 1927 - 1944; (2) Walter F. Morofsky, instructor of entomology, 1927-; (3) Andrew Braidwood, student, 1928; and (4) Goodwin S. Tolles, instructor of entomology, 1928 - 1931. In 1928, Mr. Kenneth Arbuthnot, an instructor of entomology at Michigan State in 1926 and 1927, resigned to work for the Federal Government on the corn borer at Monroe. Mr. Russell Marston was in charge of plant breeding at the Monroe Laboratory.

On February 23, 1927, Congress appropriated 10,000,000 dollars for corn borer eradication work in the United States.[24]

In the heavily infested states of Michigan, New York, Pennsylvania, Ohio, and Indiana, corn growers were directed "to clean up all corn debris existing on their premises."[25] For their efforts, growers were reimbursed at the rate of two dollars an acre.[26] This project, supervised by the Bureau of Entomology which had headquarters at Toledo, Ohio, began March 14, 1927 and terminated July 2, 1927.[27] Eradication measures were taken by 300,000 farmers on 2,000,000 acres of corn land located in 64 counties extending 350 linear miles from New York to Indiana.[28] Counts of corn borers made immediately after the close of this campaign indicated that about 95 percent of the borers had been destroyed.[29] Despite the campaign of 1927, infestations of the corn borer increased and, by 1929, the insect had spread to within 30 miles of Illinois. Hope no longer remained for the complete eradication of the corn borer in the United States.

In 1936, results of a survey financed by the Federal Works Administration indicated that twenty-eight townships in Michigan were newly infested with borers.[30]

By 1951, the corn borer was present in 1,456 counties in thirty-seven states.[32] Losses to the insect in 1951 were estimated at 35,812,000 bushels of corn worth approximately fifty-seven million dollars.[31]

C. Grasshoppers

Prior to 1934, little was recorded concerning grasshopper outbreaks and their control in Michigan. Reasons for this are: (1) the United States Entomological Commission (1877 - 1880), in its study of grasshopper outbreaks, did not record much about grasshoppers in Michigan;[32] and (2) heavy rainfall tends to prevent increases of grasshoppers;[33] hence, Michigan, usually having an annual rainfall of 25 to 30 inches, does not commonly have severe outbreaks of grasshoppers.

The grasshoppers, Camnula pellucida (Scudder), Melanoplus differentialis Thomas, M. bivittatus Say, M. femoratus (Burm.), M. mexicanus (Sause), M. femur-rubrum (DeGeer), Dissosteria carolina (Linne), and Encoptolophus sordidus (Burm.) have been the primary cause of grasshopper outbreaks in Michigan.[34]

Before 1934, grasshopper control in the United States was financed wholly by individual states or communities.[35] In Michigan, provision for the control of grasshoppers was first made in 1919 when the Legislature passed Act 6, Public Acts of 1919, which authorized county and township supervisory boards to devote funds to the control of grasshoppers and other insect pests. In 1921, Act 358, Public Acts of 1921, provided for the reimbursement of counties and townships to the extent of one-half of the sums spent by them for such control.

In 1931, following a severe outbreak of grasshoppers in several western states, officials from the affected states and the United States Bureau of Entomology met at Sioux City, Iowa to discuss Federal-State grasshopper control with anticipated appropriations from Congress. An agreement was reached that co-operative action would be more beneficial than individual state efforts.

In 1933, after a grasshopper egg survey in six western states indicated the possibility of a severe grasshopper outbreak in 1934, Congress appropriated 2,354,893 dollars for grasshopper control.[36] Not only did a severe infestation of grasshoppers occur in 1934 in the states surveyed in 1933 but one also occurred in Michigan.[37] From 1934 through 1949, annual recurrences of moderate to large grasshopper populations made Michigan the recipient of Federal grasshopper control aid. This aid consisted of a bran bait containing sodium arsenite as a poison prior to 1939 and sodium fluosilicate thereafter. Water, black strap molasses, and oil were successfully used as wetting agents for the bait. Poison bran baits were obtained in the following manner:

The ingredients for bran baits were purchased and shipped by the Federal Government to individual states, allotments being made according to the severity of grasshopper outbreaks. At main distribution points, the bait materials were received by county agents or other community leaders who were responsible for the establishment of mixing stations. It was from these stations that baits were distributed to individual farmers or scattering crews. The baits were issued in bags which bore "poison warning" tags. For a summary of records concerning the use of poison-bran bait for grasshoppers in Michigan from 1934 to 1949, inclusive, the reader is referred to Table III.

Beginning in 1949, grasshopper control was left to the individual farmer. That year, the use of newly developed organic insecticides was begun for grasshopper control. Among these were: (1) benzene hexachloride; (2) toxaphene; and (3) chlordane.

D. Chinch Bug - *Blissus leucopterus* (Say)[39]

Between 1934 and 1949, the Federal Government also furnished states with crude creosote oil for the construction of barriers around corn fields to protect them from chinch bugs migrating from small-grain crops. Michigan received creosote only in 1934, at which time 104,154 gallons were used for making 1,920 rods of barrier.[40] Enough creosote was left over from the 1934 operations to fulfill chinch bug needs in 1935. The 1934 - 35 creosote program was conducted primarily in Berrien, Lenawee, Monroe, Washtenaw, and Wayne Counties.

E. Oriental Fruit Moth - *Grapholitha molesta* (Busck).[41]

From 1929 to 1943, the liberation of insect parasites for the biological control of the Oriental Fruit Moth in the Eastern States was given considerable attention by the Bureau of Entomology and Plant Quarantine. This method of control, done in co-operation with various state agencies, was emphasized because of the lack of a generally accepted artificial control for this very destructive insect and the

TABLE III

RECORD OF BAIT USED IN MICHIGAN GRASSHOPPER CONTROL
1934 - 1949[38]

Year	Tons Bait Spread (Dry Weight) by All Agencies	Acres Baited, All Agencies	Acres Protected by Control Measures	Number of Farmers Spreading Bait	Value of Crops Saved by Baiting Operations, Dollars
1934	1,195	239,000	*	*	$ *
1935	900	180,000	*	*	500,000
1936	390	78,000	*	*	264,500
1937	669	252,261	*	5,107	600,001
1938	2,091	266,429	498,971	13,761	1,118,158
1939	881	179,804	460,989	7,373	638,492
1940	646	104,665	163,610	4,321	241,457
1941	840	147,140	212,240	4,037	302,590
1942	438	89,735	108,260	2,506	152,065
1943	36	12,195	14,150	232	24,190
1944	14	3,001	4,001	*	10,325
1945	53	4,756	6,366	210	20,830
1946	41	7,092	9,292	147	22,790
1947	102	16,387	27,322	386	110,631
1948	484	76,066	141,204	2,211	1,108,086
1949	404	78,434	146,180	2,385	669,195

* No data

TABLE III
(extended)

Year	Value of Crops Destroyed by Grasshoppers, Dollars	Expenditures for Baiting Operations by States, Counties and Local Agencies, Dollars	Expenditures for Baiting Operations by the BE and PQ, Dollars	Total Costs of Baiting Operations All Agencies Dollars	Dollars Saved For Each Dollar Spent for Grasshopper Control
1934	$500,000	$ *	$29,875	$ *	$ *
1935	218,750	*	22,500	*	*
1936	43,000	*	3,460	8,530	*
1937	354,092	17,597	10,081	36,375	22.00
1938	431,903	20,747	32,616	80,546	21.00
1939	190,177	9,913	25,589	46,955	18.00
1940	161,757	4,933	16,437	29,768	11.00
1941	202,425	6,138	27,214	45,952	9.00
1942	148,825	3,623	15,381	29,954	8.00
1943	29,675	895	2,778	4,953	7.00
1944	6,700	300	1,016	1,814	78.00
1945	24,500	1,172	3,322	6,365	5.00
1946	35,870	812	1,893	3,804	8.00
1947	136,226	1,353	6,372	10,445	14.00
1948	762,112	5,131	25,433	49,912	36.00
1949	319,069	6,025	229	22,434	107.00

* No Data

observation that native insect parasites were effective in controlling the fruit moth in some fruit regions. In Michigan, the liberation of parasites was done in co-operation with the Michigan State College Experiment Station. All liberated parasites were reared at Moorestown, New Jersey. Lansing and Grand Rapids served as trans-shipment points for parasites sent to Michigan.[42] Permits for the liberation of Oriental Fruit Moth parasites had to be obtained from the Division of Foreign Plant Quarantines, Bureau of Entomology and Plant Quarantine, Washington, D.C.[43]

Oriental Fruit Moth parasites were released in Michigan for the first time in 1931.[44] This liberation consisted of two colonies of Macrocentrus ancylivorus (Hymenoptera), one colony numbering 445 specimens and a second numbering 409, sent to Mr. Stanley Johnson at South Haven.[45,46] Mr. Johnson, being in charge of the Michigan State College Sub-Experiment Station at South Haven, released the parasites as a College project. One colony of 400 parasites of the same species was also released at Fennville in 1931. The parasites liberated in 1931 were established in the State by 1932.

Between 1931 and 1935, the following parasites (with county, year, and town of release, and number released, appended) were liberated in Michigan:[47]

1. Apanteles molestae (Uchida)

   Berrien: 1934, Benton Harbor (98).

   Van Buren: 1934, South Haven (94).

2. *Agathis conspicuus* (Wesm.)

   Berrien: 1934, Eau Claire (23)

3. *Agathis diversus* (Mues.)

   Berrien: 1934, Eau Claire (4)

4. *Cremastus flavo-orbitalis* (Cam.)

   Berrien: 1934, Eau Claire (12)

5. *Horogenes molestae* (Uchida)

   Berrien: 1934, Berrien Springs (231), Eau Claire (243),

   Sodus (218), Derby (240).

   Van Buren: 1934, South Haven (229)

6. *Macrocentrus ancylivorus* Roh.

   Allegan: 1931, Fennville (400); 1934, Casco Township (432) and (416).

   Berrien: 1932, Berrien Springs (258), Royalton (250),

   Eau Claire (250), Lakeside (250), Millburg (249), Sodus (249), Watervliet (250); 1934, Berrien Center (353), Berrien Springs (388), Eau Claire (437), Royalton (367), Sodus (391) (401).

   Oakland: 1932, Farmington (425), Novi (250) and (425), Rochester (250) and (425).

   Van Buren: 1931, South Haven (445); 1934, Geneva (422), South Haven (409).

7. *Macrocentrus thoracicus* Gravenhorst.

   Berrien: 1934, Benton Harbor (245)

8. Pristomerus vulnerator Panzer

Berrien: 1934, Eau Claire (30).

In addition to the above releases, the following liberations were made in Berrien and Van Buren counties after 1935[48]:

1. 1936 - 21 colonies which included Horogenes molestae, Macrocentrus thoracicus, M. ancylivorus, Eubadizon extensor, Phaeogenes haeussleri, and Agathis diversus.
2. 1937 - 3 colonies of Macrocentrus ancylivorus and various species of Japanese parasites.
3. 1938 - 2 colonies of Phaeogenes haeussleri.
4. 1939 - 2 colonies of Gambrus stokesii, an Australian parasite.
5. 1943 - 15 colonies of Macrocentrus ancylivorus Roh., 3,750 specimens.

The liberation of Oriental Fruit Moth parasites in Michigan was done by personnel of the Michigan Agricultural Experiment Station and the Bureau of Entomology and Plant Quarantine Parasite Rearing Laboratory, and by county agents of Berrien and Van Buren Counties. The collection of infested peach twigs, from which parasite recoveries were made, was also done by these workers. Macrocentrus ancylivorus Roh., an insect indigenous to the United States, was the only parasite successful in colonizing itself in Michigan and other eastern states. The value of this insect in reducing Oriental Fruit Moth infestations was not ascertained.

The cost of parasite liberations was estimated at about five dollars per thousand specimens.[49]

Parasite liberations were terminated in Michigan in 1943 because DDT became a generally accepted control material for the Oriental Fruit Moth.

F. Forest Insects

Forest insects in Michigan received little consideration before 1927.[50] Although there had been considerable interest in the control of forest insects for many years prior to 1927, methods for the study of forest entomology and means for control were not available.[51] In 1927, when Professor Samuel A. Graham joined the University of Michigan School of Forestry and Conservation at Ann Arbor, research was begun on forest insects. Since that time, detailed life history, habit, ecological, and control studies have been made of the larch sawfly, Pristiphora erichsonii (Htg.), jack-pine sawfly, Neodiprion banksianae Roh., spruce budworm Choristoneura fumiferana (Clem), other pine sawflies, walking sticks, and other forest insects.[52] A study of the relative resistance of various forest types to insect injury has been a major project.[53]

From 1930 to 1935, the United States Bureau of Entomology and Plant Quarantine, in co-operation with the University of Michigan and the United States Forest Service, maintained a forest entomological laboratory at Ann Arbor. This was known as the Lake States Forest Insect Laboratory. Professor Graham was chief collaborator and in charge.[54]

Besides continuing those forest insect studies initiated by Professor Graham in 1927, investigations were made of white grubs in forest nurseries and plantations and the application of preventative methods through forest management. In 1935, the Lake States Laboratory was transferred to Milwaukee, Wisconsin where it is still maintained. Its present name is "Forest Insect Investigation Laboratory". In Milwaukee, the Laboratory is in closer contact with the activities of the United States Forest Service.

During the era of the "Emergency Conservation Work" and the "Civilian Conservation Corps" (programs conducted between 1933 and 1943 by the Federal Government to provide employment for young men through the performance of public conservation work) the Milwaukee Insect Laboratory used considerable conservation labor to conduct insect survey and control programs in various Michigan National Forests.[55] Surveys for aquatic insects were also undertaken by conservation laborers.[56] Some of the forest insect survey and control programs (with the year in which they were conducted, appended) consisted of[57]:

1. making white grub surveys of proposed tree planting sites (1934 - 1937). Adult beetles were collected at camp lights for the determination of species present and specie abundance. Some beetles were collected from host plants to determine food preferences. Grubs were collected by examining one square-foot

samples of soil at intervals of one and two chains. One-chain intervals were used on soils suspected to be heavily infested. Using one-chain intervals, 100 samples were taken in a forty acre plot. The presence of one or more Phyllophaga grubs in more than one-half of the samples in a tract of ten acres or more in size was considered too heavy an infestation for planting. Much of the white grub work was done at the Huron National Forest, East Tawas.

2. distributing poison bran bait for grasshoppers on 20,000 acres of young plantations in the Baldwin and Cadillac Districts of the Manistee National Forest, (1936).

3. spraying red and jack-pine, _Pinus resinosa_ and _P. banksiana_, respectively, in co-operation with the Michigan State Highway Department, along the highway between St. Ignace and Sault Ste. Marie for LeConte's Sawfly (_Neodiprion lecontei_ Fitch), (1937).

4. baiting 14,873 acres for grasshoppers in the Cadillac District of the Manistee Forest, (1937).

5. spraying about 10,800 acres of red and jack-pine for LeConte's Sawfly and other sawflies in the Upper Michigan National Forest at Escanaba, and the Manistee Forest, (1938).

6. spraying about 6,516 acres for LeConte's Sawfly in the Upper Michigan and Manistee Forest, (1939).

7. baiting 10,000 acres for grasshoppers at Manistee and spraying lead arsenate on about 7,000 trees infested with LeConte's Sawfly at Marquette,(1940).

By 1940, the activities of the Civilian Conservation Corps had been drastically curtailed in favor of national defense; thus the reporting of outbreaks of forest insects was left to forest supervisors. Survey and control programs became dependent on the airplane.

Since about 1940, considerable collaboration on insect survey and control programs in Michigan and other states in the Great Lakes Region has been received by the Milwaukee Insect Laboratory from the following agencies:

1. Lake States Forest Experiment Station, St. Paul, Minnesota.
2. Central States Forest Experiment Station, Columbus, Ohio.
3. Indian Service, United States Department of Interior, Neopit, Wisconsin.
4. University of Michigan, Ann Arbor, Michigan
5. University of Minnesota, St. Paul, Minnesota.
6. United States Soil Conservation Service, Ohio Valley Region, Dayton, Ohio.
7. Consumers Power Company, Manistee, Michigan.
8. Michigan State College, East Lansing, Michigan

In 1947, forest insect survey and control programs in Michigan and the rest of the United States were given

considerable impetus by the enactment of a Federal "Forest Pest Control Act." This act was approved by Congress on June 25. With reference to insect surveys and control, Section 2 of the Act states:

> The Secretary of Agriculture is authorized either directly or in cooperation with other departments of the Federal Government, with any state, Territory, or possession, organization, person, or public agency, subject to such funds as have been, or may hereafter be, made available for these purposes, to conduct surveys on any forest lands to detect and appraise infestations of forest insect pests and tree diseases, to determine the measures which should be applied on such lands, in order to prevent, retard, control, suppress, or eradicate incipient, threatening, potential, or emergency outbreaks of such insect or disease pests, and to plan, organize, direct, and carry out such measures as he may deem necessary to accomplish the objectives and purposes of this Act: Provided, that any operations planned to prevent, retard, control, or suppress insects or diseases on forest lands owned, controlled, or managed by other agencies of the Federal Government shall be conducted with the consent of the agency having jurisdiction over such lands.[58]

In Michigan as a result of the Federal Forest Pest Control Act, a State Division of Forest Entomology was organized in the Spring of 1950. This division became a part of the Michigan State Department of Conservation, Lansing. Mr. Richard Fox was appointed "forest entomologist." Mr. Fox is the first State employee to have such a designation. Prior to 1950, the Forestry Division of the State Conservation Department depended upon Professor Walter F. Morofsky and Dr. Samuel A. Graham, forest entomologists of the Michigan State College and the University of Michigan, respectively, for advice on forest insect and disease problems. The work of the State Forest Entomology Division, undertaken co-operatively with the State Conservation and Forestry Departments,

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Michigan State Bureau of Plant Industry, Michigan State College, University of Michigan, and United States Bureau of Entomology and Plant Quarantine Forest Insect Laboratory at Milwaukee, consists of detecting forest insects and diseases by collecting data on their occurrence and damage, and carrying out control programs. With reference to the latter, attempts are made to reduce populations of injurious insects and disease before they can become epidemic. Besides State and Federal agencies, the Forest Entomology Division has enlisted the aid of private forest industries. This provides a more thorough coverage of the State, especially of the Upper Penninsula. One of the largest industrial concerns to co-operate is that of the Bonifice Lumber Company, Iron Mountain, Michigan. This organization is a subsidiary of the Kimberly-Clark Corporation, Neenah, Wisconsin, which has enormous holdings of timber in Canada, the Great Lakes States, and the South. The Bonifice Lumber Company employs an entomologist and several plant pathologists for their forests. The company maintains a laboratory at Iron Mountain.

By the end of 1953, the State Forest Entomology Division had established about 609 permanent insect-disease observation areas on State and private lands in Michigan. The observation areas consist of forty-acre tracts of trees, principally of pine, aspen, and tamarack. The plots vary in age. Each "forty" is inspected by a district forester at least once a year. Some areas have been inspected four or five times annually. The inspections, for which report forms are filled out and sent to Lansing, are made principally for the following insects:

1. Jack-pine Sawfly - Neodiprion banksianae Roh.
2. Red-headed Pine Sawfly - N. lecontei (Fitch).
3. Saratoga spittle bug - Aphrophora saratogensis (Fitch).
4. Pine spittle bug - A. parallela (Say).
5. White-pine weevil - Pissodes strobi (Peck).
6. Larch sawfly - Pristiphora erichsonii (Htg.).
7. Larch casebearer - Coleophora laricella (Hbn.).
8. Spruce budworm - Choristoneura fumiferana (Clem.).
9. European pine shoot moth - Rhyacionia buoliana (Schiff.).
10. Forest tent caterpillar - Malacosoma disstria Hbn.
11. Anomala Beetle - Pachystethus oblivia Horn.
12. Hemlock Looper - Lambdiana fiscellaria (Guen.).

Reports of insect and disease conditions in Michigan forest observation areas are presently made on the form which follows this page.

In 1948, the United States Bureau of Entomology Milwaukee Forest Insect Laboratory undertook extensive studies of forest insects in Michigan, some of which had been started in 1941 and had been interrupted by the war, and continued control programs with DDT sprayed by airplanes. Emphasis was placed on the Saratoga spittle bug, Jack-pine budworm, LeConte's Sawfly, and the White-pine weevil. Considerable information has been gathered on these insects.

MICHIGAN FOREST PEST DETECTION PROGRAM - Observation Report

PEST ______________________________ (Write in name if known)

Col. 3-4. DAY ______
Col. 5-6. MONTH ____
Col. 7-8. YEAR _____
Col. 9-10-11. SAMPLE AREA NO. ______

Col. 12-13. DISTRICT ______
Col. 14-15. TOWN ________ N S
Col. 16-17. RANGE ______ E W
Col. 18-19. SECTION _______
Col. 20-21. FORTY ________

Col. 22 OWNERSHIP
__1. Federal
__2. State
__3. Com. or Sch.
__4. Private

Col. 23. ORIGIN
__1. Seed
__2. Sprout
__3. Plantation

Col. 24. FIRE RECORD
__1. Unburned
__2. Current yr.
__3. Previous yr.
__4. Past 2-5 yrs.
__5. Older

Col. 25. CUTTING RECORD
__1. None within 5 yrs.
__2. Clearcut " "
__3. Partial cut "
__4. Thinned within 1 yr.
__5. Pruned " 5 yrs.

Col. 26. WINDFALL
__1. Normal or none
__2. Current yr.
__3. Previous yr.
__4. Past 2-5 yrs.
__5. Older

Col. 27. GRAZING RECORD
__1. None
__2. Currently
__3. Past 2-5 yrs.
__4. Older

Col. 28. SOIL GROUPS
__1. Porous
__2. Nonporous
__3. Rock outcrop
__4. Stagnant bog
__5. Stagnant marsh
__6. Seepage
__7. Flood plain

TREE SPECIES PRESENT IN ORDER OF ABUNDANCE
Col. 29-30. A ____________
Col. 31-32. B ____________
Col. 33-34. C ____________
Col. 35-36. D ____________
Col. 37-38. E ____________

Col. 39. % SHADED BY VEGETATION OVER 1 FOOT
__1. 1-20
__2. 21-40
__3. 41-60
__4. 61-80
__5. 81-100

Col. 40. % DENSITY TREE CROWNS OVER 20 FEET
__1. 1-20
__2. 21-40
__3. 41-60
__4. 61-80
__5. 81-100

Col. 41. ATTACK RECORD
__1. Started this yr.
__2. Started last yr.
__3. Started earlier
__4. Old attack evident, none now
__5. None evident

HOST OR HOSTS UNDER ATTACK
Col. 42-43. A ____________
Col. 44-45. B ____________
Col. 46-47. C ____________
Col. 48-49. D ____________
Col. 50-51. E ____________

Col. 52. ATTACKED TREES AVERAGE SIZE
__1. Under 2 ft.
__2. 2-6 ft.
__3. 6-15 ft.
__4. 15-30 ft.
__5. 4-6 in. diam.
__6. 6-12 in. "
__7. 12-18 in. "
__8. Over 18 in. diam.

Col. 53. % ALTERNATE HOST ATTACKED
__1. 1-10
__2. 11-20
__3. 21-40
__4. 41-60
__5. 61-80
__6. 81-100

Col. 54. HOST HEALTH CLASSES
__1. Good
__2. Medium (Dead twigs, foliage faded)
__3. Poor (Dead branches, leaves small)
__4. Dying
__5. Dead

Col. 55. % STAND COMPOSED OF HOST SPECIES
__1. 1-20
__2. 21-40
__3. 41-60
__4. 61-80
__5. 81-100

Col. 56. % SUSCEPTIBLE TREES ATTACKED
__1. 0-1
__2. 2-10
__3. 11-20
__4. 21-40
__5. 41-60
__6. 61-80
__7. 81-100

Col. 57. STAGE OF PEST
__1. Egg
__2. Larva or nymph
__3. Pupa
__4. Adult

Col. 58. DEGREE OF ATTACK

Bark Beetles
__1. One attack per sq. ft.
__2. Two attacks " " "
__3. Three " " " "
__4. Four " " " "
__5. Five or more" " "

Defoliation or Terminal Injury
__1. 1-20%
__2. 21-40%
__3. 41-60%
__4. 61-80%
__5. 81-100%

Number of Stem Cankers
__1. One
__2. Two
__3. Three
__4. Four
__5. Five or more

Col. 59. SIMILAR STANDS IN AREA
__1. Predominant
__2. Frequent
__3. Scattered
__4. Scarce

Col. 60. ABUNDANCE OF PEST IN SIMILAR STANDS
__1. None
__2. Same
__3. Lighter
__4. Heavier

OBSERVER ______________________________

(Fill out back of sheet, and make sketch map to show local distribution if this can be determined. Also indicate under remarks any information which will give a more complete picture of the situation.)

Name of owner: ______________________________
(If other than state or federal)

Map scale: ______________________________ Estimated acreage: __________

1. In your opinion, is the abundance of this insect increasing or decreasing as compared to last year on this sample area?

   Increasing __________ Decreasing __________

2. What is the situation regarding the abundance of this insect as compared to last year on your entire district?

   Increasing __________ Decreasing __________

3. REMARKS:

Beginning in 1951, the Milwaukee Insect Laboratory instigated annual conferences in Milwaukee on forest insect surveys in Michigan, Wisconsin, and Minnesota. The first of these conferences was held on April 24, 1951; the second, February 14, 1952; and the third on February 18, 1953. The purpose of these conferences is:

> to review developments in the organization and operation of forest insect detection survey programs of state and federal agencies.[59], and to discuss reconnaissance and appraisal survey procedures for certain specific insects.[60]

The meetings are intended to bring together entomologists and foresters concerned with the protection of forests from insects. Mr. C. B. Eaton, in charge of the Milwaukee Laboratory in 1951 was in charge of the 1951 Conference. In 1952 and 1953, Mr. H. J. Mac Aloney, head of the Milwaukee Laboratory, was in charge of the Conference.

In 1952, the following personnel represented Michigan at the Milwaukee Conference:

1. Walter F. Morofsky, Professor of Entomology at Michigan State College.
2. Samuel A. Graham, Professor of Economic Zoology, University of Michigan.
3. N. F. Smith and R. C. Fox, Staff Forester and Forest Entomologist, respectively, Forest Division, Michigan State Department of Conservation, Lansing.
4. D. Lovitt, Bureau of Plant Industry, Michigan State Department of Agriculture, Lansing.

At the 1951 conference, N. F. Smith reported that 342 observation areas were established in Michigan during 1950 for obtaining reports on forest insect conditions. The 1952 conference dealt primarily with legislation and industry interest in forest pest control. In 1953 the conference emphasized improvement in survey techniques, surveys for Saratoga spittle bugs, and co-cperative efforts.

G. The Mackinac Island Fly Control Program[61,62]

Michigan was one of the first states to have access to DDT for demonstrations of community insect control. The first project of this kind in the state occurred on Mackinac Island, in the Straits of Mackinac, in the summer of 1945 when an intensive fly control program was undertaken through spraying and sanitary measures.

A fly control program on Mackinac Island was prompted by the following facts:(1) Prior to 1945, Mackinac Island, a historical summer resort and tourist site, had been the locale of almost annual outbreaks of dysentery. These outbreaks were believed by the Michigan State Health Commissioner, Dr. William E. DeKleine, to be due to excessive populations of flies. The presence of so many flies was the result of numerous fly breeding places consisting primarily of manure accumulations from about 300 carriage-horses kept on the island for the transportation of tourists (no motor vehicles are allowed on Mackinac Island). Since livery owners devoted most of their time to the tourist

trade, few efforts were expended in hauling manure from stables regularly and disposing of it properly. Manure was frequently piled in alleys or dumped in inconspicuous places along roadsides. Every summer, the Michigan State Department of Public Health had emphasized and encouraged sanitation as an aid to fly control on Mackinac Island but sanitation alone was insufficient, and the net result was that sanitary efforts were neglected because the general populace was convinced that sanitation would not work;
(2) the need of having sanitary and fly-free surroundings for a national conference of state governors that was scheduled to be held on Mackinac Island in the summer of 1945;
(3) The island was separated from the mainland by a wide expanse of water; hence its isolation would facilitate the control of flies by eliminating outside sources of flies;
(4) DDT, having shown promise as a fly control material while in use by the United States Armed Forces, was released by the Federal Government for civilian use; thus a project was organized to attempt the control of flies by this means on the island.
(5) Because DDT was being manufactured in large quantities by the Michigan Chemical Corporation, St. Louis, Michigan, easily accessible and readily available supplies of DDT were on hand.

The following personnel (with the organizations they represented, appended) were involved in the Mackinac Island Fly Control Project:

1. William Doyle - in charge of the Mackinac Island State Park Commission, representing the businessmen of Mackinac Island.

2. Colonel L. S. Fisher and Captain James Steele - United States Public Health Service, Washington, D.C.

3. LaRue L. Miller - Michigan State Department of Public Health, Lansing. Mr. Miller was coordinator of the project.

4. Arthur Wolcott - Michigan Chemical Corporation.

5. Dr. Herman L. King - Extension Specialist in Entomology, Michigan State College, East Lansing.

6. Michigan State Department of Parks and Recreation, Lansing. Transportation for this work was provided by the Mackinac Island Carriage Drivers Association, and hotel accomodations for the project were provided by the Management of Mackinac Island

A sanitation survey of Mackinac Island was made during the period of June 27 to July 5. This survey consisted of:

1. Investigations by Dr. King and Messrs. Miller and Wolcott to determine breeding sites of flies and the species of flies present. Manure and garbage were found to be the principal sources of flies. The housefly, *Musca domestica* Linn., and the stable fly, *Stomoxys calcitrans* Linn., were the most prevalent flies. Dr. King and Mr. Wolcott also

demonstrated the use of DDT using hand-operated spray atomizers and 3-gallon sprayers. They sprayed DDT in several kitchens, hotel lobbies, boat loading docks, garbage containers in the vicinity of food establishments, and stables. The effectiveness of the DDT, combined with sanitary measures, aroused the enthusiasm of everyone on Mackinac Island for the control of flies.

2. Inspection of food-handling establishments and stables by Captain Steele. He also recommended sanitary measures, enforced minimum sanitary standards in food establishments, and presented a number of lectures on sanitation to food dealers.

3. A visit to Round Island not far from Mackinac Island, by Dr. King and Colonel Fisher, to investigate the claims of numerous Mackinac residents that swarms of flies migrated from Round Island to Mackinac Island. The United States Coast Guard provided transportation for the survey work on Round Island. Few flies were found there. Between July 6 - 15 and August 7 - 15, large scale applications of DDT (first and second applications, respectively) were made to about thirty stables, about thirty miles of roadway, a public dump, exteriors of buildings, outside toilets, alleys, streets, two boats that made regularly scheduled trips between Mackinac Island and the mainland, and picnic areas. The DDT was sprayed by two employees of the Mackinac Island State Park Commission. These workers also supervised

the elimination of fly-breeding refuse and its hauling to dumps. About 1000 dollars worth of DDT was provided by the Michigan Chemical Corporation. The large-scale spraying was done with a two-nozzle sprayer mounted on an old fire engine chassis.

At the termination of the Mackinac Island Fly Program on August 15, 1945, the State Health Commissioner reported that astonishing control of flies had been achieved on the Island. The mayor of Mackinac Island lighted a fire for the burning of several hundred old fly traps.

The Mackinac project served as evidence that nuisance insects in any community can be effectively controlled by co-operative sanitary and insecticidal measures. The success of DDT on Mackinac Island prompted the United States Army to rush DDT to Rockford, Illinois on August 19, 1945 to kill flies in an effort to combat a severe epidemic of poliomyelitis.

By September 19, 1945, smaller demonstrations of the fly-killing effectiveness of DDT had been successfully undertaken in numerous stables, chicken coops, dairies, barns, hospitals, laboratories, parks, fairgrounds, and schools in Michigan.

In 1946, numerous communitites throughout Michigan purchased and applied DDT. These applications were made with a power sprayer furnished by the Michigan State Department of Public Health.

Communities in Iowa, Kansas, and other midwestern states were so impressed with the Mackinac Island Project that they undertook similar programs. In fact, since 1945, other states have had considerable initiative in conducting community fly control programs; but Michigan has had little. The lack of fly control programs in Michigan might be due to the following factors:

1. lack of enthusiasm.
2. high costs.
3. lack of technical personnel and necessary money, equipment, and labor.
4. reluctance of community officials to keep spray programs going.
5. people waiting too long in the season before taking the necessary steps to arrange a control program.

Since 1945, flies have continued to be a problem on Mackinac Island. Fly control has been undertaken annually. Besides DDT, the following insecticides have been used on Mackinac Island: (1) lindane; (2) chlordane; (3) benzene hexachloride; and (4) dieldrin. In 1952, the cost of fly control on the Island was about 1200 dollars.

H. The Muskegon Fly Control Program[63]

In 1947, the City of Muskegon, Michigan, along with Charleston, South Carolina; Phoenix, Arizona; Topeka, Kansas; and Troy, New York, was selected by the United States Public Health Service, Washington, D.C., to participate in a five-

city fly control program. Muskegon, like the other test cities had frequently experienced a high annual mortality rate from dysentery, a fly-borne disease; thus it was believed to be an ideal community in which to determine whether the control of flies would significantly decrease the occurrence of dysentery. Dr. Richard Sears, Director of the Muskegon County Department of Health, was responsible for the choice of Muskegon as a test site. The control programs in each of the test cities were expected to last about five years, a period believed to be sufficient for the epidemiological appraisal of not only dysentery but also of diarrhea and poliomyelitis. The latter two diseases also had been quite prevalent in Muskegon.

The fly control program in Muskegon emphasized both sanitation and the application of insecticides. The program began in 1948 and was terminated in 1950. Beginning July 1, 1948 and continuing until late autumn the activities of the program consisted of surveys for the location of fly-breeding places, determination of fly species, and estimation of fly abundance. The surveys were conducted in Muskegon, Muskegon Heights, North Muskegon, Roosevelt Park and Norton and Muskegon Townships. In the summer and autumn of 1949, an enthusiastic sanitation campaign and spraying program was conducted in the localities surveyed in 1948. DDT and chlordane were the insecticides applied. Work crews cleaned up piles of refuse which served as sources of flies, and insecticides were applied in alleys, in picnic areas, at market places, at garbage disposal sites, and other places where flies breed. Considerable publicity in the newspapers made the populace quite conscious of flies, and the citizens were urged to use sanitary measures for controlling flies themselves. Unfortunately, little significant data could be derived from this intensive program, for in July and August of 1945, 1946, and 1947 mortality rates due to dysentery, diarrhea, and poliomyelitis were quite low despite enormous populations of flies. In 1950, only insecticidal sprays were applied, and the spraying was all done by June 30. In 1949 and 1950, the residents of metropolitan Muskegon contributed about 8,000 and 4,000 dollars, respectively, for the fly control program. Although no correlation could be made between the incidence of disease and size of fly populations in Muskegon, the community was provided evidence that sanitation and insecticides provide fly abatement of a high order.

The Muskegon fly control program was conducted by the following personnel:

1. Christopher M. Elmore, entomologist in charge.
2. Kenneth E. Nutter, area supervisor.
3. six entomological aides.
4. a part-time sanitary engineer.
5. a part-time statistician.

The services of each of these people, except Mr. Nutter, and four spray trucks, the insecticides, and other field equipment were provided by the United States Public Health Service. In 1948, Muskegon provided office and garage space, clerical assistance, and labor for the driving of trucks and spraying.

Considerable co-operation was received from the Michigan State Department of Public Health, Lansing.

I. Rocky Mountain Spotted Fever Tick - Dermacentor variabilis (Say)[64,65]

The presence of this tick in Michigan was ascertained in 1942 by a field survey conducted by the Bureau of Epidemiology, Michigan State Department of Public Health, in co-operation with the Michigan State College Department of Entomology. The tick was found in the southwestern portion of the State and throughout the western portion of the Upper Peninsula.

In the summer of 1946, the Bureau of Engineering, Michigan State Department of Public Health, conducted a survey for ticks in the Upper Peninsula. The work of the survey was done by Alex MacVitte, a Detroit school teacher. Over a period of sixty working days, 350 specimens of Dermacentor variabilis (Say) were collected. Most of these were obtained in May and June. All but 96 of the specimens were found within a fifteen-mile wide area along the Michigan-Wisconsin Boundary.

The presence of a Rocky Mountain Spotted Fever Tick in Michigan presents a new health hazard. Although Rocky Mountain Spotted Fever has occurred in Michigan, infected ticks have not yet been isolated in the State. The first confirmed case of Rocky Mountain Spotted Fever in Michigan occurred in the State in August, 1945. This case was in Berrien County. A definite record of a tick bite was not obtained. Prior to

August, 1945, five cases of this disease had been reported in Michigan but none could be confirmed in the laboratory. Contact with infected ticks might have been made outside of the State. The first case in Michigan having a definite record of a tick bite was reported in May, 1949. This case also occurred in Berrien County, 13 miles southeast of the first confirmed case of Rocky Mountain Spotted Fever in Michigan, and twenty-two miles southwest of a suspected case in 1944. Only one suspected case of the disease has been reported from the Upper Peninsula. That was in July, 1941.

J. Mosquitoes

Late in the summer of 1943 a malaria mosquito survey of southern Michigan was made by Curtis W. Sabrosky, Associate Professor of Entomology at the Michigan State College. This survey was made in co-operation with the Michigan State Department of Public Health. Data was recorded on breeding sites and the abundance, distribution, and species of malaria mosquitoes.[66] New records of anopheline species obtained by this survey prompted the Michigan State Department of Public Health to undertake a state-wide mosquito survey. This survey was made in the summers of 1944 and 1945. Its purposes were to determine:

1. the distribution and occurrence of malaria fever mosquitoes.
2. the distribution of mosquitoes classified as pests.

3. the abundance of anopheles mosquitoes in Michigan. For the 1944 and 1945 survey, the Lower Peninsula was divided into five districts, each comprised of fourteen counties. The Upper Peninsula, having fifteen counties, was designated a sixth district. One worker was assigned to each district, and larval and adult stages of mosquitoes were collected at a total of 1662 sites. Michigan was the first state to attempt and complete a state-wide survey of the distribution and specie occurrence of mosquitoes.[67] Up to 1945 Michigan was the only state which had made a state-wide mosquito survey like that done in 1944 and 1945.[68]

In 1947, a study was made of the history and county distribution of the immature and adult stages of forty-eight species of mosquitoes known to inhabit Michigan. This was done by Calvin Pederson, a graduate student in the Michigan State College Department of Entomology.[69] The Michigan State Department of Public Helath co-operated on this project.

No mosquito-borne malaria fever has occurred in Michigan since 1934. In that year, Michigan had 104 cases of the disease. Five deaths occurred. Most of the cases were in the vicinity of Paw Paw (Van Buren County) where a dam for an artificial lake broke and the resulting swamp served as an excellent breeding site for malaria mosquitoes.[70]

K. <u>Nematodes</u>

In the summer of 1953, Dr. B. G. Chitwood, one of the worlds' leading authorities on nematodes, was employed by the Michigan State College Experiment Station to conduct a survey of the plant nematode diseases of Michigan. This was the first nematode survey in Michigan since about 1920 when some work on such a project was done by Dr. Ernst A. Bessey, Professor of Botany at the Michigan State College. Since the control of nematodes is much like the control of soil insects, Dr. Chitwood was provided office and laboratory space in the Department of Entomology.

CHAPTER X

THE ORIGIN OF CHEMICAL PEST CONTROL IN MICHIGAN AND DEVELOPMENTS PRIOR TO 1900

A. Control of Insects by Insecticides

The first systematic investigation of the insecticidal control of insects in Michigan was made by Albert John Cook, Professor of Entomology at the Michigan Agricultural College (1867 - 1893). It appears that his first investigation was made in 1868. That year, he studied the control of the orange-striped oakworm, *Anisota senatoria* A. and S., and reported to the Michigan State Board of Agriculture, the governing board of the Agricultural College, that "from experiments tried during the summer, we are convinced that syringing the trees with solutions, will avail but little."[1]

Since the first systematic attempt to control an injurious insect in the United States had not occurred until about 1865, when Paris green was used on the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say)[2] Professor Cook was a pioneer in controlling insects with chemicals sprayed or dusted on agricultural cropplants as it is done at present.

Although a record of Professor Cook's insecticidal research did not appear until after his affiliation with the Michigan Agricultural College, this writer believes that Professor Cook probably undertook such studies prior to 1868. This belief is supported by the fact that after his graduation from the Michigan State Agricultural College in 1862, Albert John Cook managed a fruit farm at Courtland, California where "-----he got interested in orchards and insects and anything in general that affected fruit."[3] He managed the farm until 1867 for a sister (Mrs. Gammon) whose husband had drowned in the Sacramento River. Professor Cook's college training in entomology, his independent study of the subject, and his orchard experiences in California no doubt had aroused an interest in insect control.

The following is a chronological account of the most significant insecticidal researches conducted by Professor Cook:

Upon his joining the college, he was confronted with the matter of controlling the Colorado Potato Beetle which had entered Michigan about 1866. He began his researches with Paris green in 1868. He may have tested Prussian blue, a dye chemical; for it was reported as having been used in Michigan for the potato beetle in 1869.[4]

In 1874, Professor Cook reported to the Michigan State Board of Agriculture that he had been the most successful with Paris green on potatoes by using the following two methods: (1) mixing one heaping teaspoonful of Paris green with ten quarts of water, and sprinkling the mixture with a common sprinkler or a broom; and (2) mixing one part of Paris green with six parts of flour and sifting the mixture on dry plants through a muslin bag attached to a handle or through a wire-gauze stretched over an open bottom of a pail. Regardless of the method used, two to three applications of Paris green were required for satisfactory results. Professor Cook's experiments indicated that wheat flour was the most satisfactory adhesive of those tested for Paris green.[5]

By 1876, such insects as the cankerworm (Geometridae), the codling moth, Carpocapsa pomonella Linn., scales (Coccidae), white grubs, Phyllophaga spp., and cutworms (Noctuidae) had become a menace in Michigan and Professor Cook urged farmers to undertake persistent efforts to control destructive insects. He emphasized that these efforts should be made by all growers in a community, not by a few individual ones as had been the practice. At an institute for farmers at Allegan, Michigan on January 11, 1876, Professor Cook said:

> ---- there should be such interest elicited, through grange and club, that every man in every neighborhood of our state should give battle in lines already marked out, and adopt new ones so soon as they were suggested by the investigators ---- the means must be generally known to all our farmers and fruit growers, and then all must be fired with such zeal that practicing may keep pace with knowledge.[6]

By 1876, Professor Cook was making the following insecticidal recommendations:

1. white hellebore dust for the imported currant worm, Nematus ribesii (Scop.), on currant.
2. road dust or quick lime thrown into cherry trees for the cherry slug, Caliroa cerasi (L).
3. Paris green syringed on trees to kill cankerworms.

For the syringing or spraying of trees with an insecticide, a "Whitman Fountain Pump" or a "Johnson Pump" was recommended by Professor Cook. Both of these were small hand pumps consisting of a tube and a piston. The Whitman Pump forced liquids as high as thirty feet. The Johnson Pump sent liquids a shorter distance but pumped them faster. A "Ruggles Exterminator", a knapsack sprayer, was recommended for the spraying of potatoes and other row crops.

In 1877, Professor Cook discovered a kerosene oil-soap emulsion which killed piercing-sucking insects by contact action. This discovery was to play a significant role in furthering entomology in the United States, for it is believed that Professors Cooks' emulsion was the first diluted, permanently mixed, easily handled, and inexpensive contact insecticide that did relatively little harm to foliage; thus it marked the beginning of research for contact insecticides. Professor Cook's directions for making his kerosene oil-soap emulsion were:

> I mix one quart of soft soap or one-fourth lb. of hard soap with one or two quarts of boiling water; as soon as the soap is all disolved I stir in, while all is yet hot, one pint of kerosene oil. This is now violently stirred till it is permanently mixed - that is till upon standing the oil will not rise to the top but will remain incorporated with the liquid. This stirring is best done by use of a force pump - pumping back into the vessel containing the liquid. When we are ready to use this stir in enough water to make fifteen pints in all - that is one fifteenth of the liquid applied would be kerosene oil,[7]

Professor Cook's emulsion was recommended to the public in 1878 and remained the only standard contact insecticide recommended by Experiment Stations until about 1916. "Cook was probably the first experimenter to recommend the use of a mixture of kerosene oil and soap water."[8]

In 1878, Professor Cook conducted what is believed to have been the first recorded experiment in Michigan for the control of the codling moth by sprays. This experiment was conducted in an orchard believed to have been located adjacent to Professor Cook's residence in Faculty Row on the campus of the Michigan Agricultural College. Two Siberian crab apple trees were used. One of the trees was sprayed once a week from May 20 to June 20 with a strong solution of soft soap. The other tree was not sprayed. The sprayed tree yielded apples free of codling moth injury. The apples on the other tree were badly infested. Fewer apples remained on the unsprayed tree than on the sprayed tree. With probable reference to this experiment, in 1892, one of Professor Cook's former students and a noted entomologist himself, Clarence M. Weed, stated that:

> A decade has scarcely passed since Professor A. J. Cook, of the Michigan Agricultural College, began his experiments in spraying apples to prevent the injuries caused by the codling moth-experiments which first proved to the horticultural public that the remedy was safe and sure.[9]

In 1879, Professor Cook initiated spraying tests with London purple. Paris green was subjected to further tests also. London purple was sprayed on one tree in an orchard on May 20 and again on June 15. One tablespoonful of the material was used in two gallons of water. The sprayed tree produced apples with no injury from the codling moth while adjacent untreated trees had many infested fruits. Besides testing the effectiveness of London purple as an insecticide, Professor Cook had samples of the sprayed apples analyzed at harvest time for the presence of residual arsenic. Sprayed apples picked in September yielded no residual London purple. The residue analyses were performed by Dr. Robert C. Kedzie, Professor of Chemistry at the Michigan Agricultural College (1863 - 1902). Both Professors Cook and Kedzie anticipated the inauguration of residue arguments as a result of the use of pesticides.

Through continued experiments with London purple and Paris green in 1881 and 1882, Professor Cook was convinced that they were the most effective and economical poisons for the protection of fruit from codling moth. One pound of either of the poisons in 100 gallons of water or a dust consisting of one part poison and 100 parts of plaster of Paris was found to be the most effective on insects having chewing mouth parts.

By 1883, experiments with kerosene oil-soap emulsion to kill aphids had met with considerable success.

In 1885, an act of the Michigan Legislature provided for the publication of bulletins by the Michigan Agricultural College for the dissemination of information. This was a convenient method by which Professor Cook could inform the farmers of insect controls. The first entomological bulletin giving chemical controls for insects was published May 1, 1886.

This concerned fruit insects.[10] For the control of codling moths, Professor Cook preferred London purple to Paris green, for it was cheaper and easier to mix as well as just as effective. The amount recommended was one pound in fifty gallons of water. One common pailful of spray was said to be sufficient for just a few trees. In large orchards, the spray was pumped from barrels on wagons. The Whitman Pump was still highly recommended by Professor Cook.

In 1887, Professor Cook recommended pumps manufactured not only by the J. A. Whitman Pump Company, Providence, Rhode Island but also those produced by the following companies:

1. Victor Field Force Pump, Lockport, New York.
2. Gould Manufacturing, Seneca Falls, New York.
3. P. C. Lewis, Catskill, New York.
4. A. I. Root, Medina, Ohio.
5. Nixon Nozzle and Machine, Dayton, Ohio.

The pumps from each of these companies could be attached to pails, barrels or tanks. The Nixon Pump was built in a tank mounted on casters. The Field Pump was furnished with a hose, nozzle, and 40-gallon tank mounted on two wheels. This pump was for gardens. Another Field Pump, for large orchards, consisted of a double acting force pump which could be attached to a wagon wheel for power. Most hand spray pumps for orchards were mounted in fifty-gallon barrels set on end in a wagon.[11] One could obtain about seventy-five pounds of pressure with these.[12]

From spraying experiments with arsenicals in 1888, Professor Cook made the following conclusions:

1. spraying should be done only after fruit blossoms have fallen off trees. This prevents the killing of honey bees or the poisoning of honey.
2. sprays applied too early are washed off before they can kill insects.
3. in case of heavy rains after one application of insecticide, one should apply the material a second time. The second spray should be applied about two weeks after the first.
4. one should use London purple at a strength not greater than one pound in 100 gallons of water.
5. arsenical spray-drippings on pasture grasses from orchard trees constitute no source of poisoning by residues for foraging livestock.

Experiments in 1888 and 1889 with Paris green on the plum curculio, Conotrachelus nenuphar (Hbst.), indicated that effective control was possible if the insecticide could be kept on the tree.

In 1890, Professor Cook's insecticidal and other research work became part of the activities of the Agricultural Experiment Station. The Michigan Experiment Station had been established on February 26, 1888 under the provisions of the Hatch Act passed by Congress in 1887.

By 1892, Professor Cook had made experiments with, and recommended, the following additional insecticides:

1. carbolized plaster.
2. carbolic acid emulsion.
3. white hellebore.
4. cyanogen.
5. kerosene ointment.
6. tobacco decoction.
7. pyrethrum.

He had further determined that Paris green and London purple were compatible with lime and Bordeaux Mixture. Some additional insecticidal discoveries by Professor Cook during his twenty-six years at the Michigan Agricultural College were:

1. Arsenicals are stomach poisons for insects that defoliate fruit, shade, and some ornamental trees.
2. Insecticides must be inexpensive, efficient, safe and convenient for application.
3. Arsenicals may accumulate as dangerous residues on fruits if used later than four to five weeks prior to harvest.
4. The use of arsenicals must be avoided on cabbage or other vegetables after they start to form heads.
5. The residual effectiveness of arsenicals may last as long as twenty days.
6. Insecticidal applications by growers frequently are heavier than necessary.
7. Insecticides should be stored in containers that are securely covered.

8. Forceful spraying with a pump gives better insecticidal coverage and kill than spraying with a common sprinkler.
9. Fine insecticidal deposits and applications to undersides of leaves give better insect control.
10. Insecticidal solutions should be agitated to keep the chemicals in solution.
11. More than one application of insecticide may be necessary.

The following are some interesting facts about Professor Cook's insecticidal researches and his reports to the State Board of Agriculture:

(1) He let a discovery be known immediately. Some insect controls were recommended because growers were desperate. Others were told with all the details, to let the grower himself decide what course to follow.

(2) His experiments were tried by a number of his students and student assistants for the verification of results. The most noteworthy of these students were: (1) Clarence M. Weed (1880 - 1885); (2) Howard E. Weed 1885 - 1889); (3) James Troop (1878 - 1884); (4) Clarence P. Gillette (1880 - 1888); (5) Fred H. Hillman (1884 - 1888); (6) Arthur B. Cordley (1885 - 1890); (7) Frank J. Niswander (1885 - 1891); and (8) Charles F. Baker (1887 - 1892).

While Charles F. Baker, a noted entomologist who died in 1927, was an assistant under Professor Cook he said,

> I have contributed not a little towards spreading Prof. Cook's fame as an entomologist. Many of the discoveries that he has announced in his reports and bulletins as made by himself - I have made - and I have the wherewith to prove it - if ever necessary. He thinks that as long as I was studying under him - it was just the same as if he had done the work, I have done the work and placed my results and the accompanying material in his hands - his part consisted in putting it into presentable shape. I have never received any credit for my work - nor do I want it. I am very glad to be able to do it - for Prof. Cook - and he fully appreciates what I have done.[13]

Evidently Professor Cook was an adherent of the "the professor wrote the introduction and the assistant the treatise"[14] custom which enabled acientific men to receive all the credit and their assistants none for entomological investigations or discoveries published in the early years of the development of economic entomology in America.[15]

(3) Professor Cook was practical entomologist.[16] This was shown by the fact that he realized farmers were interested in preparing insecticides with materials on hand; thus he highly recommended soft soap rather than hard soap for his kerosene emulsion because most growers usually had soft soap on hand.

(4) In 1877, Professor Cook received one of three samples of London purple sent to the United States by the Hemingway and Company, London, England. Due to either Professor Cook's delay in reporting results or having obtained unsatisfactory results, the first experimental shipments of London purple in 1878 went to Dr. Charles E. Bessey, Professor of Botany at the Iowa State College, Ames; thus Dr. Bessey (father of E. A. Bessey, M.S.C.) was the first

to report the use of London purple.[17]

(5) In 1890, Professor Cook was visited by Charles V. Riley, entomologist of the United States Department of Agriculture, Washington, D.C., who informed Professor Cook that he thought the Cook kerosene oil-soap emulsion was a mechanical mixture rather than a true emulsion. Mr. Riley had prepared a kerosene oil-milk emulsion in 1880 which he claimed to be superior to Professor Cook's. Shortly after this incident, the same year, Professor Cook and Mr. Riley were at an entomology meeting at the University of Illinois, Champaign-Urbana, and Mr. Riley again remarked that the Cook Formula was a mixture. Most of those present agreed with Mr. Riley's statement. Professor Cook was astounded, for his emulsion had been recommended since 1878 and had been satisfactory. He returned to the Agricultural College and with Levi R. Taft, horticulturist at the Michigan Agricultural College, conducted independent tests with the Cook, Riley, and other emulsions. These tests indicated that Professor Cook's emulsion was the superior one. Mr. Riley had failed to observe that the Cook formula contained excess soap thus causing the emulsion to separate and rise above the soap solution if allowed to stand a while; but no free oil was present.[18]

(6) The spraying of arsenites for fruit trees in Michigan probably was not recommended first by Professor Cook, but probably by G. M. Smith, Berlin, Wisconsin.

Mr. Smith recommended arsenites in 1870 to the Horticultural Society of Saint Joseph, Michigan for the control of the plum curculio.[19]

(7) Professor Cook was not the first to write reports about insects and their control in Michigan. This honor goes to Sanford Howard, Secretary of the Michigan State Board of Agriculture in 1865, who recorded notes on the habits, damage, and control of the cankerworm, armyworm, Cirphis unipuncta (Haworth), and the Colorado Potato Beetle in the fourth annual report (1865) of the Secretary of the State Board of Agriculture.

(8) Professor Cook was the first to study the comparative injuriousness to foliage of London purple, Paris green, and white arsenic.[20] His results indicated that white arsenic did the most harm to foliage and Paris green the least.

(9) Professor Cook's experiments, many of which were performed with the aid of students, influenced a number of students to make insecticidal investigations after leaving the Michigan Agricultural College. Clarence M. Weed (Class of 1883), Clarence P. Gillette (Class of 1884), and Arthur B. Cordley (Class of 1888) were the most prominent of these to make noteworthy contributions to the field of insecticides. In 1889, C. M. Weed conceived the idea of applying insecticides and fungicides together."[21]

Probably through his co-operation with Professor Albert John Cook, Dr. Robert C. Kedzie had become interested in insecticides and at some time previous to 1895 or 1896

had used his chemical knowledge to prepare an insecticide known as the "Kedzie Mixture". This insecticide was an arsenical and a good substitute for Paris green but had the disadvantage of not having a warning coloration. Dr. Kedzie gave the following directions for making his insecticide:

> To make the material for 800 gallons of spraying mixture, boil two pounds of white arsenic with eight pounds of sal soda ----- in two gallons of water. Boil these materials in any iron pot not used for other purposes. Boil for 15 minutes or until the arsenic dissolves, leaving only a small muddy sediment ----- label 'poison', stock material for spray mixture. The spraying mixture can be prepared ----- by slaking two pounds of lime, adding this to forty gallons of water; pour into this a pint of the stock arsenic.[22]

In 1896, Dr. Kedzie tested a mixture of salt water and Paris green on grasshoppers attacking peppermint.

B. Control of Plant Diseases by Fungicides

Since the spraying of fungicides for plant diseases is commonly done in combination with the spraying of insecticides for economic reasons, the following summary of the origin of the control of apple scab, Venturia inaequalis (Cooke), by fungicides at the State Agricultural College of Michigan is presented:

Levi Rawson Taft, Professor of Horticulture and Landscape Gardening and Superintendent of the College Farm (1888 - 1902) "-----was the first in America to publish the results of a successful effort to control apple scab."[23] This occurred in 1890. Professor Taft's experiments had been made with fungicides in 1889. The experiments that year were made in co-operation with the United States Section

of Vegetable Pathology, Washington, D. C., and were conducted in an orchard at the Michigan Agricultural College. Professor Taft had begun experiments for the control of diseases of the apple and other fruits while employed by the Missouri State Agricultural College, Columbia, between 1885 and 1888. He had been particularly interested in apple scab for that disease was threatening to force apple growers in many regions out of business. In addition, the demand for clean fruit by consumers had induced vigorous competition among growers for the production of premium apples.

In 1889, Professor Taft's experiments involved twelve trees of Northern Spy Apple. This variety was selected because of its extreme susceptibility to scab. The test trees were thirty-two years old and were selected for equal vigor at blossom time. On May 22, all the test trees were given an application of London purple, at the rate of one-half pound per 100 gallons of water, for codling moth control. Six applications of fungicide were made to each of the test trees between May 23 and August 2. The dates of the applications were: (1) May 24; (2) June 6; (3) June 12; (4) June 25; (5) July 6; and (6) August 1. Sprays were also applied on July 24, but to only five trees. The ten test trees were divided into five groups of two trees. Each group was treated with one of five different chemicals. About three gallons of fungicide were sprayed on each tree during each application. The sprays were applied with a

Little Climax Pump, a single cylinder hand pump, made by the Nixon Nozzel and Machine Company, Dayton, Ohio. The pump sprayed liquid from a 3-gallon water bucket. Two trees were left unsprayed for checks. For the type of fungicide applied to each group of trees and a diagram of the experimental plot, the reader is referred to Figure 6. The most satisfactory control of apple scab was obtained with Bordeaux Mixture and a mixture of copper carbonate and ammonia-Bordeaux Mixture, resulting in 88 and 59 percent freedom from scab on each of two apple trees, respectively.

Professor Taft's initial work on the chemical control of apple scab is commemorated by a plaque located near the Horticulture Building at the Michigan State College. The inscription on the plaque reads as follows:

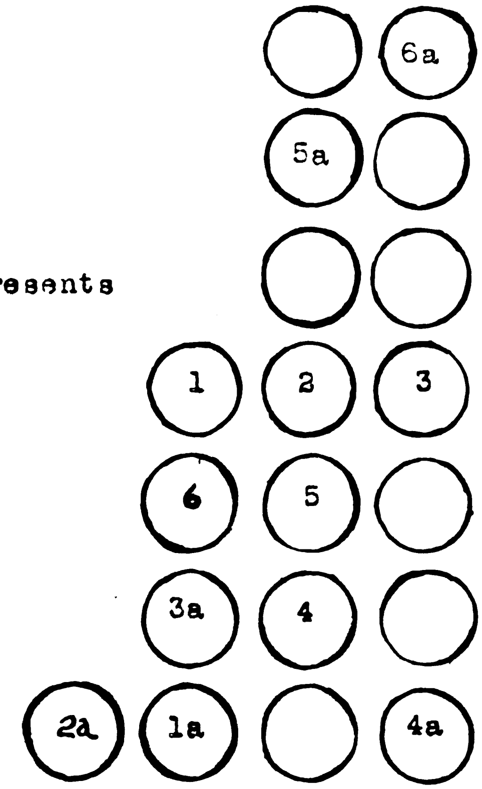
> On this spot, May 24, 1889, Professor Levi Taft, first in Michigan, pioneer in America, began the control of orchard disease by spraying.

The plaque, with Professor Taft observing it at its dedication in July, 1935, is illustrated by Figure 7.

Professor Taft continued his experiments on fungicides and did considerable research with insecticidal sprays until about 1919 when he became State Horticulturist.

The first Michigan Agricultural College Spraying Calender, which gave recommendations for the control of insects and plant diseases was issued March 31, 1895. It was included within a bulletin on "The Pests of the Orchard and Garden" by Levi R. Taft and Gager C. Davis.[25]

Legend:
One Circle Represents
One Apple Tree



a-only trees sprayed on July 24

Plots	I&Ia	- Potassium Sulphide	-5 oz	to 10 Gal. H_2O
"	2&2a	- Sodium Hyposulphite	-1 lb.	to " " "
"	3&3a	- Sulphur Solution	-1	" " " " "
"	4&4a	- Copper Carbonate+	-3oz	" 22 " "
		Ammonia	-1qt.	for mixture
"	5&5a	- Bordeaux Mixture+	-2lb.	$CuSO_4$
		Soda Carbonate+	-2lb.	
		Ammonia	-2pt.	
		mix in 22 Gal. H_2O		
"	6&6a	- Unsprayed		

Figure 6

A Diagram of R.L.Taft's Fungicide Plots and A List of Chemicals Used On Each Plot.[24]

FIGURE 7

PROFESSOR LEVI R. TAFT VIEWING A PLAQUE COMMEMORATING HIS PIONEER CHEMICAL CONTROL OF APPLE SCAB. THIS PHOTOGRAPH WAS LOANED TO THIS WRITER, AND PERMISSION GRANTED FOR ITS REPRODUCTION, BY HOWARD TAFT, SON OF L.R. TAFT AND FRUIT GROWER, EVELINE ORCHARDS, EAST JORDAN, MICHIGAN.

C. Chemical Control of Insects and Plant Diseases in the Southwestern Michigan "Fruitbelt".

About 1890, a few of the apple growers in the southwestern Michigan "fruitbelt" began using hand spray pumps to apply Paris green and Bordeaux Mixture for the codling moth and apple scab, respectively. About 1895, severe outbreaks of the codling moth and cankerworms impressed growers with the fact that to avoid crop losses they would have to spray. Besides simple hand pumps mounted in barrels on wagons, pumps were used which were powered by the movement of wagon wheels, steam, and carbonic acid gas. Mr. Buskirk at Paw Paw, Michigan and the Marsh Spray Pump Company at Battle Creek Michigan (now the American-Marsh Pumps, Inc.) both built steam powered sprayers between 1880 and 1900.

The presence of San Jose Scale, *Aspidiotus perniciosus* Comstock, being recorded in Michigan for the first time in 1896, instigated the use of a home-prepared Lime Sulphur spray. This was made by boiling quick lime and flowers of sulphur together. This mixture was applied to trees while it was hot. If it was allowed to cool, it crystalized and could not be forced t rough spray nozzles. It even clogged hoses and pipes when it was cool. The hot lime-sulphur mixture was universally used and the mixture was considered the best control for scales, by both the growers and the Michigan Agricultural College.

CHAPTER XI

THE CHEMICAL CONTROL OF INSECTS IN MICHIGAN SINCE 1900

A. Insecticide Application Equipment.

It is believed that the first factory-built gasoline-powered sprayer was used in Michigan in 1904; at least the first one used in the southwestern "fruitbelt" was introduced in 1904.[1] This sprayer was purchased by Mr. Roland B. Collis, spraying equipment dealer at Benton Harbor, for about 200 dollars, and was manufactured by the Hardie Spray Pump Company, Hudson, Michigan. In fact, this sprayer was the first of its kind manufactured by the Hardie Company.[2] Mr. Collis sold three of the Hardie gasoline-operated sprayers to his neighbors, Lott Sutherland, John Downing, and James Jakway, in 1904.[3] Figure 8 illustrates the first factory-made power sprayer used in the fruitbelt. It took considerable effort to keep the 1904 Hardie Sprayer working, but it did the spraying better and more rapidly than the hand pump.[4]

Gasoline engines had been attached to hand pumps prior to 1904 but the results were unsatisfactory because the relief valves, used to take care of the liquid when the spray was shut off, frequently failed to work and serious breakage occurred.[5] Relief valves were the primary problem in the development of power spray pumps.[6] The greatest difficulty was the collection of spray liquid sediment in valves; thus the valves were prevented from opening or closing.

The origin of the present pressure regulator occurred in Michigan in 1909.[7] That year, Mr. Dwight Wadsworth of Fennville invented a balanced valve and used it on a Meyers Spray Pump.

Prior to 1920, Les Tyrell of Bridgeman, Michigan built a number of atomizer type sprayers. The pressure for these sprayers was furnished by an engine-driven air-pump and both air and spray liquids were carried through separate hoses which joined at a single nozzle.[8] These atomizer sprayers failed to gain popular approval because the amount of liquid delivered was small. The spray left the nozzle as a very fine mist but did not go far beyond the nozzle and did not penetrate dense foliage. If a blower could have been installed on this atomizer sprayer to force the spray to tops of trees and the spray chemical made four to six times stronger, a concentrate sprayer would have been produced.

Since 1920, the development of spraying and dusting equipment has been based on the designing of pumps or blowers capable of producing higher pressures and increasing the size of tanks and engines for more rapid and efficient spraying. Airplanes have even assumed an important role in spraying and dusting. Since early in the 1940's the airplane has

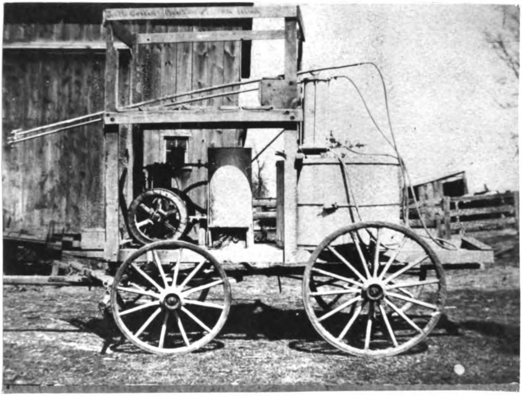


FIGURE 8

FIRST FACTORY-MADE POWER SPRAYER IN FRUITBELT. PURCHASED BY MR. R.B. COLLIS, FARMER AND LOCAL AGENT FOR HARDIE HAND PUMPS, HUDSON, MICHIGAN IN 1904. THIS SPRAYER WAS FIRST DEMONSTRATED AT SPINKS CORNERS, BAINBRIDGE TOWNSHIP, BERRIEN COUNTY ABOUT MARCH 12, 1904.

been used for the insecticidal dusting of blueberries, corn, muck crops, and forest insects. Experiments in the airplane application of insecticidal and fungicidal dusts on sour cherry and peach were made in Michigan for the first time in 1944 and were continued in 1945.[10] The results of these tests indicated that the cost of airplane dusting is not unreasonable compared to operations on the ground, and that airplane dusting could be more effective if better equipment and dusts were available.

Insecticidal experiments with a helicopter were made in Michigan for the first time in 1945. In October of that year, a Sikorsky R-6a helicopter, piloted by Captain Harold H. Hermans of Wright Field, Dayton, Ohio, dusted test plots on the campus of the Michigan State College.[11]

The reader is referred to the appendix of this thesis for a pictorial history of the development of spraying and dusting equipment since 1883.

B. Investigations by the United States Bureau of Entomology and Plant Quarantine, Washington, D.C.

1. Fruit Insects.

Apple losses due to the codling moth, *Carpocapsa pomonella* Linne, were so extensive in the United States by 1909 that the United States Bureau of Entomology and Plant Quarantine (at that time, the Bureau of Entomology) undertook the establishment of temporary field stations in apple regions for the study of the life-history and control of the codling moth. One of these stations was located at Douglas, Michigan. The activities of this station ranged within the "fruitbelt" along the western boundary of the State from Benton Harbor to Pentwater. Insecticidal studies for the codling moth were begun at this station in 1909 by Mr. R. W. Braucher,[12] assisted by Mr. W. Postiff.[13] Mr. Braucher continued his studies until 1911 when Mr. Eugene W. Scott replaced him.[14] In 1910, Mr. A. G. Hammar was assigned to the station to direct its activities and to study the life-history of the codling moth.[15] In 1911, Mr. E. H. Siegler joined the staff at Douglas to aid in the codling moth research.[16] In 1910 and 1911, Mr. Earl R. Van Leeuwen served as a summer research assistant.[17] All the personnel at Douglas, except Mr. Van Leeuwen and Mr. Postiff, were regular employees of the Bureau of Entomology.

Between 1909 and 1911 considerable effort was expended in demonstrating to orchardists the spraying of lead arsenate for the control of the codling moth, plum curculio and other fruit insects, and determining whether a "one-spray method" for codling moth control was more desirable than a series of three to five summer sprays used in demonstrations. The demonstration sprayings convinced growers that the codling moth could be satisfactorily controlled with several sprayings. The success of the "One-spray method" was found to depend on thorough spraying immediately after petal-fall to fill the calyx cups of fruit with lead arsenate; thus killing the first brood of the codling moth. An analysis of one-spray results in Michigan, Delaware, Virginia, and Kansas indicated that such a method yielded higher percentages of codling moth damage than several sprays.

In 1911, the spray tests made by the Douglas Station were compared with similar tests in New Mexico to determine the condition of numerous varieties of apple after being sprayed at petal-fall under humid and arid climates, respectively.

In 1912, headquarters for the Bureau of Entomology fruit insect activities in Michigan were transferred to Benton Harbor. This station remained in operation until about 1920.[18] The personnel at Benton Harbor between 1912 and 1920 (and their dates of employment) included:[19,20,21] (1) Eugene W. Scott (1912 - 1914, in charge;(2) E. H. Siegler (1912 - 1913); (3) J. H. Paine (1913); (4) Howard G. Ingerson (1914 - 1916); (5) F. L. Simanton (1915 - 1920); (6) A. J. Ackerman (1915 - 1918); (7) D. M. Hamilton (1914); and (8) Earl R. Van Leeuwen.

In the years 1912, 1913, and 1914, the investigations at Benton Harbor were directed toward the discovery of substitutes for arsenate of lead for the codling moth and other chewing insects. Field and laboratory experiments were made with a variety of homemade and proprietary insecticides and other chemicals. They were tested alone and combined. In 1912, thirty-two materials were tested.[22] Among these were arsenate of iron, arsenate of zinc, arsenate of lime, calcium arsenate, and lime-sulphur. At the end of 1914, the following conclusions were made concerning the insecticidal trials at Benton Harbor:[23]

1. Arsenate of lead was the most consistent and valuable stomach poison.
2. Arsenate of lime was a better insecticide in some respects than other arsenicals.
3. Arsenate compounds were dangerous to use on foliage.
4. A combination of lime-sulphur, arsenate of lead and nicotine made a good spray to kill both chewing and piercing-sucking insects.
5. Calcium arsenate gave satisfactory control of the codling moth.

It was through experiments at the Benton Harbor Field Station that calcium arsenate received its first commercial promotion and ultimately became an outstanding insecticide against the cotton boll weevil (Anthonomus grandis Boheman).[24] The first calcium arsenate analyzed by the United States Bureau of Chemistry, Washington, D.C., was prepared by E. H. Siegler in the laboratory of the Benton Harbor Field Station.[25]

In 1915, the Benton Harbor Station made extensive tests with insecticidal dusts for the control of the plum curculio on peach. These tests were compared with similar ones made in Maryland and Virginia that year, and the results indicated that lead arsenate dust was the best insecticide for the plum curculio and it gave very satisfactory control.

From 1916 to 1920, it appears that efforts were concentrated on investigating nicotine sulphate as a codling moth insecticide. Nicotine sulphate had been so promising in the apple regions of the Yakima Valley, Washington, that "in 1917 --- experiments were conducted by the United States Bureau of Entomology in Colorado, Michigan and New Mexico."[26]

In 1918 the Bureau studied the effect of calcium arsenate, arsenate of lead, sulphur and other chemicals on pome and stone fruits and grapes.[27]

2. Vegetable and Field Crop Insects

In the years 1904 and 1905, the United States Bureau of Entomology conducted wheat-sowing experiments in Michigan to ascertain the best time to sow wheat to avoid damage by the Hessian Fly, Phytophaga destructor (Say).[28]

In 1916 the Bureau studied the cabbage maggot, Hylemyia brassicae (Bouche), and the onion maggot, Hylemyia antiqua Meigan, in Michigan.[29] In 1917, it studied melon, squash and cucumber insects. Particular attention was given to the transmission of cucurbit diseases by cucumber beetles, Chrysomelidae.[30]

C. Investigations by Personnel at the Michigan State College

1. Mode of Action of Contact Insecticides

From 1908 to 1915, Dr. George D. Shafer, Research Entomologist of the Experiment Station made an extensive study on the subject "How Do Contact Insecticides Kill

Insects?" This work is believed to have been the first thorough research of its kind. The results, published in 1911[31] and 1915,[32] probably have been quoted more than those from any other source on the subject. It is important to note that Dr. Shafer observed that lethal concentrations of contact insecticides adversely affected enzymes in intact tissues of living insects. The enzymes, evidently being of vital importance to insect life processes, were believed to be a determining factor in the death of insects treated with contact insecticides. Dr. Shafer's study of insect enzymes and insecticides appears to have been the pioneering work of that kind. Despite Dr. Shafer's enzymological studies, it has been only recently, with the development of parathion and other anticholinesterases, that the study of insect enzymology has been considered necessary for a better understanding of the killing action of insecticides.

The investigation of how insects are killed by contact insecticides was financed with funds provided by the Adams Act of 1906. The latter had been enacted by Congress for the further endowment of Experiment Stations.

2. Nicotine

One of the first trials with nicotine-bentonite (Black Leaf 155) for control of the codling moth on apple was conducted by the Michigan State College Agricultural Experiment Station.[33] This occurred in the years 1934 and 1935 when James M. Merritt, a graduate student in entomology at the Michigan State College, investigated the effect of environmental conditions in Michigan on various nicotine combinations which had been shown to be toxic to the codling moth in other states. This interest in nicotine was prompted by the fact that entomologists were seeking a substitute for lead arsenate, the application of which was necessitated so frequently in most apple regions for the satisfactory control of codling moths that excessive lead and arsenic residues occurred on harvested fruit. These residues were considered dangerous to consumers. Mr. Merritt's experiments were made in the vicinity of Benton Harbor in 1934, and at Mason in 1935. In both years, nicotine-bentonite and summer-oil combinations and nicotine-bentonite dusts gave good control of the codling moth, with little or no injury to foliage. Nicotine-sulphate and summer-oil combinations also provided satisfactory control. The results of Mr. Merritt's trials with nicotine-bentonite were used to develop the final formula for nicotine-bentonite.[34]

3. "Dinitro" (DN) Compounds[35,36]

From 1934 to 1938 the Experiment Stations of the Michigan and Iowa State Colleges cooperated with the Dow Chemical Company, Midland, Michigan in the thorough investigation of the insecticidal properties of 4,6-Dinitro-o-cyclohexylphenol. This chemical was placed on the market in 1938. It was recommended as a dormant spray for aphid eggs, and was the first of a long series of "dinitro" insecticides.

D. Insect Control Services of the Michigan State College Entomology Department

1. Insect Emergence and Timing of Sprays

a. Cherry Fruit Flies, *Rhagoletis cingulata* (Loew) and *R. fausta* Osten Sacken.

Through information on the emergence of cherry fruit flies provided annually by the Michigan State Bureau of Plant Industry and private citizens, the Entomology Department recommends the best dates for applying insecticidal sprays to cherries and also recommends the most satisfactory insecticides, and the amount to be used for control. This advice is given to orchardists over the radio, in newspaper releases, by telephone, and through letters to county agents and district horticulture agents. The importance of this service lies in the fact that a State Law prohibits the canning of cherries infested with maggots of cherry fruit flies and requires growers to burn or bury infested cherries. Violations of the law result in either fines or imprisonment or both; thus both the canner and the grower rely on the spraying service to provide consumers with maggot-free cherries.

The originator of the Michigan cherry fruit fly spraying service was Professor Rufus H. Pettit, head of the Michigan State College Entomology Department from 1906 to 1934. The timing of sprays by the emergence of flies in cages began in 1925. In 1927, Professor Pettit reported to the Michigan State Board of Agriculture that "the exact time for best results in controlling the cherry maggot in canning cherries was like-wise determined."[38] By 1932 canners were refusing to buy cherries that had not been sprayed as recommended by Michigan State College. The spray dates are established according to the emergence of adult flies from infested cherries placed in the soil over winter and by observation of trees infested the previous season. Flies emerging from cherries in the soil are trapped in screened cages placed over the cherries. The cages and field observation points are located at several sites in the cherry growing regions from Berrien County to Cheboygan County along Lake Michigan. Because fruit flies in the most southern tier of cherry counties in the state frequently emerge about two weeks prior to those in the most northern tier of cherry counties, the scattering of fruit fly cages and observation points provides a more accurate knowledge of general emergence; hence a more optimum spray date can be issued. This date is different for the southern, central, and northern tiers of counties.

Since 1930, the annual emergence of the first cherry fruit fly in cages has been observed as early as May 31 and as late as June 23.[39] These first emergences have been recorded only in Berrien County, Van Buren County, and Kent County. Since 1941, the spray date for cherry fruit flies has ranged from June 10 to July 15 in the six southern tiers of counties and June 17 to July 2 in the remaining tiers of counties.[40]

Besides instigationg the cherry fruit fly spray service in Michigan, Professor Pettit was the first to suggest to Michigan canneries that they soak cherries to vats of cold water to detect curculio infested cherries.[41] The latter would float on the surface of the water.

b. <u>Codling Moth</u>

Spraying and insecticide recommendations are also provided orchardists for control of the codling moth on apple and other pome fruits. The emergence of codling moths and the timing of sprays is done almost like that for cherry fruit flies. The important feature of this service is that recommendations are made for two broods of the codling moth; one in the spring and the other about mid-summer. The emergence of codling moths is reported by orchardists upon whose premises cages have been placed by the Entomology Department. Spraying for the spring brood of the codling moth depends upon the blooming date.

Data for the years 1941, 1942, 1948 and 1950 to 1953, indicate that the summer brood of codling moth has emerged in cages as early as June 26 at Paw Paw and as late as August 9 at Traverse City.[42] Moths of the summer brood usually emerge between July 15 and August 9.[43] Investigations concerning the emergence of codling moth broods and the timing of sprays were initiated at the Michigan State College in 1903 by Professor Rufus H. Pettit. Emergence cages for the codling moth were used by Professor Pettit for the first time in 1920.

c. <u>Apple Maggot-Rhagoletis pomonella (Walsh)</u>[44]

Fly emergence operations and spray recommendations are made in practically the same manner as for the cherry fruit fly and codling moth. The timing of sprays for the apple maggot by emergence of flies in cages began in Michigan in 1925, but for the past twenty years has been made from orchard observations of the adult flies.

Data for the years 1941, 1943 to 1946, 1948 and 1950 to 1953 indicates that the adult apple maggot fly began its emergence as early as June 24. The dates upon which first sprays should have been completed for this insect range from June 24 to July 21.[45]

2. Answers to Letters of Inquiry About Insects and Related Pests.

Several thousand requests for insect and related pest identifications and controls are received from private individuals, county agents, district horticultural agents and other sources in Michigan and many other states each year. In 1953, about 3,200 letters were sent in reply to such requests.[46] In addition about 1,900 circular letters on special topics were mailed to private individuals, county agents, district horticultural agents, and other interested persons.[47]

Since 1925, a record has been kept of all correspondence concerning insects sent in reply to letters of inquiry. This writer has selected 45 economically important insects and related pests, and has tabulated the average number of letters sent in response to inquiries about them each year for five five-year chronological periods from 1925 to 1950 and one four-year period since 1950. This data is presented in Table IV.

3. Radio and Television Programs.

A rise in the number of inquiries about many of the pests in Table IV probably is due to the fact that through more publicity on the control of certain pests with the newer organic insecticides, the public has become more insect control conscious. Some of the fluctuation in numbers of inquiries probably is due to the effects of amount of rainfall and variations in temperature.

Information on insects, especially their chemical control, is regularly dispensed by radio. Every Friday, a staff member speaks to the public on insects for about ten minutes during a "Farm Service Hour" broadcast by Radio Station WKAR, Michigan State College. The Farm Service Hour originated about 1923 and entomological talks on the program began at that time. Talks on insects are also made at other radio stations in Michigan. Programs on insects are also featured on WKAR Television. The latter began operations in January, 1954. Entomological programs are presented on other Michigan television stations too. In 1953, five television appearances were made by entomology staff members.

4. Extension Entomology

A program of extension entomology designed to help the farmers and other residents of Michigan solve their insect problems is given special consideration. Although not officially designated as extension entomology, this service was begun by Albert John Cook when he became Professor of Entomology at the Michigan Agricultural College in 1867. He answered numerous letters requesting information on insects and made trips to farms and orchards to recommend control measures. He even attended Farmers Institutes to dispense entomological information. Professor Cook was noted for his apicultural work, much of which was of an extension-like nature. His teaching of the first course of beekeeping to be offered in any college, in 1867, and his aid in organizing the Michigan Beekeepers' Association, in 1869, which provided a better means of informing beekeepers about the control of foulbrood diseases of bees and the improvement of apiary management, appears to have made Professor A. J. Cook the first extension apiculturist in the United States.[50] In addition, Professor Cook probably was the first to do entomological extension work of any kind in the United States.

The first worker designated as a full-time extension apiculturist at the Michigan Agricultural College was Mr. Edwin Ewell. He was appointed May 18, 1918.[51] Since 1918, the following personnel (with their dates of tenure) have been associated with extension apiculture at the Michigan

TABLE IV

AVERAGE NUMBER OF ANSWERS TO LETTERS OF INSECT AND RELATED PEST INQUIRIES PER YEAR FOR THE FOLLOWING PERIODS:

	1925-29	1930-34	1935-39	1940-44	1945-49	1950-53
Slugs - Snails	9.3	7.5	6.4	8.0	7.2	12.2
Centipedes	2.0	1.5	6.8	8.6	9.4	15.5
All Mites Except Clover Mites	18.0	43.0	30.6	15.8	37.8	45.0
Clover Mites	2.3	4.2	2.8	12.4	15.4	19.7
Maple Bladder Gall	12.3	10.0	9.4	26.0	19.2	81.5
Silverfish	1.6	16.7	13.2	33.4	20.0	11.7
Cockroaches	5.0	28.2	71.4	40.6	29.0	33.0
Grasshoppers	5.3	17.2	24.0	20.2	26.4	3.5
Termites	.33	28.7	33.2	49.4	85.2	71.0
Thrips	4.3	35.5	31.0	19.2	32.6	19.0
Cicadas	1.3	1.5	15.4	3.2	1.4	4.5

TABLE IV (continued)

	1925-29	1930-34	1935-39	1940-44	1945-49	1950-53
Spittle Bugs	2.0	3.0	1.0	13.8	31.8	21.2
Aphids	73.3	116.2	104.2	28.4	83.4	68.2
Scales	61.6	87.7	59.0	32.2	51.8	56.7
Squash Bugs	2.0	45.5	15.4	18.2	14.6	3.5
Boxelder Bugs	0.0	34.0	33.0	34.8	37.6	73.7
Flea-Beetles	12.0	19.5	13.4	8.4	7.8	8.7
Strawberry Root Weevils	.66	9.0	8.0	30.8	45.6	49.7
Carpet Beetles	9.0	33.5	53.6	65.6	91.6	77.7
Plum Curculios	5.0	8.5	8.6	8.0	9.8	15.7
Wireworms	14.3	18.5	7.6	11.8	20.6	19.7
White Grubs	9.6	64.0	27.0	27.4	31.6	34.2
Rose Chafers	13.0	26.5	34.4	61.6	28.4	54.0
Powder Post Beetles	4.3	21.5	39.6	44.0	79.4	64.2

TABLE IV (continued)

	1925-29	1930-34	1935-39	1940-44	1945-49	1950-53
Bark Beetles	8.0	41.7	12.0	4.4	14.8	11.2
Codling Moths	20.3	65.5	89.4	34.6	15.4	7.0
Peach Tree Borers	15.3	38.2	26.2	23.0	24.2	9.5
Oriental Fruit Moths	3.0	31.7	20.0	23.6	19.6	6.0
Corn Earworms	12.6	26.2	12.2	12.2	4.4	4.0
Squash Vine Borers	.66	10.2	10.0	31.8	29.6	20.7
Cutworms	53.3	42.7	21.6	17.0	12.8	11.2
European Corn Borers	61.0	16.5	8.8	32.6	23.2	20.0
Clothes Moths	10.3	30.5	37.2	36.4	22.2	14.5
European Pine Shoot Moths	1.6	13.7	9.8	17.4	34.8	20.2
Red-Banded Leaf Rollers	1.6	13.0	.8	4.4	5.0	1.7

TABLE IV (continued)

	1925-29	1930-34	1935-39	1940-44	1945-49	1950-53
Cherry Fruit Flies	9.6	36.0	2.2	3.4	5.4	8.0
Soil Maggots	53.0	42.0	19.8	26.8	24.4	42.0
Fly Control in Houses and Barns	7.6	33.0	26.0	18.8	46.2	56.7
Mosquito Control	3.0	5.5	18.2	20.2	29.6	36.0
Fleas	11.6	29.0	46.0	47.4	21.2	11.5
All Ants Except Carpenter Ants	49.3	103.0	57.6	55.6	61.4	50.2
Carpenter Ants	2.0	5.0	10.8	36.6	22.4	47.7
Honey Bees and Wasps in Buildings	.66	2.5	7.8	19.6	16.8	44.2
Sawflies	5.0	15.7	37.4	21.0	27.4	22.2
Pests in Stored Products	18.0	150.0	63.4	71.6	85.2	44.0
Totals	605.11	1433.00	1186.2	1180.2	1363.64	1352.30

State College:

1. Edwin Ewell (1918 - 1928)
2. John C. Kremer (1929 - 1935)
3. Russell H. Kelty (1936 - 1944)
4. Ethelbert C. Martin (1951 -)

The Apicultural Extension Activities have consisted of organizing county beekeepers associations, improving beekeeping methods through demonstration apiaries, assisting fruit and seed growers with pollination probelms, improving marketing methods and aiding beekeepers in the control of foulbrood diseases, and the improvement of apiary management. "Since 1935, the specialist has spent one-third time on apiary extension work fostering organization, apiary management and honey marketing projects."[52,53]

By 1941, the apicultural extension service had been responsible for the "Organization of 39 county and five district associations as well as the state organization."[54] One of the most noteworthy of these was the Michigan Honey Institute. It was organized in 1938.[55]

The first worker actually designated as an extension entomologist at the Michigan State College was Mr. Donald Whelan, a graduate of the Kansas Agricultural College, Manhattan. He was appointed July 1, 1915.[56] The appointment of an extension entomologist at the Michigan State College resulted from the passage by Congress of the Smith-Lever Act in 1914. This Act provided for co-operative agricultural extension work between state agricultural colleges and the United States Department of Agriculture. Prior to 1915, the extension activities of the Entomology Department had been conducted by staff members - primarily A. J. Cook (1867 - 1893), Gager C. Davis (1893 - 1896, and R. H. Pettit (1897 - 1915). From 1915 to 1946, extension entomology workers at the college were designated as "Field Agents", "Extension Specialists in Entomology" and "Extension Specialists in Insect Control". Since 1946, extension entomology has been done under the title of "Extension Entomologist". Since 1915, the following personnel (with their dates of tenure) have been associated with extension entomology at the college: (1) Donald Whelan (1915 - 1919); (2) Russel M. Hain (1919 - 1922); (3) John H. Harman (1923 - 1925);(4) Charles B. Dibble (1927 - 1944); (5) Herman L. King (1945 - 1946); and (6) Ray L. Janes (1947 -).

Extension entomologists at the Michigan State College, in cooperation with county agents have been concerned primarily with the following activities (other than apiculture):[57,58]

1. Development of codling moth, cherry fruit fly, and apple maggot spraying dates by determining the annual emergence-time of these insects in cages.

2. Demonstrations of the effectiveness of rotenone and pyrethrum (prior to 1945) and DDT, methoxychlor and lindane (after 1945) in killing livestock pests. In 1937, a series of "bug flashes" consisting of post-card releases giving recommendations for the control of livestock pests

was started. The card releases were known as "Livestock Pest Control Calendars". Recommendations for the control of other insects were also put on card releases. These cards were used until about 1949.

3. Intensive control campaigns for the European Corn Borer, chinch bugs, and grasshoppers.

Considerable effort was expended prior to 1930 on corn borer control activites. In 1927, a half-time extension specialist (Charles B. Dibble) was appointed particularly to inform farmers about the corn borer and to investigate the control of this insect. In 1934 and 1935 surveys were made to determine chinch bug populations, and creosote from the Federal Government was distributed to farmers for the construction of chinch bug barriers around corn fields. From 1934 to 1949, considerable time was devoted to the distribution of poison bran baits allotted to Michigan by the Federal Government for the control of grasshoppers.

4. Lecturing before groups on the control of insects attacking vegetables, fruit, stored products, shelters, ornamental trees, and other plants, forest trees, field crops, and animals. Until 1934, these lectures were on a general problem basis. Since 1934, selected insects have been discussed in the lectures.

5. Informing insecticide and other chemical dealers of recent developments in pest control.

6. Conducting classes in entomology among 4-H Club groups. "Entomology was introduced into the 4-H club program

in 1935 at the three state camps".[59]

7. Conducting special or emergency meetings for informing growers of insect control measures.

8. Answering letters of inquiry and telephone calls on insect problems.

9. Attending conferences.

10. Writing radio talks, newspaper releases, office reports, circular letters recommending insect controls, and articles for publication.

11. Conducting insect surveys.

12. Visiting farms and homes for consultation on insect problems.

In 1953, the extension activities of entomologists at the Michigan State College involved answering about 8,100 telephone calls.[60] These calls were answered by all staff members - teachers, personnel of the Experiment Station, and Extension Specialists. The need for staff members other than extension specialists to answer telephone calls, as well as to make talks on the radio, prepare newspaper releases and attend meetings, is due to an inadequate number of extension specialists. The work load on the extension specialists (two in number, one of which devotes full time to general entomology problems and another who devotes one-third of his time to apiculture) is excessive. In 1953, the extension specialists themselves attended about 200 meetings having a total attendance of about 14,000 persons, and made about 125 visits to farms and homes.[61]

E. Miscellaneous Notes on Insecticides in Michigan

1. Nicotine Sulphate

The first case of nicotime sulphate (Black Leaf 40) sold in Michigan by its manufacturer, the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky, was purchased in 1910 by Mr. Mark Hutchinson of the Sanocide Company, Fennville.[64] The latter company, a distributor of insecticides, eventually became the property of the California Spray Chemical Company of Richmond, California, which operates a branch sales office at Fennville.[65]

The appearance of nicotine sulphate in Michigan was the result of severe infestations of the Pear Psylla, Psylla pyricola Forster[66] in New York and Michigan from 1909 to about 1925.[67,68] In 1910, representatives of the Tobacco By-Products and Chemical Corporation had gone to western New York to investigate the comparative effectiveness of Black Leaf 40 and a 1½ percent water extract of nicotine on the rosy apple aphid, Anuraphis roseus (Baker),[69] and the green apple aphid, Aphis pomi DeGeer,[70] but there were few aphids in the proposed test area; therefore the nicotine products were tested on the pear psylla which was prevalent.[71] In 1911, C. C. Taylor, entomologist and insecticide salesman for the Tobacco By-Products Corporation, came to Michigan and initiated control experiments with nicotine sulphate on pear psylla.[72] These trials were started under the direction of Rufus H. Pettit, Professor of Entomology at the Michigan

State College, and were conducted in Berrien County, Van Buren County and Allegan County from 1911 to 1917.[73] (Mr. Taylor had been an entomology student under Professor Pettit and had graduated in 1909). The pear psylla was so destructive in Michigan and other Eastern states that the Northwestern States, which grew large quantities of pears themselves, established a quarantine on pears from the East,[74] and pear growers in Michigan began using nicotine sulphate for psylla control. Experimental trials and grower applications of nicotine sulphate (and nicotine mixed with soap, liquid lime sulphur or Bordeaux Mixture) for the pear psylla in Michigan yielded unsatisfactory control.[75] The nicotine sprays were not able to penetrate the dense foliage of pear trees to kill all the insects, and applications of the spray had to be made continually throughout the summer to insure adequate control.[76] By 1925, dormant spray oils had superceded nicotine as a control for pear psylla in Michigan.[77]

About 1923, while Mr. Charles C. Taylor was attempting to demonstrate the effectiveness of nicotine sulphate as a control for pear psylla in Michigan, a pear grower at Fennville named Chan Reynolds was obtaining excellent control of the insect with a "secret" nicotine spray formula. This formula, prepared by Mr. Reynolds himself, was the "mystery of Fennville",[78] and growers agreed that Reynold's pears were the only ones in the area free of psylla and Mr. Reynolds sprayed only when he pleased and payed no attention to the

College spray calendar".[79] The latter recommended lime-sulphur nicotine sulfate applications after the leaves emerged in the spring; thus the eggs of the overwintering adult pear psyllas would be killed. The lime-sulphur:

> took off everything but the bark and resulted in weak, stunted foliage and small pears, followed by light bloom the next year. To be sure to get both eggs and adults it was best to add next years profit in the form of nicotine-sulphate to the lime-sulphur. Also the grower had to walk and spray, which with dormant strength lime-sulphur and Black Leaf 40, was something to face.[80]

In 1923, 1924, and 1925, Chan Reynold's pear orchard was the only one in the vicinity of Fennville which was free from pear psylla. "Either pear psylla never set foot on his farm or Chan had something no one in North America had equalled."[81] The anxiety of other pear growers to control the psylla had caused:

> ---- many to search Chan's place for a clue[82] and they always reported empty cans of Black Leaf 40. ---- Several growers, whom Chan trusted, bartered or bought the secret and all had superior control. It was such a hot issue that, when the Reynolds family went to church, a neighbor reported to Mr. Reynolds that one of Fennvilles' most famous fruit growers was seen trying to break the lock to Reynold's spray shed, no doubt, hoping to find a labeled can or bottle that would give a clue to the secret.[83]

A demonstration of the effectiveness of the Reynolds' formula was arranged for a representative of the Tobacco By-Products and Chemical Corporation by Mr. Horace A. Cardinell, horticultural extension specialist of the Michigan State College.[84] The demonstration, having replicated treatments and checks was held on the Trevor Nichols farm at Fennville.[85] The application of the "mystery spray" mixed by Mr. Reynolds for the demonstration, was done by Mr. Cardinell. Three applications of the test spray, the first application being applied when the psylla was in the honeydew stage, gave excellent control of the psylla, the results convinced the Tobacco By-Products Corporation to negotiate with Chan Reynolds for the purchase of his secret formula.[86]

a. <u>First Michigan Experiment Station Test</u>

The first Experiment Station tests with nicotine sulphate for the control of chicken lice were made at the Michigan State College Experiment Station in 1928.[87] This occurred as a result of C. C. Taylor, field manager of the Tobacco By-Products and Chemical Corporation, receiving a letter from a poultryman in California who told of delousing his flock of chickens by painting nicotine sulphate on his chicken roosts. Mr. Taylor, upon receiving the letter, contacted John Hannah of the Michigan State College Poultry Department (Dr. Hannah is now the President of Michigan State College) and requested permission to conduct trials with nicotine sulphate painted on chicken roosts for killing lice. Permission for the trials was granted and successful tests were made at East Lansing and Grand Rapids by Mr. Taylor. The latter related the following incident about the Grand Rapids trials to this writer.[88]

The chickens at Grand Rapids were very heavily infested

with lice; therefore the poulty houses and ckicken roosts were thoroughly painted with nicotine sulphate. It happened that the weather was quite hot at the time of this trial and the nicotine could have caused the death of the chickens. Mr. Taylor, after having finished the application of the nicotine sulphate,was informed that many of the chickens in the houses he had painted were prize stock. One of the chickens was worth about 250 dollars. During the evening and night following the painting of the poultry houses, Mr. Taylor was so worried about what the nicotine might do to the chickens that he couldn't sleep and he didn't leave his hotel room, for he was expecting the college officials to call him at any moment to inform him of disaster.

b. Original Black Leaf 40 Work

The original experimental work with Black Leaf 40 as a contact orchard spray was done in New York by Dr. P. J. Parrott of the New York Agricultural Experiment Station.[89] It was Dr. Parrott's study of the control of the rosy apple aphid and the black cherry aphid, *Myzus cerasi* (F.), with nicotine sulphate that resulted in investigations of the same kind being undertaken in Michigan.[90]

2. The Discovery and First Use of Nicotine-bentonite

Nicotine-bentonite, eventually marketed widely as Black Leaf 155, was first used in Berrien County, Michigan.[91] This occurred in 1929 when Mr. Charles C. Taylor, sales-

manager for the Tobacco By-Products Chemical Corporation, tried the compound as a codling moth control. Mr. Taylor himself had been responsible for the discovery of nicotine bentonite. Its discovery happened as follows:[92]

> On a journey to the West about 1926, to observe the results of nicotine sulphate and nicotine-water extract spray applications for codling moth control in apple orchards at Grand Junction, Colorado, Mr. Taylor heard that Wyoming Bentonite was being used to remove ink from printing press rollers. He decided that if the bentonite could absorb ink, it might possibly absorb nicotine; therefore Mr. Taylor took five pounds of bentonite to Louisville, Kentucky where the Tobacco By-Products Corporation tested its absorptive power. The bentonite was found to "fix" large quantities of nicotine. Three years were required for developing the nicotine and bentonite combination for use by orchardists. Nicotine-bentonite was first sold in Michigan at the Chamberlin Hardware Store, Hartford, in 1929.[93]

3. Insecticide-Fungicide Compatibility Charts

Since some insecticides and fungicides, when either mixed with other insecticides and fungicides, respectively, or with each other, produce injurious chemical combinations, "insecticide-fungicide compatibility charts" are prepared for growers. These indicate the most suitable combinations of chemicals for mixtures or close use in spray schedules. In Michigan, the first such compatibility charts distributed by the Michigan Agricultural College were prepared by Professor Rufus H. Pettit of theEntomology Department. This occurred about 1920.[94] Professor Pettit probably was one of the first in the United States to prepare insecticide-fungicide compatibility charts.

4. DDT on Potatoes

One of the most phenomenal increases in crop yields per acre in Michigan caused by insecticides has been that obtained with DDT on potatoes. Superior yields of potatoes as a result of excellent control of leafhoppers with DDT in the State was first reported in 1944, by J. H. Muncie and W. F. Morofsky.[95] For the seven year period 1946 to 1952, inclusive, DDT was a major factor in providing an average annual per acre yield inclrease of potatoes in Michigan of about 54 percent over that average yield for a seven year period preceding 1945.[96,97] The average increase in potato yields with DDT in Michigan almost parallels that average annual potato yield increase reported nationally since the advent of DDT in 1945.[98]

5. The Regulation of Pest Control Chemical Distribution, Transportation, and Sales in Michigan

Regulations for the distribution, transportation, or sale of pest control materials in Michigan were first made in

1905. That year, the Legislature passed Public Act 332, in which section 18 provided for the sale of Paris green, white hellebore, and other insecticides by physicians in communities where there was no registered pharmacist within a radius of five miles. Section 18 also granted merchants and drug dealers the right to sell pharmaceuticals and such insecticidal materials as Paris green, borax, sulphur, blue vitriol, and copperas, provided that the name of the pharmacist that prepared the material, dosages, and antidotes were mentioned on the container. Act 332 of the Public Acts of 1905 was approved June 20 and became effective September 16.

The first Michigan Legislative Act devoted to the prevention of fraud in the public sale of pest control chemicals was enacted on May 18, 1909. This was Act 91. It required every manufacturer of Paris green whose product was sold in Michigan as an insecticide to send a sample of the chemical to the Director of the Experiment Station at the Michigan Agricultural College, East Lansing, for a chemical analysis and certification as to its amount of combined arsenic (Public Act 91 stated that every sample of Paris green had to contain 50 percent arsenious oxide and not more than 4 percent arsenious oxide in an uncombined form.) A written statement giving the brand name, weight of package, name(s) of manufacturers, amount of combined arsenic, and a guarantee of the combined arsenic content had to accompany each sample of Paris green sent to the Experiment Station. The analysis and certification regulation of Act 91 also applied to retail and wholesale dealers of Paris green if their supplies of the insecticide did not already bear labels guaranteeing the arsenic c ntent. The results of Paris green analyses were sent to the Michigan State Board of Agriculture by the Director of the Experiment Station. The penalty for failure to submit samples of Paris green for certification consisted of a fine of not less than 50 dollars and not more than 200 dollars.

Another Act, Number 163, was passed in 1909 that concerned the sale of pest control chemicals other than Paris green to be used as insecticides, fungicides or fumigants on fruit trees or for other purposes. Among those substances required to be tested under this law were arsenate of lead, sulphur, lime-sulphides, miscible combinations of mineral or vegetable oils, copper sulphate, and Bordeaux Mixture. The State Inspector of Orchards and Nurseries was assigned the task of obtaining samples of pest control chemicals and sending them to the Experiment Station for testing. The test results were reported to the State Board of Horticulture. The most significant provision of Act 163 was that every package of spray material sold or offered for sale was to bear a label upon which was stated the contents in detail and other information that was to be filed with the Experiment Station by manufacturers or dealers. Act 163 of the Public Acts of 1909 was approved on June 1. Its violation was punishable by a fine of not less than 50 dollars nor more than 100 dollars plus court costs. The passage of Public Acts 91 and 163 probably was brought about by the Federal Food and Drug Act of 1906. Both Acts preceded the Federal Insecticide Act of 1910.

Further regulations concerning pest control chemicals were enacted in 1913. In that year, Act 254 (section I) made it:

> ---- unlawful for any person to manufacture, sell, offer or expose for sale within the state of Michigan any insecticide, Paris green, lead arsenate or fungicide which is adulterated or misbranded within the meaning of this act; and any person who shall violate any of the provisions of this act shall be guilty of a misdemeanor and upon conviction thereof shall be fined not to exceed 300 dollars, or sentenced to imprisonment in the county jail for a period not exceeding 90 days, or both in the discretion of the court.[99]

The provisions of Act 254 were to be carried out under the direction of the Michigan State Board of Agriculture. Samples of chemicals were to be tested by the Experiment Station. An interesting fact about the 1913 pest control chemical act was that the necessary funds authorized to be paid for carrying out its provisions could not exceed a total of 500 dollars in any fiscal year.

From 1913 to 1914, except for an Act passed in 1915 pertaining to poisonous fly paper and fly killers and one in 1921 which transferred the insecticidal activities of the Michigan State Board of Agriculture to the Michigan State Department of Agriculture which was created by the same Act, no changes or improvements were made in the regulation of pest control chemicals by legislation in Michigan. On

May 17, 1915 the Legislature passed Act 269 which deemed unlawful the manufacture, compounding, or sale of fly papers or flykillers containing arsenic or other poisons in quantities dangerous to human life, unless the fly papers or fly killers could be made or protected so that they would be inaccessible to people that might eat, drink, or swallow them. Violators of Act 269 were subject to fines and imprisonment. In 1921, Legislative Act 13 "---- transferred to the state department of agriculture, and vested therein, the powers and duties of the state board of agriculture with reference to ---- the testing and examination of insecticides, ----".[100]

In 1949, the Michigan Legislature enacted "The Insecticide, Fungicide, and Rodenticide Act." This Act was patterned after the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 and includes recommendations of the council of state governments.[101]

A copy of the 1949 Michigan Insecticide, Fungicide, and Rodenticide Act is included in this text(following this page).

6. The Michigan Insecticide and Fungicide Institute

The Michigan Insecticide and Fungicide Institute (frequently called the M.I.F.I.) has held a conference annually at the Michigan State College since abut 1945. This conference, which lasts about two days, is conducted in cooperation with the Departments of Entomology, Botany and Plant Pathology, and Horticulture. Its purpose is that of informing and educating dealers concerned with insecticides,

STATE OF MICHIGAN
65TH LEGISLATURE
REGULAR SESSION OF 1949

Introduced by Reps. Cavanagh and Hutchinson

ENROLLED HOUSE BILL No. 362

AN ACT to regulate the distribution, transportation, sale of insecticides, fungicides, rodenticides, larvicides, ovicides, herbicides and other "economic poisons" and devices, to prohibit adulterated and misbranded economic poisons and devices; to provide for registration and fixing a fee therefor, guarantees, and labeling of all economic poisons and devices; to authorize the expenditure of such fees; to authorize seizure of misbranded, adulterated or unregistered economic poisons and devices and to fix penalties for the violation of this act, and to repeal all acts or parts of acts in conflict.

The People of the State of Michigan enact:

Sec. 1. This act may be cited as "The insecticide, fungicide, and rodenticide act of 1949."

Sec. 2. For the purpose of this act:

a. The term "economic poison" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, fungi, weeds, or other forms of plant or animal life or viruses, except viruses on or in living man or other vertebrate animals, which the director shall declare to be a pest.

b. The term "device" means any instrument or contrivance intended for trapping, destroying, repelling, or mitigating insects or rodents or destroying, repelling, or mitigating fungi or weeds, or such other pests as may be designated by the director, but not including equipment used for the application of economic poisons when sold separately therefrom.

c. The term "insecticide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects which may be present in any environment whatsoever.

d. The term "fungicide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any fungi.

e. The term "rodenticide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating rodents or any other vertebrate animal which the director shall declare to be a pest.

f. The term "herbicide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any weed.

g. The term "larvicide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any larvae which may be present in any environment whatsoever.

h. The term "ovicide" means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any ova.

i. The term "insect" means any of the numerous small invertebrate animals generally having the body more or less obviously segmented, for the most part belonging to the class Insecta, comprising six-legged, usually winged forms, as, for example, beetles, bugs, bees, flies, including eggs, larvae, and immature forms, and to other allied classes of arthropods whose members are wingless and usually have more than six legs, as, for example, spiders, mites, ticks, centipedes, and wood lice.

j. The term "fungi" means all non-chlorophyll-bearing thallophytes (that is, all non-chlorophyll-bearing plants of a lower order than mosses and liverworts) as, for example, rusts, smuts, mildews, molds, yeasts, and bacteria, except those on or in living man or other vertebrate animals.

k. The term "weed" means any plant which grows where not wanted.

l. The term "ingredient statement" means:

(1) A statement of the name and percentage of each active ingredient, together with the total percentage of the inert ingredients, in the economic poison.

(a) Or, in the case of "economic poison", household disinfectants or household germicides, for preventing, destroying, repelling, or mitigating common household pests, a statement of the name of each active ingredient together with the name of each and total percentage of the inert ingredients, if any there be, in the economic poison (except option 1 shall apply if the preparation is highly toxic to man, determined as provided in section 6 of this act); and

(2) In case the economic poison contains arsenic in any form, a statement of the percentages of total and water soluble arsenic, each calculated as elemental arsenic.

m. The term "active ingredient" means an ingredient which will prevent, destroy, repel, or mitigate insects, fungi, rodents, weeds, or other pests.

n. The term "inert ingredient" means an ingredient which is not an active ingredient.

o. The term "antidote" means a practical immediate treatment in case of poisoning and includes first aid treatment.

p. The term "person" means any individual, partnership, association, corporation, or organized group of persons whether incorporated or not.

q. The term "director" means the director of the Michigan department of agriculture.

r. The term "registrant" means the person registering any economic poison pursuant to the provisions of this act.

s. The term "label" means the written, printed, or graphic matter on, or attached to, the economic poison, or device, or the immediate container thereof, and the outside container or wrapper of the retail package, if any there be, of the economic poison or device.

t. The term "labeling" means all labels and other written, printed, or graphic matter—

(1) Upon the economic poison or device or any of its containers or wrappers;

(2) Accompanying the economic poison or device at any time;

(3) To which reference is made on the label or in literature accompanying the economic poison or device, except when accurate, non-misleading reference is made to current official publications of the United States departments of agriculture or interior, the United States public health service, state experiment stations, state agricultural colleges, or other similar federal institutions or official agencies of this state or other states authorized by law to conduct research in the field of economic poisons.

u. The term "adulterated" shall apply to any economic poison if its strength or purity falls below the professed standard or quality as expressed on its labeling or under which it is sold, or if any substance has been substituted wholly or in part for the article, or if any valuable constituent of the article has been wholly or in part abstracted.

v. The term "misbranded" shall apply—

(1) To any economic poison or device if its labeling bears any statement, design, or graphic representation relative thereto or to its ingredients which is false or misleading in any particular;

(2) To any economic poison—

(a) If it is an imitation of or is offered for sale under the name of another economic poison;

(b) If its labeling bears any reference to registration under this act, except as provided in Sec. 3, a, (6);

(c) If the labeling accompanying it does not contain instructions for use which are necessary and, if complied with, adequate for the protection of the public;

(d) If the label does not contain a warning or caution statement which may be necessary and, if complied with, adequate to prevent injury to living man and other vertebrate animals;

(e) If the label does not bear an ingredient statement on that part of the immediate container and on the outside container or wrapper, if there be one through which the ingredient statement on the immediate container cannot be clearly read, of the retail package which is presented or displayed under customary conditions of purchase;

(f) If any word, statement, or other information required by or under the authority of this act to appear on the labeling is not prominently placed thereon with such conspicuousness (as compared with other words, statements, designs, or graphic matter in the labeling) and in such terms as to render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use, or

(g) If in the case of insecticide, fungicide, herbicide, larvicide, or ovicide, when used as directed or in accordance with commonly recognized practice, it shall be injurious to living man or other vertebrate animals or vegetation, except weeds, to which it is applied, or to the person applying such economic poison.

Sec. 3. a. It shall be unlawful for any person to distribute, sell, or offer for sale within this state or deliver for transportation or transport in intrastate commerce or between points within this state through any point outside this state any of the following:

(1) Any economic poison which has not been registered pursuant to the provisions of section 4 of this act, or any economic poison if any of the claims made for it or any of the directions for its use differ in substance from the representations made in connection with its registration, or if the composition of an economic poison differs from its composition as represented in connection with its registration: Provided, That in the discretion of the director, a change in the labeling or formula of an economic poison may be made within a registration period without requiring reregistration of the product.

(2) Any economic poison unless it is in the registrant's or the manufacturer's unbroken immediate container, and there is affixed to such container, and to the outside container or wrapper of the retail package, if there be one through which the required information on the immediate container cannot be clearly read, a label bearing:

(a) The name and address of the manufacturer, registrant, or person for whom manufactured;

(b) The name, brand, or trade mark under which said article is sold; and

(c) The net weight or measure of the content subject, however, to such reasonable variations as the director may permit.

(3) Any economic poison which contains any substance or substances in quantities highly toxic to man, determined as provided in section 6 of this act, unless the label shall bear, in addition to any other matter required by this act:

(a) The skull and cross bones;

(b) The word "poison" prominently, in red, on a background of distinctly contrasting color; and

(c) A statement of an antidote for the economic poison.

(4) The economic poisons commonly known as standard lead arsenate, basic lead arsenate, calcium arsenate, magnesium arsenate, zinc arsenate, zinc arsenite, sodium fluoride, sodium fluosilicate, and barium fluosilicate unless they have been distinctly colored or discolored as provided by regulations issued in accordance with this act, or any other white powder economic poison which the director, after investigation of and after public hearing on the necessity for such action for the protection of the public health and the feasibility

of such coloration or discoloration, shall, by regulation, require to be distinctly colored or discolored, unless it has been so colored or discolored: Provided, That the director may exempt any economic poison to the extent that it is intended for a particular use or uses from the coloring or discoloring required or authorized by this section if he determines that such coloring or discoloring for such use or uses is not necessary for the protection of the public health.

(5) Any economic poison which is adulterated or misbranded, or any device which is misbranded.

(6) Any economic poison which has been registered under protest unless each package bears a label printed in bold face on a strongly contrasting background the words "WARNING: REGISTERED UNDER PROTEST IN MICHIGAN."

b. It shall be unlawful—

(1) For any person to detach, alter, deface, or destroy, in whole or in part, any label or labeling provided for in this act or regulations promulgated hereunder, or to add any substance to, or take any substance from, an economic poison in a manner that may defeat the purpose of this act.

Sec. 4. Each and every manufacturer, importer, jobber, firm, association, corporation or person manufacturing, distributing or selling any economic poison as defined in section 2 of this act, shall pay to the director of agriculture on or before the first day of November, 1949, and annually thereafter, a registration fee of $5.00 for each and every brand or separate economic poison sold, offered or exposed for sale, or distributed in this state: Provided That for each and every registration in excess of 10 in any year by the same person, the registration fee shall be $2.00. Fees so collected shall be paid into the state treasury and credited to the economic poison control fund hereby created. The moneys so collected shall be used to defray the expense incurred in collecting and analyzing samples of economic poisons, publishing results of analysis and all other expenses incidental to carrying out the provisions of this act, including the establishing and maintaining of chemical laboratories. Any surplus from registration fees remaining on hand at the end of the fiscal year shall be credited to the general fund.

(1) Provided, That whenever a manufacturer, importer, jobber, firm, association, corporation or person manufacturing or selling a brand of economic poison, shall have paid the registration fee as provided for in this section, no other agent, importer, jobber, firm, association, corporation or person shall be required to pay such fee upon such brand, nor is registration required in the case of an economic poison shipped from one plant within this state to another plant within this state operated by the same person;

(2) Provided, That the provision of this section requiring registration shall not apply to economic poisons that have been discontinued by manufacturers or to stocks of economic poison in the possession of dealers until 1 year after the effective date of this act.

Sec. 5. Should any economic poison be registered in this state and it is afterward discovered that such registration is in violation of any of the provisions of this act, the said director shall have the power to cancel such registration. The director shall have the power to refuse to allow any manufacturer, importer, jobber, firm, association, corporation or person to lower the guaranteed analysis or change the active ingredients of any brand of his or their economic poison during the term for which registered unless reasons satisfactory to said director are presented for making such change or changes: Provided, That a person who has been denied a registration of an economic poison or whose registration has been cancelled may be granted an appeal hearing before the commission of agriculture, whose finding of fact shall be justification for sustaining or overruling of the director.

If it does not appear to the commission of agriculture that the article is such as to warrant the proposed claims for it or if the article and its labeling and other material required to be submitted do not comply with the provisions of this act, the director shall notify the registrant of the manner in which the article, labeling, or other material required to be submitted fails to comply with the act so as to afford the registrant an opportunity to make the corrections necessary. If, upon receipt of such notice, the registrant insists that such corrections are not necessary and requests in writing that it be registered, the director shall register the article, under protest, and such registration shall be accompanied by a warning, in writing, to the registrant of the apparent failure of the article to comply with the provisions of this act.

Sec. 6. a. The director is authorized, after opportunity for a hearing

(1) To declare as a pest any form of plant or animal life or virus which is injurious to plants, men, domestic animals, articles, or substances;

(2) To determine whether economic poisons are highly toxic to man; and

(3) To determine standards of coloring or discoloring for economic poisons, and to subject economic poisons to the requirements of section 3a (4) of this act.

b. The director is authorized, after due public hearing, to make appropriate rules and regulations for carrying out the provisions of this act, including rules and regulations providing for the collection and examination of samples of economic poisons or devices. Rules and regulations promulgated under the provisions of this act shall be subject to the provisions of Act No. 88 of the Public Acts of 1943, as amended, being sections 24.71 to 24.82, inclusive, of the Compiled Laws of 1948.

Sec. 7. a. The examination of economic poisons or devices shall be made under the direction of the director for the purpose of determining whether they comply with the requirements of this act. If it shall appear from such examination that an economic poison or device fails to comply with the provisions of this act, and the director contemplates instituting criminal proceedings against any person, he shall cause appropriate notice to be given to such person. Any person so notified shall be given an opportunity to present his views, either orally or in writing, with regard to such contemplated proceedings and if, thereafter, in the opinion of the director it shall appear that the provisions of the act have been violated by such person, then the director shall refer the facts to the prosecuting attorney for the county in which the violation shall have occurred with a copy of the results of the analysis or the examination of such article.

b. It shall be the duty of each prosecuting attorney to whom any such violation is reported to cause appropriate proceedings to be instituted and prosecuted in the circuit court without delay.

c. The director shall, by publication in such manner as he may prescribe, give notice of all judgments entered in actions instituted under the authority of this act.

Sec. 8. a. The penalties provided for violations of this act shall not apply to—

(1) Any carrier while lawfully engaged in transporting an economic poison within this state, if such carrier shall, upon request, permit the director or his designated agent to copy all records showing the transactions in and movement of the articles;

(2) Public officials of this state and the federal government engaged in the performance of their official duties;

(3) The manufacturer or shipper of an economic poison for experimental use only.

(a) By or under the supervision of an agency of this state or of the federal government authorized by law to conduct research in the field of economic poisons, or

(b) By others if the economic poison is not sold and if the container thereof is plainly and conspicuously marked "For experimental use only—Not to be sold," together with the manufacturer's name and address: Provided, however, That if a written permit has been obtained from the director, economic poisons may be sold for experimental purposes subject to such restrictions and conditions as may be set forth in the permit.

b. No article shall be deemed in violation of this act when intended solely for export to a foreign country, and when prepared or packed according to the specifications or directions of the purchaser. If not so exported all the provisions of this act shall apply.

Sec. 9. Any manufacturer, importer, jobber, firm, association, corporation, or person, who shall sell, offer, or expose for sale, or distribute in this state, or who shall take or receive from any firm, association, corporation, or person in this state any order for the sale of any economic poison or device as defined in section 2 of this act, or who shall directly or indirectly contract with any manufacturer, importer, jobber, firm, association, corporation, or person in this state for the sale of such economic poison or device to be delivered in this state by common carrier or otherwise, which has not been registered as required by the provisions of this act, or without complying with the labeling requirements of this act or who shall impede, obstruct, or hinder such director or his authorized agents in the performance of his or their duty in connection with the provisions of this act, or who shall violate any of the rules or regulations promulgated by the director as provided herein, shall be deemed guilty of a violation of the provisions of this act and, upon conviction thereof, shall be sentenced to pay a fine of not more than $200.00, or to imprisonment of not more than 60 days in the county jail, or both such fine and imprisonment in the discretion of the court: Provided, however, That nothing in this act shall be construed as requiring the director to report for prosecution or for the institution of libel proceedings, minor violations of the act whenever he believes that the public interest will be best served by a suitable notice of warning in writing.

Sec. 10. The director, his deputy, or any person by said director duly appointed for that purpose, is authorized at all times to seize and take possession of any and all economic poisons or devices, substitutes therefor, or imitations thereof, kept for sale, exposed for sale, distributed, or held in possession or under the control of any person, which are contrary to the provisions of this act.

1. The person so making such seizures as aforesaid, shall take from such goods as seized a sample for the purpose of analysis and shall cause the remainder thereof to be boxed and sealed and shall leave the same in the possession of the person from whom they were seized, subject to such disposition as shall hereafter be made thereof according to the provisions of this act.

2. The person so making such seizure shall forward the sample so taken to the chief chemist of the department of agriculture for analysis, who shall make an analysis of the same and shall certify the results of such analysis which certificate shall be prima facie evidence of the fact or facts therein certified to in any court where the same may be offered in evidence.

3. If upon such analysis it shall appear that said economic poison or device is adulterated, misbranded, a substitute or imitation within the meaning of this act, said director, or his deputy or any person by him duly authorized, may make complaint before any justice of the peace or police justice having jurisdiction in the city, village, or township where such goods were seized, and thereupon said justice of the peace shall issue his summons to the person from whom said goods were seized, directing him to appear not less than 6 nor more than 12 days from the date of the issuing of said summons and show cause why said goods should not be condemned and disposed of. If the said person from whom said goods were seized cannot be found said summons shall be served upon the person then in possession of the goods. The said summons shall be served at least 6 days before the time of appearance mentioned therein. If the person from whom said goods were seized cannot be found, and no one can be found in possession of said goods, and the defendant shall not appear on the return day, the said justice of the peace shall proceed in said cause in the same manner provided by law where a writ of attachment is returned not personally served upon any of the defendants and none of the defendants shall appear upon the return day.

4. Unless cause to the contrary thereof is shown, or if said goods shall be found upon trial to be in violation of any of the provisions of this act or other laws which now exist or which may be hereafter enacted, it shall be the duty of said justice of the peace or police justice to render judgment that said seized property be forfeited to the state of Michigan, and that the said goods be destroyed or sold by the said director for any purpose other than to be used for economic poisons or devices. The mode of procedure before said justice shall be the same, as near as may be, as in civil proceedings before justices of the peace. Either parties may appeal to the circuit court as appeals are taken from justices' courts, but it shall not be necessary for the people to give any appeal bond.

5. The proceeds arising from any such sale shall be paid into the state treasury and credited to the general fund: Provided, That if the owner or party claiming the property or

goods so declared forfeited can produce and prove a written guarantee of purity, signed by the wholesaler, jobber, manufacturer or other party from whom said articles were purchased, then the proceeds of the sale of such articles, over and above the cost of seizure, forfeiture, and sale, shall be paid over to such owner or claimant to reimburse him, to the extent of such surplus, for his actual loss resulting from such seizure and forfeiture, as shown by the invoice: And provided, further, That upon payment of costs and execution and delivery of a good and sufficient bond conditioned that the article shall not be disposed of unlawfully, the court may direct that said article be delivered to the owner thereof for relabeling or reprocessing as the case may be.

6. It shall be the duty of each prosecuting attorney when called upon by said director or by any person by him authorized as aforesaid, to render any legal assistance in his power in proceedings under the provisions of this act, or any subsequent act, relative to the adulteration, misbranding, substituting, imitating or selling economic poisons or devices.

Sec. 11. All authority vested in the director by virtue of the provisions of this act may with like force and effect be executed by such employees of the department of agriculture as the director may from time to time designate for said purpose.

Sec. 12. The director is authorized and empowered to cooperate with, and enter into agreements with, any other agency of this state, the United States department of agriculture, and any other state or agency thereof for the purpose of carrying out the provisions of this act and securing uniformity of regulations.

Sec. 13. Jurisdiction in all matters pertaining to the distribution, sale and transportation of economic poisons and devices is by this act vested exclusively in the department of agriculture and all acts and parts of acts inconsistent with this act are hereby expressly repealed. Act No. 254 of the Public Acts of 1913, being sections 286.151 through 286.160 of the Compiled Laws of 1948, is hereby repealed.

....
Clerk of the House of Representatives.

....
Secretary of the Senate.

Approved ....

....
Governor.

fungicides, and other agricultural chemicals about control recommendations, legislation, and hazards of chemicals, application equipment, and other special topics. The conference provides dealers with the opportunity to discuss their problems with each other.

Insecticide conferences conducted by the Michigan State College Entomology Department originated in 1935.[102] At that time, a series of district schools on insecticide and fungicide dealer training was instituted by the extension entomologist and plant pathologist. The work was continued, with some interruption during World War II, until 1945; in 1945, the M.I.F.I. was organized and incorporated.

The success of the M.I.F.I. has been mediocre during recent years. Although supported by agricultural chemical manufacturers, commercial dealers have taken little interest in the Institute. Even those local dealers (operators of drug stores and hardwares at which agricultural chemicals are sold) who can easily reach the Institute meetings do not attend. The dealers, like the farmers to whom they sell, are quite dependent upon the college extension specialists for information.

The attitude of dealers toward the M.I.F.I. probably has resulted from the following facts:

1. Both the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 and the Michigan Insecticide, Fungicide, and Rodenticide Act of 1949 have eliminated false claims

and misbranding on pest control chemical containers and have insured the listing of the ingredients in the contents of containers; whereas dealers before 1947 were frequently requested by their customers to provide much information about the contents of pest control chemical containers. Since 1949 the labels on such containers have provided the essential facts that dealers frequently sought at the M.I.F.I.

2. " ---- housewives each year purchase upwards of 100 million dollars worth of the so-called household type insecticides, ----".[103] Most of these purchases are probably made at drug, hardware, and department stores, and the present labels probably are sufficient, without asking too many questions of salespeople, to inform one of their nature and use.

3. Since about 1935, the total number of farms in Michigan has decreased from about 196,000 to about 155,000, and the total number of farmers who work off the farm has increased from about 56,000 to about 72,000.[104] This situation has decreased the number of growers seeking detailed information on pest control from agricultural chemical dealers.

7. Commercial Pest Control Operators in Michigan

The commercial pest control operators of Michigan have organized two associations for the purpose of disseminating information on pest control to the individual members of each association. These are:

a. <u>The Wolverine Pest Control Association, Inc.</u>[105] This organization originated on March 5, 1951. On that date, seven pest control operators attended an organizational meeting in the Dime Building, Detroit, Michigan. The first officers were: (1) J. Watkins - President. (2) Charles Wells - Vice-president, and (3) Myron Sempliner - Secretary and Treasurer. At present, there are about 20 members and the officers for 1953 - 54 are (1) Charles Wells - President; (2) Harlem Ives - Vice-president; and (3) J. Watkins - Secretary and Treasurer. Although most of the Wolverine members are members of the National Pest Control Association, 30 Church street, New York 7, New York, the Wolverine Association itself is not directly affiliated with it.

The Wolverine Association does not issue any publications. It does keep its members posted on pest control developments, and believes that any matter affecting the pest control industry should be discussed openly. Non-members are invited to all meetings of the Association.

b. <u>The Michigan Pest Control Association, Inc.</u>[106] This organization originated on February 12, 1945, at Lansing, Michigan. The first officers were: (1) Harold Smitter - President; (2) Oscar Potter - Vice-president; and (3) Edward Van Core - Secretary-Treasurer. The organization had eight members at its origin. The purpose of the Michigan Pest Control Association is to promote a closer relationship between the members of the industry, seeking the promotion, advancement, and betterment of the ethics of the pest control industry. The Association presently has fifteen members. The present officers are: (1) Oscar Potter - President; (2) Harry Sinclair - Vice-president; and (3) Edward Van Core - Secretary-Treasurer.

CHAPTER XII

ENTOMOLOGICAL ACTIVITIES OF THE MICHIGAN DEPARTMENT OF AGRICULTURE[1]

The discovery of San Jose Scale in Michigan in 1897 led the Legislature to pass a bill which required the inspection of all nursery stock offered for sale in the State, whether grown in or out of the State, and compelled the inspection and treatment of all fruit trees suspected to be infested with pests. This action was taken in 1897 and in the same year, Professor Ulysses P. Hedrick of the Michigan Agricultural College Horticultural Department was appointed State Inspector of Orchards and Nurseries.

Present inspection and control activities of the Michigan Department of Agriculture are conducted by the Bureau of Plant Industry, a part of the Department. The Bureau is concerned with the following insects:

A. Japanese Beetle

Extensive trapping and control operations for this insect have been conducted in the Lower Peninsula since 1930. For a more detailed account of this work the reader is referred to Chapter IX, Co-operative Survey and Control Programs, Section A.

B. Cherry Fruit Flies

Since a State Law prohibits canneries from canning

cherries that are infested with cherry maggots, annual summer inspection and eradication campaigns for cherry fruit flies are conducted in 22 cherry growing counties. These campaigns, conducted since 1929 and financed entirely by State funds, are authorized by Act 86, Public Acts of 1929, the Cherry Fruit Fly Act. Each campaign benefits not only the canneries but also the cherry growers.

The cherry fruit fly service consists of providing cherry inspectors for each county. The principal duties of the inspectors are:

a. To prepare and watch cherry fruit fly cages for the emergence of adult flies and to scout orchards for the adult insect. These observations are made in the spring and the presence of flies in cages and orchards is reported to the Chief of the Bureau of Plant Industry, Lansing. The Bureau Chief in turn, reports such information to the Michigan State College Entomology Department, East Lansing. The Entomology Department uses the dates of fly emergence or fly observance to establish spraying dates for the cherry fruit flies.

The fruit fly emergence cages, which the inspectors watch are 3 to 4 feet square, about 1 foot high, and have wooden sides over which a 16-inch mesh fly-proof screen is stretched. The cages are set over maggot-infested cherries which have been placed on cultivated soil. The fruit-fly cages are illustrated by Figure 9. Since these cages are prepared at harvest time for the following spring, a light cover of arsenate of lead is applied to the fruit to protect it from rodents and other pests until the maggots have entered the soil, and leaves or hay are placed on top of the cherries to protect the overwintering fly puparia. The leaf or hay mulch is removed early in the spring. The emergence cages are scattered at various points from Berrien County to Chegoygan County.

b. To visit growers during the growing season and inspect samples of cherries from their orchards for the presence of maggots. Cherry samples are also collected for the official verification of maggot-infested fruit by a traveling laboratory operated by the Bureau of Plant Industry. The traveling laboratory moves from the southern portion of the State to the northern portion, with the progressive south to north cherry harvest. The traveling laboratory had its origin in 1931.

c. To inspect samples taken from loads of cherries entering canneries.

d. To condemn cherry orchards infested with maggots. A State Law requires growers to destroy condemned cherries either by burying them with lime at least two feet in the ground, or by burning. The cherry inspector must witness this procedure. The burying of cherries is illustrated by Figure 10.

e. To collect and label specimens of cherry maggots and other fruit pests. Records are kept by the Bureau of

Plant Industry on the apple maggot, plum curculio, rose chafer, cherry case bearer, cherry aphid, fruit tree bark beetle, cherry slug, cherry leaf beetle, cherry leaf roller, cherry leaf spot, cherry yellows, and brown rot of stone fruits.

f. To prepare classified lists of approved and condemned cherry orchards.

A summary of various cherry fruit fly statistics, averaged for three five-year periods and one four-period for the years 1931 to 1949, inclusive, are presented in Table V. The original data was collected by State Cherry Inspectors.

C. European Corn Borer

The reader is referred to Chapter IX, Co-operative Survey and Control Programs, Section B.

D. Grasshoppers

The reader is referred to Chapter IX, Co-operative Survey and Control Programs, Section C.

E. Insects Attacking Ornamental Shade Trees and Forest Trees

1. Christmas Tree Insects. All Christmas trees shipped into the State are carefully inspected to determine whether they are infested with the Gypsy Moth, *Porthetria dispar* (L.), the Brown Tail Moth, *Nygmia phaeorrhoea* (Donov.), and other insects. These inspections occur at road blockades established on main highways and at railroad freight depots. County agents, county sheriffs, the Michigan Department of

Conservation, and the Michigan State Police co-operate with the Bureau of Plant Industry on the Christmas tree inspection work.

2. Dutch Elm Disease and Bark Beetles. Since 1950 when Dutch Elm Disease (caused by the fungus *Ceratostomella ulmi*) was first found in Michigan, in the eastern Detroit-Grosse Point area along the Detroit River, considerable co-operation has been given many Michigan communities in conducting community-financed surveys to determine the extent of Dutch Elm Disease infections and to find infestations of the European Elm Bark-Beetle, *Scolytus multistriatus* (Mar.), the principal vector of Dutch Elm Disease. In 1952, the City of Detroit alone spent 27,000 dollars for Dutch Elm Disease surveys and controls. In 1953, Detroit spent 41,000 dollars for sprays to protect elms from Dutch Elm Disease.

In 1953, the Legislature appropriated 10,800 dollars for a Dutch Elm Disease Survey. This survey was made in most of the municipalities from Mount Clemens south to Monroe and as far westward as Ann Arbor. Some entire townships were also covered in the survey.

TABLE V

AVERAGE ANNUAL CHERRY FRUIT FLY STATISTICS, 1931-1949

	1931-35	1936-40	1941-45	1946-49
No. Properties Inspected	2353	3694	3630	3496
No. Inspections	3326	5001	4650	4394
No. Cherry Trees				
Sweet	59406	110518	190983	197223
Sour	828512	146599	1603702	1768336
No. Sprayed Properties	1520	2315	2428	2676
No. Unsprayed Properties	960	1382	1173	816
No. Cultivated Orchards	1184	1969	2070	2065
No. Uncultivated Orchards	1252	1681	1573	----
No. Tests For Maggots	1314	2304	1918	----
No. Properties Infested with Cherry Maggots	283	311	265	122
Earliest Fly Observation Date	June 4	June 3	June 2	May 31
Latest Fly Observation Date	Aug. 5	Aug. 8	Aug. 9	Aug. 14
Earliest Maggot Record	June 14	June 17	June 19	June 7
Latest Maggot Record	July 28	Aug. 10	Aug. 7	Aug. 14
Largest No. Maggots In a Pint Sample	185	160	99	115

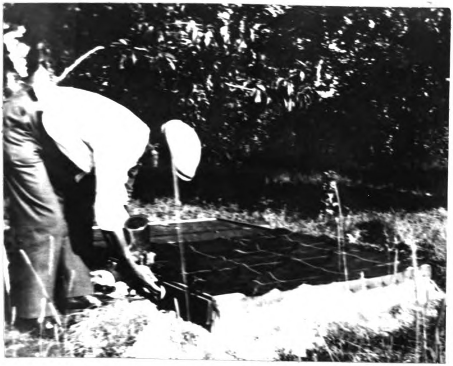


FIGURE 9

CHERRY FRUIT-FLIES BEING REMOVED FROM AN EMERGENCE CAGE

FIGURE 10

BURYING MAGGOT-INFESTED CHERRIES TO CONTROL THE CHERRY FRUIT FLY

CHAPTER XIII

SOME MICHIGAN MANUFACTURERS OF
PESTICIDES AND APPLICATION EQUIPMENT

A. Spray and Dust Equipment

1. American Marsh Pump Company, Inc., Battle Creek.[1] Origin: 1854. As the Battle Creek Machinery Company, this organization began the manufacture of Simplex Steam Pumps in 1880. The first successful experiment with a steam sprayer, which occurred in 1894, was made with a steam pump manufactured by the Marsh Steam Pump Company, Battle Creek.[2] This manufacturer also has been known as the Battle Creek Pump Company and the American Steam Pump Company. At present it manufactures pumps for a wide variety of uses.

2. Morrill and Morley Company, Benton Harbor.[3] Origin: 1894. This organization manufactured spray pumps and spraying apparatus until about 1916. In the 1899 Benton Harbor Directory the company was listed as "Pump Manufacturers"; in 1902, as producers of "Eclipse Spray Pumps and Atomizers"; in 1904, as "Sprinkler Manufacturers"; from 1907 to 1908, as "Sheet Metal Workers"; in 1915 - 16, as producers of "Eclipse Spray Pumps" and "Jobbers of Spray Apparatus".

In 1894, Morrill and Morley introduced quite a revolutionary type of spray pump. A cylinder containing a piston was placed at the bottom of the pump; hence, the pump needed no priming.[4] The new pump was reported to be quite simple and powerful and quite popular. This pump is illustrated in Figure 11.

3. Universal Metal Products Company Saranac.[5] Origin: 1935. Hand-operated dusters are the principal agricultural products of this company.

4. Champion Sprayer Company, Detroit.[6] Origin: 1933. This company manufacturers hand-operated knapsack sprayers and dusters, hand dusters, slide sprayers, wheelbarrow sprayers, self-loading compressed-air sprayers of several mounting styles, and a power sprayer.

5. Universal Stamping and Machine Company, Plymouth.[7] Origin: 1934. This company was organized as the Universal Power Sprayer Company. It ceased the manufacture of sprayers in 1941.

6. Acmeline Manufacturing Company, Traverse City.[8] Origin: 1885. Hand-operated dusters are made by this company.

7. Lowell Manufacturing Company, Lowell. This company is one of Michigan's largest manufacturers of sprayers and dusters.

8. The Hardie Manufacturing Company, Hudson.[9] Origin: 1903. This company was established for the manufacture of paint coating machines. Prior to 1903 its founder, Mr. Harry Hardie, was engaged in making hand spray-pumps at Detroit. The company started the manufacture of gasoline-

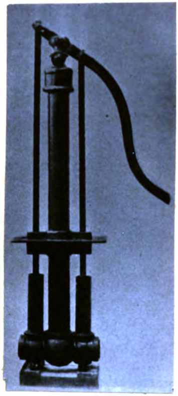


FIGURE 11

A NEW TYPE OF SPRAY PUMP INTRODUCED IN 1894 BY THE MORRILL AND MORLEY COMPANY, BENTON HARBOR (REPRODUCED FROM E.G. LODEMAN, THE SPRAYING OF PLANTS. NEW YORK: THE MACMILLAN COMPANY, 1916, P. 192. (COPYRIGHTED, 1896, BY THE MACMILLAN COMPANY). THIS WRITER WAS GRANTED PERMISSION TO REPRODUCE THIS PHOTO BY THE MACMILLAN COMPANY.

powered sprayers in 1904. In 1908, a manufacturing branch of the Hardie Company was established in Portland, Oregon. Another such branch was established in Los Angeles, California in 1912.

9. The Maud S. Windmill and Pump Company, Lansing. Origin: 1892. This company was a leading spray manufacturer of spray pumps in 1895.[10]

10. Hildreth Manufacturing Company, Lansing. Origin: 1895. This company was first called the Cady and Hildreth Company. It was a leading manufacturer of spray pumps in 1895.[11]

11. Bean - Chamberlin Manufacturing Company, Hudson. Origin: About 1890. This company made pneumatic spraying pumps that used a force to compress air in a reservoir for their operation rather than using a force from a moving piston.[12] The company no longer exists. It was also known as the Chamberlin Manufacturing Company, and Hazen Pump Company,[13] Bean-Hook Company, and Hook-Hardie Company.[14] Figure 12 illustrates a spray pump munufactured by the Chamberlin Company. John Bean (who started the John Bean Spray Pump Company at San Jose, California in 1884) and his son, Roscoe Bean started the Bean-Chamberlin Company prior to 1883.[15] Roscoe Bean continued making pumps at Hudson after John Bean went to California in 1883.[16] His pumps were used primarily for white-washing chicken coops, barns, and other buildings.[17]

12. The John Bean Manufacturing Company, Lansing. Origin: 1884. This company had its beginning at San Jose,

California. In 1884 Mr. John Bean invented the first hand-operated continuous spray force pump.[18,19] This pump is illustrated in Figure 13. Mr. Bean had worked on pumps since early in the1850's and was the inventor of the first well pump in which the cylinder was carried by the discharge pipe.[20] This was a double-acting force pump.[21] The 1884 invention was prompted by an invasion of San Jose Scale, _Aspidiotus perniciosus_ Comstock, in California citrus orchards in 1883. Mr. Bean, who had lived in Hudson, Michigan for many years prior to 1883 and had gone to California because of ill health[22], had begun work on a spray pump that would be forceful enough to spray San Jose Scale for a thorough kill. He tested his pump in his own infested orchards. In 1884, Mr. Bean's pump was shown at fairs throughout California and such a demand was made for the pump that Mr. Bean started to manufacture it at San Jose. His factory was called the John Bean Spray Pump Company. In 1908, the company sold manufacturing rights to Bean Spray Pumps to the Ohio Rubber Company of Cleveland. The rubber company which manufactured the pumps at Berea, Ohio, suffered severe financial losses and, in 1914, the John Bean Company bought the Berea production facilities. These were moved to Lansing, Michigan in 1915. Increasing sales of sprayers in Michigan and surrounding states influenced the move to Michigan. In 1911 the Bean Company had perfected a pressure regulator that was to be one of the greatest single improvements

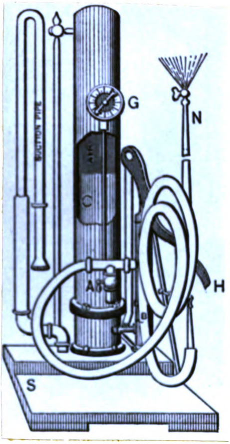


FIGURE 12

A SPRAY PUMP MADE BY THE CHAMBERLIN MANUFACTURING COMPANY. (REPRODUCED FROM E.G. LODEMAN, THE SPRAYING OF PLANTS. NEW YORK: THE MACMILLAN COMPANY, 1916, P. 193. COPYRIGHTED, 1896 BY THE MACMILLAN COMPANY. THIS WRITER WAS GRANTED PERMISSION TO REPRODUCE THIS PHOTO BY THE MACMILLAN COMPANY

FIGURE 13

JOHN BEAN AND HIS INVENTION OF 1884. THE FIRST CONTINUOUS HIGH PRESSURE SPRAY PUMP WITH AIR PRESSURE (THIS PHOTO WAS LOANED TO THE WRITER, AND PERMISSION GRANTED FOR ITS REPRODUCTION BY THE JOHN BEAN MANUFACTURING COMPANY, LANSING, MICHIGAN.)

in the development of modern spray equipment. Since 1915 the Lansing Plant has been a division of the Food machinery and Chemical Corporation, San Jose, California. By 1928, the John Bean Company was producing such a variety of agricultural products that its name was changed to the "John Bean Manufacturing Company". This company now manufactures various types of sprayers, crop harvesters, fire engines, carwashers, wheel aligners, and numerous other products.

13. The Novo Engine Company, Lansing.[23] Origin: 1880. This organization began under the name of Cady and Glassbrook and specialized in the manufacture of gasoline engines having horizontally moving pistons in horizontal cylinders. The name NOVO was adopted in 1907, at which time the company changed its horizontal engine to a vertical position; thus the pistons moved vertically. Novo engines were used in all types of farm machinery. The company ended operations on December 31, 1953.

14. The Church Manufacturing Company, Adrian. Origin: Prior to 1900 this organization made a variety of sprayers.

B. Chemicals

1. The E-Z Flo Chemical Company,[24] Lansing. Origin: 1928. From 1928 to 1951 this company was known as the Michigan Fertilizer Company. Until 1945, fertilizers were its only business. In 1945, Mr. B. C. Manker, the

manager, conceived the idea of selling insecticides and fungicides with fertilizers, for the company salesmen were dealing closely with the farmers and knew of their pest problems.

The E-Z Flo Company is a division of the Consolidated Chemical Company, the home office being the Diamond Fertilizer Company at Sandusky, Ohio. The E-Z Flo Company represents 25 national manufacturers of agricultural chemicals. It sells insecticides, fungicides, week killers, seed protectants, wood preservatives, and fumigants. The company formulates a number of pesticide dusts of its own. The chemicals handled by E-Z Flo make up one of the largest varieties of pesticides under one roof in Michigan. The distribution of E-Z Flo chemicals is done through 800 dealers in Michigan and Indiana.

2. Michigan Chemical Corporation, St. Louis.[25]

Origin: This company entered the organic pesticide field in 1940. By July, 1944, it was one of the largest producers of DDT for the United States Armed Forces. Michigan Chemical DDT, sold under the Pestmaster Trade Mark, is known throughout the world because of its extensive use in agricultural and public health campaigns.

3. The Dow Chemical Company, Midland.[28]

Origin: 1890. Until 1897 this company was successively known as the Midland Chemical Company and the Dow Process Company. The Dow Company's interest in insecticides and other agricultural chemicals was instigated by Dr. Herbert

H. Dow, founder of the company. Mr. Dow was interested in fruit orchards and noted the insect and disease damage to trees in his own apple orchards. His business inclined him to think in terms of chemical control. In 1910, Dow began the manufacture of lime-sulphur and lead arsenate for pest control. These were Dow's first agricultural products. In 1922, Dow Scientists began a systematic study of chemicals in an effort to develop new and better insecticidal and fungicidal sprays and dusts. The Dow Orchards were used as an experimental farm.

What is believed to have been the first synthetic organic substance ever used as an agricultural chemical was tried experimentally in the summer of 1925 when E. C. Britton and W. R. Veazey used butyl pyrrolidine from the Dow Laboratories as a substitute for nicotine in the control of aphids. Its toxicity alone ruled it out of commercial production, but the idea of synthetic organics as pest control materials had had its origin. Dinitro-orthocyclohexyl-phenol, developed by Dow and used as a dormant ovicide as early as 1937, probably was the first synthetic organic chemical manufactured for pesticide use in the United States that did not contain arsenic or lead. At present the Dow Chemical Company manufactures a large variety of insecticides, fungicides, nematocides, week killers and defoliants. For the testing of its pest control chemicals, Dow maintains an agricultural research station at South Haven, Michigan.

4. Cal1fornia Spray Chemical Corporation, Fennville.[27] Origin: about 1917. This is a branch of the home office in Richmond, California. Although a warehouse and office had not been established in Michigan until May, 1948 (at South Haven) the company had warehoused its products at the Michigan Supply Company in South Haven. In March, 1950, the Company purchased the Sanocide Spray Company in Fennville, and in May, 1950, moved into a new building at Fennville. In May, 1952 the headquarters for this branch was moved to Maumee, Ohio, where it includes an agricultural chemical research department.

5. The Tanglefoot Company, Grand Rapids.[28] Origin: 1885. "No history of entomology in any part of the world would be complete without a mention of Tanglefoot, as this Company was once the world's largest manufacturer of sticky fly-paper, and distribution was on a world-wide basis." Tree Tanglefoot, a sticky banding compound used to control climbing insects on orchard and ornamental shade trees, has provided the Tanglefoot Company with considerable fame. It was first produced in 1906. The most extensive sales of Tanglefoot occurred prior to the advent of DDT and other synthetic organic insecticides. "In the field of insect control by means of toxic chemicals, Tanglefoot was one of the first to market a steam vaporizer type sprayer for applying pyrethrum insecticides." The company also once operated a pyrethrum extracting plant and marketed a complete line of pyrethrum sprays.

6. Parsons Chemical Works, Grand Ledge.[29] Origin: 1916. This company was a pioneer in "Pyrethrum and Rotenone Insecticides, Veterinary Medicinal Chemicals and Sanitation Disinfectants." This company formulates a wide variety of "small-package" pesticides which are widely distributed in a number of states.

CHAPTER XIV

MISCELLANEOUS NOTES ON ENTOMOLOGY IN MICHIGAN

A. Bibliography on Michigan Insects

In 1903, Professor Rufus H. Pettit and his assistants began compiling a bibliography of writings on Michigan insects. Considerable effort was expended on this project, and the entries were complete up to about 1940. The references were put on index file cards, of which there are several thousand.

B. Entomology Department Photographic Work

In 1905, Professor Pettit started making blueprints of numerous photographic negatives of insects and historical pictures of the Michigan Agricultural College. In fact, the Entomology Department assumed the status of campus photographic headquarters. Evidence of this is that the Entomology Department presently possesses several thousand glass-plate negatives and blueprints of pictures. Professors Pettit and McDaniel did most of the photographic work. Many of the insect pictures taken by these two workers presently appear in numerous entomological textbooks.

C. Biological Control of Insects in Michigan

Professor Pettit was one of the first American entomologists to be interested in the biological control

of insects. While a student at Cornell University, Ithaca, New York, he made a study of entomogenous fungi for an undergraduate thesis. The excellence of his work prompted the University to publish it as an Experiment Station Bulletin, No. 97, titled "Studies In Artificial Cultures of Entomogenous Fungi", 1895. After coming to the Michigan Agricultural College in 1897, Professor Pettit made extensive experiments in the control of various economically important insects with fungi. This work continued until about 1911.

D. Cultural Control Studies of the Hessian Fly

Wheat is the most valuable crop in Michigan. Unless the Hessian Fly (a very destructive insect of autumn - sown wheat) is controlled, wheat can not be grown in the State. Since the expense of controlling the insect by spraying would be unprofitable and probably not very practical, a cultural control consisting of adjusting the planting date of wheat in the autumn to avoid the Hessian Fly has been used since about 1900. The planting date of wheat, which is referred to as the "fly-free date" varies in a progressive manner from the southern counties to the northern counties of Michigan. The warmer southern counties have later planting dates than the cool northern counties. A grower in a county south of a grower in a more northern county will probably have a planting date at least one day later than that of the more northern grower. Investigations of the fly-free date for wheat regions in the United States was begun by the United States Department of Agriculture about 1885. In Michigan, investigations of this type appear to have been emphasized by Professor Rufus H. Pettit about 1905. The fly-free dates are published in newspapers and are provided over the radio and by county agents and extension agents. The establishment of the fly-free date in Michigan probably is the most important accomplishment by the Michigan State College Entomology Department.

E. Beekeeping in Michigan

Beekeeping came to the forefront in Michigan in 1868 when Professor Albert John Cook of the Michigan Agricultural College started beekeeping. This instruction was the first of its kind in a college in the United States.[1] After 1873, when "Gleanings in Bee Culture"[2] was established, Professor Cook's frequent contributions about his bee investigations made him well known to American beekeepers.

The most noteworthy of Professor Cook's contributions, to the field of beekeeping were the following:

1. In 1875, he claimed success for the practice of placing packing around bee hives early in the autumn and retaining it until late in the spring for the winter protection of bees.

2. Identification of insects pertaining to the apiary.

3. In 1880, he convinced the United States Postal Officials to lift a ban on shipping live honeybees through the mails. The ban was instigated by poor shipping cages

which allowed bees to escape, and spilled honey which was put in the cages for bee food. Professor Cook, chosen to represent the beekeepers of America, showed postal officials in Washington, D.C. secure bee cages and solid bee candy that would correct the difficulties encountered in handling bees; and bees were re-admitted to the mails.

4. Pointed out the necessity of providing wintered bees with at least 30 pounds of food stores and a uniform winter temperature.

5. Tested honey plants to determine the most desirable ones for honey production.

6. Advised the addition of honey to sugar syrup for its inversion.

7. Bred bees to secure superior stocks.

8. Made analyses of honey to ascertain whether a reliable test could be secured for honey. In a publication on "Honey Analyses",[3] he reported that glucose, which was used to adulterate honey, is easily detected in honey. He also described a method of distinguishing between honeydew and honey adulterated with glucose. This constituted a great contribution to beekeeping because the adulteration of honey continued until 1906 when the Federal Food and Drug Act was passed.

9. Pointed out the danger of poisoning honey bees by spraying trees while they were in bloom.

10. Made tests with sugar syrup and found that bees inverted it to a product similar to honey.

11. Advocated legislation for the control of bee diseases. The first apiary law was passed in 1881, and Professor Cook was quite influential in obtaining this legislation.

Unfortunately, beekeeping in Michigan suffered a severe setback when Professor Cook left the Agricultural College in 1893. The teaching of apiculture and bee research at the College soon ceased and were not resumed until 1914. While Professor Cook was in Michigan, the State had taken a leading role in the field of beekeeping. In 1895, the following statement was made before the Michigan Bee Association: "We have been accustomed to contemplate with the position which our State has held among agricultural communities. It has been her want to be at the front; shall she because a Cook has gone be suffered to lose that position."[4]

Other individuals in Michigan who have done considerable to further beekeeping, or have become noted beekeepers include the following:

1. R. L. Taylor, La Peer.
2. W. Z. Hutchinson-publisher of the Beekeepers Review at Flint.
3. T. F. Bingham-inventor of the Direct Draft Bee Smoker in 1878. Mr. Bingham was a jeweler in Ostego and Alma and a keeper of bees.
4. Lewis C. Woodman.
5. A. G. Woodman.

6. G. Kirkpatrick.
7. Elmer Carroll-publisher of the Beekeepers Magazine at Lansing.
8. Jack Deyeel.
9. Dave Running.
10. Russell H. Kelty.
11. Hubbard Bros.
12. Others-Bartlett, Heddon, Gordon, Jaquays, Coulthard, and Chapman.

The progress of bee disease control in Michigan has been slow. From 1881, when the first apiary inspection law was passed, to 1917, no forceful legislation was available to insure good control of bee diseases. Begining in 1917, laws for the suppression of bee diseases were passed in the following years (the Act No. is appended): 1. 1917 (87); 2. 1921 (13); 3. 1923 (136); 4. 1927 (60); 5. 1935(26); 6. 1937 (86); 7. 1943 (101); 8. 1945 (12); and 1947 (276). Prior to 1921, the inspection of apiaries was directed by the State Board of Agriculture. Since 1921, such work has been directed by the Michigan Department of Agriculture, Division of Apiary Inspection, Lansing.

Up to 1927, bee inspection in Michigan was on an "area clean-up basis". This method consisted of individual counties undertaking bee inspection and eradication work. Before 1921, counties appropriated funds themselves for such activity. After that date, State-appropriated funds were provided. The northern counties of the State were the most interested in eradicating bee diseases. By 1926, the three northernmost tiers of counties in the Lower Peninsula were all making separate efforts to control apiary diseases. In 1927, legislation finally came forth making it mandatory to burn all diseased colonies throughout the State. Such action was prompted by the fact that area cleanups were too slow. Actually the latter had shown that American Foul Brood alone had gained such a foothold in Michigan that some counties had almost 70 percent of their bee colonies infested. Since 1927, except for the depression years of 1931 to 1935 when monetary appropriations were small, intensive state-wide cleanup measures have been taken against bee diseases.

The State Apiary Division renders the following services to beekeepers:

1. Makes regular and special request inspections of apiaries.
2. Makes microscopical examinations of all disease samples submitted.
3. Inspects rented bees that are moved from one locality to another.
4. Inspects apiaries of those who wish to ship honey into states requiring a statement of certification.
5. Administers quarantines where needed.
6. Inspects queen-breeder apiaries.
7. Provides information on a variety of bee problems.

Table VI presents a summary of honey production statistics for Michigan since 1939.

F. Organizations Interested in Entomology

1. Michigan State College Entomology Club. An entomology club was organized at the Michigan State College in December 1940 with a total membership of 23. There were 12 undergraduate students, 4 graduate students, and 7 faculty members. This club suspended activities in 1943 for the duration of World War II and was never reactivated.

2. Detroit Entomological Society.[6] This Society was organized in 1942 and continued until 1951. At its inception, it had 12 charter members, among whom were the following: (1.)George W. Rawson;(2.) George Steyskal;(3.) A. W. Andrews;(4.) John Newman;(5.) W. W. Newcomb;(6.) Wilbur S. Mc Alpine;(7.) Philip E. Moody; and(8.) Arthur Yates.

3. The Detroit Academy of Science.[7] This organization was formed about 1938 through the efforts of H. B. Baker. No other details are available.

4. The Detroit Nature Club.[8] This club was organized many years ago and became inactive a number of years prior to 1938. W. W. Newcomb, Arthur W. Andrews, and Sherman Moore were among the entomologists participating in its activities.

5. Michigan Beekeepers' Association. This association had its origin in 1865 and is yet in existence. Professor Albert John Cook of the Michigan Agricultural College played a large part in its inception. The purpose of this

TABLE VI[5]

MICHIGAN HONEY PRODUCTION STATISTICS SINCE 1939

Year	No. Colonies of Bees (thousands)	Honey Production (1000 ##)	Total No. Beekeepers	Value of Honey (1000 $)
1939	155	11780	----	----
1940	152	10557	----	----
1941	160	10240	----	----
1942	175	7920	----	1156
1943	172	8600	9973	1471
1944	198	6732	9067	1171
1945	198	8910	8727	1746
1946	222	5550	8304	1560
1947	204	7140	8313	1749
1948	173	8650	7871	1280
1949	183	9699	7224	1338
1950	192	9984	7481	1418
1951	184	10120	7364	1417
1952	175	8575	7626	1269
1953				

organization is to advance and protect the interests of bee-keepers both commercially and socially. In 1946 the Association had 581 members.

6. Adrian Scientific Society, Adrian. Organized in 1905.

7. Detroit Scientific Association, Detroit. Organized in 1905.

8. The Detroit Zoological Society.

9. Michigan Academy of Science.

This organization was permanently organized on December 26 and 27, 1894 at Lansing. In 1899, the Legislature provided for the publication of its papers reported at meetings. These are published under the title "The Michigan Academy of Science, Arts, and Letters". Entomological papers are frequently presented at the annual meetings. These are presented in the section on zoology.

Horticultural Societies. The horticultural societies of Michigan warrant mention here for they have been quite influential in promoting entomology in the State. They have continually requested and promoted entomological research, held well organized meetings which have provided excellent places for dispensing insect control information, and have published proceedings of their meetings that have served as a vehicle for the publication of a considerable amount of insect research.

The following is a list of the horticultural societies of Michigan:

a. Michigan State Horticulture Society-organized in 1870

b. Lenawee County Horticulture Society-organized in 1850

c. Kalamazoo County Horticulture Society

d. Antrim-Charlevoix Horticulture Society

e. Leelanau Horticulture Society

f. Benzie-Manistee Horticulture Society

g. Mason County Horticulture Society

h. Oceana County Horticulture Society

i. Berrien County Horticulture Society

j. Ionia-Montcalm Growers

k. Kent-Ottawa Horticulture Society-organized in 1934

l. Southeastern Horticulture Society

m. South Haven-Casco Horticulture Society-organized in 1870.

G. Publishers of Entomological Books

1. Edward Brothers, Inc.
   Ann Arbor

H. Distributors of Entomological Films

1. Cosmopolitan Films
   3248 Gratiot Avenue
   Detroit

2. Educational Film Service
   180 North Union Street
   Battle Creek

SUMMARY AND CONCLUSIONS

Geological evidence indicates that land inhabiting insects first appeared in Michigan about 235 million years ago. The foundations of the scientific study of entomology in Michigan were established in 1837 when the State Legisleture appropriated funds for a State Geological and Biological Survey.

In 1850, the Michigan State Agricultural Society requested the Legislature to establish an agricultural college and recoommended that "insects and their habits" be among the things studied. In 1855, an agricultural college was established at Lansing and its operation began in 1857.

Entomology was first taught at the Michigan Agricultural College in 1858. The first teacher ofentomology at the College was Dr. Henry Goadby. He taught entomology and zoology from a book called "A Textbook of Vegetable and Animal Physiology". The latter had been written by Dr. Goadby upon the request of the Michigan State Superintendent of Public Instruction, and was one of the first of its kind in America designed for instructional purposes. By virture of its teaching entomology in 1858, the Michigan Agricultural College perhaps was the second school in the United

States to teach entomology. (The first was Harvard University, 1832 - 1842, Cambridge, Massachusetts).

In 1863, entomology became a separate course at the College. In 1867, Albert John Cook, who had graduated from the Michigan Agricultural College in 1862 and who was to make magnificent contributions to the field of entomology was appointed to teach entomology at his Alma Mater. Mr. Cook's teaching of entomology is recorded in the literature as a pioneering effort in the teaching of the subject. It appears that heretofore no published record has been made of the fact that the Michigan Agricultural College actually pioneered in the teaching of entomology in 1858. Furthermore, contrary to literature stating that economic entomology was first taught at the Kansas State College, Manhattan, in 1866, this writer believes that such a distinction belongs to the Michigan Agricultural College and at an earlier date. Such a claim for 1863 is warranted by the fact that entomology became a separate course that year and constituted a study of insects injurious to vegetation and their control. Such a claim for 1850 is justified by the fact that entomology lectures and recitations that year were on "noxious animals and insects which infest fields or crops".

By 1891, through the entomological achievements of Professor Cook and excellent study facilities provided for entomology, entomological instruction at the Michigan Agricultural College had gained national recognition. After 1893, when Professor Cook left the College, the entomological status of the College faltered and little was done to enhance the position of entomology until 1906. That year entomology was made a separate department at the College and was placed under the direction of Professor Rufus Pettit. Professor Pettit put new emphasis upon the teaching of systematic and economic entomology and upon the dispensing of insect control information to the residents of Michigan. Since 1906, the Michigan State College Entomology Department (directed by Professor Pettit until 1934 and by Professor Ray Hutson since 1934) has been an immeasurably great factor in the welfare of Michigan.

An assay of the biographies of former students of entomology at the Michigan State College shows that many of these students have performed important activities in entomology or have made excellent contributions to the field of entomology.

Besides the Michigan State College, only twelve other colleges in Michigan appear to have ever offered a course of entomology. One important place of such instruction is the University of Michigan Biological Station, Cheboygan. Since most small schools in Michigan can not afford to employ trained personnel for entomology only, several professionally trained entomologists have become biology department heads or teachers of biology in these small schools.

Organized interest in the collection of insects and other natural objects in Michigan appears to have occurred for the first time in 1837 when a State Geological and

Biological Survey was undertaken by Dr. Douglass Houghton. A Department of Zoology and Botany, directed By Dr. Abram Sager, was a part of the Survey. The first extensive collecting of insects in Michigan by a resident of the State was probably done by Albert John Cook, Professor of Entomology (1867 to 1893) at the Michigan Agricultural College. Messrs. Harvey G. Hubbard and E. A. Schwarz of Detroit were among the first private individuals having no official biological status who collected insects extensively in Michigan. They started collecting about 1874. Numerous collectors of insects in the State have contributed considerable knowledge to the field of entomology.

The Michigan State College Insect Collection, which was started in 1871 by Professor A. J. Cook, presently contains about 91,000 specimens. The insect collection at the University of Michigan Museum of Zoology, Ann Arbor is estimated to contain 2,000,000 specimens.

Co-operative pest survey and control programs, undertaken by various local, State, and Federal organizations, have played an important part in the development and application of entomology in Michigan. Extensive programs have been conducted for the Japanese Beetle, European Corn Borer, grasshoppers, Chinch Bug, Oriental Fruit Moth, forest insects, flies, Rocky Mountain Spotted Fever Tick, and mosquitoes. Attempts to control such pests or to gain more knowledge about them have been very successful.

Considerable emphasis has been placed on forest entomology in Michigan since 1927. Much work in the furtherance of forest entomology in the State was done by employees of the "Emergency Conservation Work Program" and the "Civilian Conservation Corps" between 1933 and 1943. In 1947, forest insect survey and control programs in Michigan and other states were given a much needed impetus by a Federal "Forest Pest Control Act". As a result of this Act, a State Division of Forest Entomology was established in 1950. This Division presently maintains over 600 insect and disease observation areas in the forests of Michigan.

In 1945, as a result of Michigan being one of the first states to have access to DDT for civilian use after World War II, a widely publicized community fly-control program was held on Mackinac Island. The success of this program, which involved both spraying and sanitation measures, induced other communities in the State and other states to undertake such projects.

The first systematic investigation of the chemical control of insects in Michigan was made by Professor A. J. Cook of the Michigan Agricultural College. This study was made with Paris green against the Colorado Potato Beetle in 1868. Professor Cook's discovery, in 1877, of a kerosene oil-soap emulsion which was harmless to foliage marked the beginning of research for contact insecticides. In 1878, Professor Cook conducted what is believed to have been the first recorded experiment in Michigan for the control of the codling moth on apple by chemical sprays. The first successful control of apple scab by chemicals was achieved at the Michigan Agricultural College in 1889 by Professor Levi R. Taft of the Horticulture Department. Hand spray pumps for insecticides were first used in the southwestern Michigan "fruitbelt" about 1890. A factory-built gasoline-powered sprayer was first used in the "fruitbelt" in 1904. The development of spraying and spray equipment since 1883 is depicted by pictures.

Between 1909 and 1920, when the United States Bureau of Entomology and Plant Quarantine, Washington, D.C. was conducting spraying experiments and doing "demonstration" spraying for the control of fruit insects in southwestern Michigan, tests with calcium arsenate at Benton Harbor resulted in the first commercial promotion of that material as an insecticide. Calcium arsenate eventually became important in the South for cotton boll weevil control. Fundamental research on the killing action of contact insecticides and some first trials with nicotine-bentonite, nicotine sulphate, and "dinitro" compounds has been done at the Michigan State College. The recommendation of insect spray dates, answering letters of inquiry about pests, and dispensing information on insects by radio, television, group meetings, and extension workers are some of the public services provided by the Michigan State College Entomology Department.

An account is presented of developments concerning the regulation, sale, and transportation of pest control chemicals in Michigan. The entomological activities of the

Michigan State Bureau of Plant Industry, Lansing, some historical notes about a number of Michigan manufacturers of pesticides and application equipment, and miscellaneous notes on entomology in Michigan are also included in this work.

LITERATURE CITED OR CONSULTED

A. Footnote References

Chapter I.

1. William A. Kelly. Professor of Geology, Michigan State College, East Lansing. Oral communication, November 13, 1953.

2. Helen M. Martin. The Biology of the Past: Prehistoric Life in Michigan. Metropolitan Detroit Science Review 6 (1946), pp. 14-17, cont., 46-47; 7 (1946), pp. 32-35, cont., 43.

Chapter II.

1. Thomas C. Blaisdell, ed. Semi-Centennial Celebration of the Michigan State Agricultural College. East Lansing: Michigan State College, 1908, p. 42.

2. Bela Hubbard. Memorial for a State Agricultural College in Michigan. Transactions of the State Agricultural Society with Reports of County Agricultural Societies for 1850, Lansing: Published by the State, 1851, pp. 56-57.

Chapter III

1. Joseph R. Williams. Report of the President of the Agricultural College. Annual report of the Superintendent of Public Instruction of the State of Michigan with the accompanying Documents for the year 1858. Lansing: Published by the State, 1858, p. 55.

2. John M. Gregory (Secretary of the State Board of Education, ex officio). Twenty-third annual report of the Superintendent of Public Instruction of the State of Michigan for the year 1859. Lansing: Published by the State, 1860, p. 127.

3. New York: D. Appleton and Company, 1858, 313 pp. 450 illus. (partly colored).

4. Robert F. Johnstone, ed. The Agricultural College. The Michigan Farmer. 15 (June 1857), p. 184.

5. William J. Beal. History of the Michigan Agricultural College. East Lansing: Published by the College, 1915, p. 398.

6. Walter B. Barrows. Sketch of Manly Miles. Second Report of the Michigan Academy of Science for the year ending June 30, 1900. Lansing: Published by the State, 1901, p. 103.

7. Anon. Catalogue of the Officers and Students of the State Agricultural College, 1863. Lansing: Published by the State, 1863, p. 17.

8. Ibid, p. 24.

9. Thomas C. Blaisdell, ed. Semi-Centennial Celebration of the Michigan State Agricultural College. East Lansing: Michigan State College, 1908, p. 77.

10. A plaque commemorating this event is on the second floor of Agricultural Hall, Michigan State College, East Lansing.

11. Leland O. Howard. A History of Applied Entomology. Smithsonian Miscellaneous Collection 84. Washington: The Smithsonian Institution, 1930, p. 74.

12. Thaddeus W. Harris. A Treatise on Some of the Insects of New England Which are Injurious to Vegetation. 2nd. ed. Boston: Printed by White and Potter, 1852, 513 pp.

13. Theophilus C. Abbot. Report of the President, State Agricultural College, Michigan, 1866. Catalogue of the Officers and Students of the State Agricultural College, 1866. Lansing: Published by the State, 1866, p. 20.

14. Leland O. Howard, op. cit., p. 73.

15. George A. Dean. The Contribution of Kansas to the Science of Entomology. Transactions of the Kansas Academy of Science. 41 (1938), p. 61.

16. Roger C. Smith. The Courses in Entomology Offered in American Colleges. Kansas State Agricultural College, Manhattan, Kansas, Bulletin. XII (No. 1). 1928, p. 3 cont., 6.

17. Leland O. Howard., op. cit., p. 75.

18. Alpheus S. Packard. Salem, Mass.: Naturalists' Book Agency, 1869, 702 pp.

19. Thomas C. Blaisell, op. cit., p. 77.

20. Henry Valentine Clark. Presbyterian Clergyman, Clearwater, Kansas (student of Professor Cook and an 1878 graduate of the Michigan Agricultural College). Written correspondence, May 23, 1953.

21. Wilbur O. Hedrick. Professor Emeritus of Economics, Michigan State College, East Lansing. Oral communication, August 9, 1953.

22. Albert Baldwin Cook, Senior. Son of Albert John Cook and an 1893 graduate of the Michigan Agricultural College. (A resident of Newport, Michigan). Oral communication, June 4, 1953.

23. Katherine Cook Briggs and Dr. Lyman J. Briggs. Daughter and Son-in-law, respectively, of Albert John Cook, and both 1893 graduates of the Michigan Agricultural College. (Residents of Washington, D.C.) Oral communication, June 6, 1953.

24. Kent L. Pellett. A J. Cook, 1842 to 1916. The American Bee Journal 78(1938) pp. 545-547.

25. Henry Valentine Clark, op. cit.

26. Katherine Cook Briggs and Dr. Lyman J. Briggs, op. cit.

27. Edward A. Chapin. Curator of the Division of Insects, United States National Museum, Smithsonian Institution, Washington 25, D. C. Written correspondence, July 16, 1953.

28. Ernst A. Bessey. Dean Emeritus, School of Graduate Studies, Michigan State College, East Lansing. Oral communication, June 6, 1953.

29. Ernst A. Bessey. Ibid. Oral communication, December 11, 1953.

30. Albert J. Cook. Report of the Professor of Zoology and Entomology. Fifteenth annual report of the Secretary to the State Board of Agriculture of the State of Michigan, for the year ending September 30, 1876. Lansing: Published by the State, 1876, p. 91.

31. Henry Valentine Clark., op. cit.

32. Albert Baldwin Cook, Senior., op. cit.

33. Moses Quimby. New Stereotyped and Illustrated Edition. New York: O. Judd and Company, 1866, 348 pp.

34. Albert J. Cook. Report of the Curator of the General museum. Fifteenth annual report of the Secretary to the State Board of Agriculture of the State of Michigan, for the year ending September 30, 1876. Lansing: Published by the State, 1876, p. 93.

35. Albert J. Cook., op. cit., p. 90.

36. Albert J. Cook. The Apiary. Fourteenth annual report of the Secretary of the State Board of Agriculture of the State of Michigan for the year 1875. Lansing: Published by the State, 1876, pp. 315-359. (three thousand copies of this treatise were sold in 1875 under the title "A Manual of the Apiary"; a 3rd edition, revised, enlarged and mostly rewritten, with 286 pp. was published in 1878 by T. G. Newman and Son, Chicago).

37. __________. Insects Injurious to the Farm, Garden, and Orchard. Thirteenth annual report of the Secretary of the State Board of Agriculture of the State of Michigan for the year 1874. Lansing: Published by the State, 1875, pp. 106-152. (Injurious Insects of Michigan. Lansing, 1875, 48 pp.).

38. John Hunter. London: R. Hardwicke, 1875, 281 pp; 2nd. ed., London: Hardwicke and Bogue, 1876, 339 pp.

39. Alfred Neighbour. London: Kent and Co., 1865, 134 pp.

40. From a personal letter written by Charles Fuller Baker to his father, Joseph S. Baker, on April 21, 1891. This letter was loaned, and permission granted for its use, by Mr. James Stannard Baker, 433 Woodlawn Avenue, Glencoe, Illinois, on June 29, 1953.

41. Albert John Cook. Report of the Department of Zoology and Entomology, Thirty-second annual report of the Secretary of the State Board of Agriculture of the State of Michigan from July 1, 1892 to June 30, 1893. Lansing: Published by the State, 1894, p.36.

42. Albert Baldwin Cook, Senior., op. cit.

43. Katherine Cook Briggs and Lyman J. Briggs., op. cit.

44. Katherine Cook Briggs. Written correspondence, October 29, 1953.

45. Albert Baldwin Cook, Senior. Oral communication, June 4, 1953.

46. The loan of this letter was made by Mr. Albert Baldwin Cook, Junior, of Owosso, Michigan, who kindly permitted this writer to reproduce it.

Chapter IV

1. Ernest A. Bessey. Dean Emeritus, School of Graduate Studies, Michigan State College, East Lansing. Oral communication, June 1, 1953.

2. Walter B. Barrows. Animal Life and Structure. <u>The M.A.C. Record</u> II (No. 21), p. 5, col. 1, June 1, 1897.

3. Jessie A. Pettit. Widow of Rufus H. Pettit, former Professor of Entomology at the Michigan State College, East Lansing. Oral communication, June 24, 1953.

4. Ernst A. Bessey., op. cit.

5. Rufus H. Pettit. Some insects of the year 1897. Michigan Agricultural Experiment Station, East Lansing, Bull. 160, 1898;

   __________. Some insects of the year 1898. Michigan Agricultural Experiment Station, East Lansing, Bull. 175, 1899;

   __________. Some insects of the year 1899. Michigan Agricultural Experimental Station, East Lansing, Bull. 180, 1900;

   __________. Some insects of the year 1901. Michigan Agricultural Experiment Station, East Lansing, Bull. 200, 1902.

6. __________. Insect and animal life on the Upper Peninsula Experiment Station, Michigan Agricultural Experiment Station, East Lansing, Bull. 186, 1900, pp. 28-42.

7. __________. The codling moth in Michigan. Michigan Agricultural Experiment Station, East Lansing, Bull. 222, 1904.

8. Jessie A. Pettit., op. cit.

9. George D. Shafer. Professor Emeritus of Physiology and Entomology, Stanford University, Palo Alto, California. Written correspondence, July 8, 1953.

10. Eugenia I. McDaniel. Former Associate Professor of Entomology (1910-1949) at the Michigan State College, East Lansing. Oral communication, August 11, 1953.

11. George Shafer., op. cit.

12. Kenneth Arbuthnot. In charge of Cereal and Forage Insect Investigations (sub-laboratory of Ankeny, Iowa) for the United States Bureau of Entomology and Plant Quarantine, Department of Entomology, Oklahoma A. and M. College, Stillwater, and former instructor of entomology (1926-1928) at the Michigan State College. Written correspondence, February 5, 1953.

13. John H. Comstock and Anna (Botsford)Comstock. An Introduction to Entomology. Ithaca, New York: Published by the Authors, 1888, 234 pp.

14. Jessie A. Pettit., op. cit.

15. Louis C. Plant. Professor Emeritus of Mathematics, Michigan State College, East Lansing. Oral communication, June 29, 1953.

16. E. I. McDaniel. Rufus Hiram Pettit, 1869-1946. Journal of Economic Entomology 39 (August 1946), p. 554.

17. R. C. Lott. County Agricultural Agent of Genesse County, Michigan, Courthouse, Flint 3, Michigan. Written correspondence, January 18, 1954.

18. A. D. Morley. County Agricultural Agent of Allegan County, Michigan, Courthouse, Allegan, Michigan. Written correspondence, April 1, 1954.

Chapter V

1. Irving R. Wyeth. A Study of the Agricultural Graduates of Michigan State College. Unpublished Master of Science Degree Thesis. Michigan State College, East Lansing, 1953, p. 26 and p. 28.

Chapter VI

1. Harry Hansen. "American Colleges and Universities". The World Almanac and Book of Facts for 1952. New York: The New York World-Telegram and The Sun, 1952, pp. 554-573.

2. Luther S. West. Head of the Department of Biology, Northern Michigan College of Education, Marquette. Written correspondence, November 12, 1953.

3. Samuel A. Graham. Principles of Forest Entomology. New York: McGraw-Hill Book Company, Inc., 1929, 339 pp.

4. ________. Forest Entomology, 3rd. ed., New York: McGraw-Hill Book Company, Inc., 1952, 351 pp.

5. This summary was provided by Herbert B. Hungerford, Professor of Entomology, University of Kansas, Lawrence. Written correspondence, December 11, 1953. Professor Hungerford has taught entomology at the University of Michigan Biological Station since 1923.

6. Written correspondence with registrars and other faculty members of Michigan colleges, 1953.

7. William J. Gilbert. Associate Professor of Biology, Albion College, Albion, Michigan. Oral communication, August 12, 1953.

8. Ibid.

9. L. P. Coonen. Chairman of the Biology Department University of Detroit, Detroit, Michigan. Written correspondence, November 17, 1953.

10. C. M. Loesell. Head of the Natural Science Department, Michigan State Normal College, Ypsilanti. Written correspondence, October 12, 1953.

Chapter VII

1. E.O. Essig. A History of Entomology. New York: The MacMillan Company, 1931, pp. 578-581.

2. Ibid, p. 432.

3. The National Cyclopaedia of American Biography Vol XIII. New York: James T. White and Company, 1906, p. 407.

4. Herbert Osborn. Fragments of Entomological History. Columbus, Ohio: Published by the Author, 1937, p. 262.

5. Ibid, pp. 106-107.

6. J. M. Cattell (ed). American Men of Science. 2nd ed. New York: The Science Press, 1910, p. 475.

7. Ibid, p. 268.

8. J. M. Cattell and Dean R. Brimhall (eds.). American Men of Science. 3rd ed. New York: The Science Press, 1921, p. 146.

9. The National Cyclopaedia of American Biography. Current Volume A. New York: James T. White and Company, 1930.

10. Washington, D.C.: Smithsonian Institution, 680 pp.

11. J. M. Cattell (ed.) American Men of Science. 1st ed. New York: The Science Press, 1906, p. 339.

12. The National Cyclopaedia of American Biography. Vol. XXXIV. New York: James T. White and Company, 1948, p. 196.

13. E. O. Essig., op. cit., pp. 542-548.

14. Anon. Charles Fuller Baker (Obituary). Entomological News 38 (1927), pp. 261-262.

15. Various authors. In Memoriam, Charles Fuller Baker, 1872-1927. The Philippine Agriculturist 16, Special Number, 1928. (University of the Philippines Publications, Series A).

16. E. O. Essig. Charles Fuller Baker (Obituary). Journal of Economic Entomology 20 (1927), p. 750.

17. R. A. Cushman. The Charles Fuller Baker Collection. The Philippine Agriculturist 16, Special Number, 1928, p. 39. (University of the Philippines Publications, Series A).

Chapter VIII

1. Charles S. Wheeler. The Early Flora and Fauna of Michigan. Michigan Pioneer and Historical Society Collections. 32 (1903), p. 355.

2. Jonathan Carver. Travels Through the Interior Parts of North American in the Years 1766, 1767, and 1768. London: Printed for the Author, 1778, 543 pp.

3. Alexander Henry. Travels and Adventures in Canada and the Indian Territories Between the Years 1760 and 1768. In two parts. New York: Printed and Published by I. Riley, 1809, 330 pp.

4. John R. Forster (Translator and editor). Travels into North America by Peter Kalm (3 volumes). London: Printed for the Editor, 1770-1771, vol. 1 (400 pp), vol. 2 (352 pp.), vol. 3 (310 pp).

5. Isaac Weld. Travels Through the States of North America, and the Provinces of Upper and Lower Canada, During the Years 1795, 1796, and 1797. London: J. Stockdale, 1799, 464 pp.

6. John L. LeConte. (ed). The Complete Writings of Thomas Say on the Entomology of North America. New York: Bailliere Brothers, 1859, II, p. 374.

7. __________. The Complete Writings of Thomas Say on the Entomology of North America. New York: Bailliere Brothers, 1859, I, p. 245.

8. Ibid, p. 249.

9. Dumas Malone. "Thomas Say". Dictionary of American Biography. vol. XVI. New York: Charles Scribner's Sons, 1935, p. 401.

10. Helen M. Martin. A Hundred Years of Geological Survey in Michigan. Michigan Conservation. 7 (August-September 1937). p. 3.

11. Jean Louis Rodolphe Agassiz. Lake Superior, Its Physical Character, Vegetation, and Animals. Boston: Gould, Kendall, and Lincoln, 1850, 428 pp.

12. "General Remarks Upon the Coleoptera of Lake Superior."

13. Charles C. Adams. "The Coleoptera of Isle Royale, Lake Superior, and Their Relation to the North American Centers of Dispersion." An Ecological Survey of Isle Royale, Lake Superior. Report of the Board of Geological Survey for 1908. Lansing: Published by the State, 1908, pp. 157-215.

14. John B. Smith. Entomology and Entomological Collections in the United States. Entomologica Americana. 4 (1888), p. 106.

15. Ibid.

16. Robert R. Driesbach. Chemist, Dow Chemical Company, Midland, Michigan. Written correspondence, September 10, 1953.

17. Ibid.

18. Eugenia McDaniel. Former Associate Professor of Entomology at the Michigan State College, East Lansing. Oral communication, August 11, 1953.

19. - 21. Ibid.

22. J. Speed Rogers. Director of the University of Michigan Museum of Zoology, Ann Arbor, Michigan. Written correspondence, November 18, 1953.

23. Frank L. DuMond. Director of the Grand Rapids Public Museum, Grand Rapids, Michigan. Written correspondence. October 5, 1953.

Chapter IX

1. Order Coleoptera, Family, Scarabaeidae.

2. Cyrus A. Boyer. Summary of the Japanese Beetle Control Program for the Season of 1952. Inter-Office Communication of the Bureau of Plant Industry, Michigan State Department of Agriculture, Lansing, January 5, 1953, 3pp.

3. _________. Summary of the Japanese Beetle Control Program for the Season of 1953. Inter-Office Communication of the Bureau of Plant Industry, Michigan State Department of Agriculture, Lansing, January 5, 1954.

4. Ibid, p. 1.

5. Details of construction can be found in: Frederick W. Metzger. Trapping the Japanese Beetle. United States Department of Agriculture, Washington, Misc. Publ. 147. 1932.

6. Cyrus A. Boyer. Summary of the Japanese Beetle Control Program for the Seasons of 1950, 1952, and 1953. Inter-Office Communications of the Bureau of Plant Industry, Michigan State Department of Agriculture, Lansing.

7. C. L. Marlatt. Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1932. U. S. Gov. Printing Office, Washington, D. C., Sept. 30, 1932, p. 8.

8. Lee A. Strong. Report of the Entomologist, for the Fiscal Year Ended June 30, 1936. United States Gov. Printing Office, Washington, D.C., September 15, 1936, p. 16.

9. Adapted from Tables Occurring:
(a) Paul N. Annand. Japanese Beetle Trapping and Control Operations in 1942. United States Government Printing Office, Washington, D.C., December 21, 1942, 15 pp.

(b) __________. Report of Japanese Beetle Scout Inspection Outside Federal Regulated Areas, Positive Results, 1943-1947. United States Government Printing Office, Washington, D.C., 3 pp.

(c) Reports of Japanese Beetle Surveys and Control Programs in Michigan (1950 to 1954), provided by C. A. Boyer, Chief of the Michigan State Bureau of Plant Industry, Lansing. January 5, 1954.

10. Lee A. Strong. Report of the Entomologist, for the Fiscal Year Ended June 30, 1938. United States Government Printing Office, September 26, 1938, p. 7.

11. __________. Report of the Entomoligist, for the Fiscal Year Ended June 30, 1936. United States Government Printing Office, Washington, D.C., September 15, 1936, pp. 16-17.

12. Ibid, p. 18.

13. Lee A. Strong. Report of the Entomologist, for the Fiscal Year Ended June 30, 1935. United States Government Printing Office, Washigton, D.C., September 16, 1935, p. 19.

14. Paul N. Annand. Report of the Chief of the Bureau of Entomology and Plant Quarantine, for the Fiscal Year Ended June 30, 1944. United States Government Printing Office, Washington, D.C., September 15, 1944.

15. Excluding the Years 1948 and 1949. No records are available for these years. The Michigan State Bureau of Plant Industry files are incomplete due to a fire in 1951.

16. Paul N. Annand. Report of the Chief of the Bureau of Entomology and Plant Quarantine, for the Fiscal Year Ended June 30, 1945. United States Government Printing Office, Washington, D.C., September 15, 1945, p. 25.

17. Order Lepidoptera, Family, Pyralididae.

18. Leland O. Howard. Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1922. United States Government Printing Office, Washington, D.C., August 22, 1922, pp. 8-9.

19. Ibid.

20. Leland O. Howard. Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1925. United States Government Printing Office, Washington, D.C., September 20, 1925, p. 11.

21. Quarantine Number 126.

22. L. Whitney Watkins. Rules and Regulations Governing the Control and Spread of the European Corn Borer. Mimeograph, Bureau of Agricultural Industry, Michigan State Department of Agriculture, July 27, 1925, p. 1.

23. Walter F. Morofsky. Professor of Entomology at the Michigan State College, East Lansing. Oral communication, December 18, 1953.

24. Leland O. Howard, Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1927. United States Government Printing Office, Washington, D.C., September 1, 1927, pp. 12-13.

25. - 29. Ibid.

30. Lee A. Strong. Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1936, United States Government Printing Office, Washington, D.C., September 15, 1936.

31. Avery S. Hoyt. Report of the Chief of the Bureau of Entomology and Plant Quarantine, for the Fiscal Year Ended June 30, 1952. United States Government Printing Office, Washington, D.C., September 15, 1952.

32. J. R. Parker. Grasshopper Outbreaks During the Last 100 Years. Mimeographed report written for a conference of grasshopper control leaders in 1940. Unpublished. United States Bureau of Entomology and Plant Quarantine, Bozeman, Montana, p. 1.

33. Ibid, p. 4.

34. R. L. Shotwell. Species and Distribution of Grasshoppers Responsible for Recent Outbreaks. _Journal of Economic Entomology_ 31 (Oct. 1938), pp. 602-610.

35. Claude Wakeland. Grasshopper Control. _Agricultural Chemicals_ 1 (Aug. 1946), p. 16.

36. Lee A. Strong. Report of the Chief of the Bureau of Entomology, for the Fiscal Year Ended June 30, 1934. United States Government Printing Office, Washington, D.C., August 31, 1934, p. 7.

37. Ibid.

38. This table was supplied by Dr. Claude Wakeland, Entomologist (Grasshopper Control Project) of the United States Bureau of Entomology and Plant Quarantine, Denver, Colorado.

39. Order Hemiptera, Family, Lygaeidae.

40. Claude Wakeland. Entomologist, Grasshopper Control Project, United States Bureau of Entomology and Plant Quarantine, Denver, Colorado. Written correspondence, August 19, 1953.

41. Order Lepidoptera, Family Olethreutidae.

42. Ray Hutson. Michigan State College Entomology Department Correspondence with Stanly E. Slater, Moorestown, New Jersey, June 26, 1939.

43. Ibid.

44. H. W. Allen. Entomologist in charge of the Oriental Fruit Moth Investigations Laboratory, Bureau of Entomology and Plant Quarantine, Moorestown, New Jersey. Written correspondence, September 24, 1953.

45. Ibid.

46. H. W. Allen, and others. Importation, Rearing, and Colonization of Parasites of the Oriental Fruit Moth. United States Department of Agriculture, Washington, Circular 561, (June 1940), p. 36.

47. Ibid, pp. 31-44.

48. H. W. Allen. Entomologist in charge of the Oriental Fruit Moth Investigations Laboratory, United States Bureau of Entomology and Plant Quarantine, Moorestown, New Jersey. Written correspondence, September 24, 1953.

49. Ibid.

50. Walter F. Morofsky. Professor of Entomology, Michigan State College, East Lansing. Oral communication, December 18, 1953.

51. Ibid.

52. Samuel A. Graham. Professor of Economic Zoology, University of Michigan, Ann Arbor. Written correspondence, November 23, 1953.

53. - 54. Ibid.

55. H. J. Mac Aloney. Entomologist in charge, United States Bureau of Entomology and Plant Quarantine Forest Insect Laboratory, Milwaukee, Wisconsin. Written correspondence, August 24, 1953.

56. Walter F. Morofsky. Professor of Entomology, Michigan State College, East Lansing. Oral communication, December 18, 1953.

57. From annual reports on Insect Control (S, R-9) to the Chief Forester in Washington, D.C., prepared by Directors of the Forest Insect Laboratory, United States Bureau of Entomology and Plant Quarantine, Milwaukee, Wisconsin, 1934 to 1953, unpublished.

58. Forest Pest Control Act. 61st. Statute, 80th. Congress, 1st Session, Chapter 141, June 25, 1947 (S.597), Public Law 110. United States Statutes at Large, Vol. 61, Part I. United States Government Printing Office, Washington, 1948, p. 177.

59. Digest of the 1952 Conference on Forest Insect Surveys in the Lake States. Mimeographed Reports from the Forest Insect Laboratory, United States Bureau of Entomology and Plant Quarantine, Milwaukee, Wisconsin, Unpublished, p.1.

60. Ibid.

61. Herman L. King. Associate Professor of Entomology, Michigan State College, East Lansing, Michigan. Written correspondence February 22, 1954.

62. From numerous newspaper articles and letters of correspondence between the Michigan State Department of Public Health, Lansing, and the United States Public Health Service at Chicago, Illinois and Atlanta, Georgia, and the Michigan Chemical Corporation, St. Louis, Michigan, 1945. This material was loaned to this writer by Mr. LaRue L. Miller, Chief of the Section of Environmental Sanitation, Division of Engineering, Michigan State Department of Public Health, September 11, 1953.

63. Summarized from numerous letters of correspondence between the Muskegon County Department of Public Health, Muskegon, the Michigan State Department of Public Health, Lansing, and the United States Public Health Service at Chicago, Illinois and Atlanta, Georgia, 1948, 1949, and 1950. These letters were loaned to this writer by Mr. LaRue L. Miller, Chief of the Section of Environmental Sanitation, Division of Engineering, Michigan State Department of Public Health, September 11, 1953.

64. Class Arachnida, Order Acarina, Family Ixodidae.

65. Summarized from an unpublished compilation of data concerning Rocky Mountain Spotted Fever in Michigan. This data was compiled by Mr. Robert W. Menges of the Division of Veterinary Public Health, United States Public Health Service, and was sent as written correspondence, from the Hixon Memorial Laboratory, University of Kansas Medical Center, Kansas City, Kansas, to Dr. Fred S. Leeder of the Michigan State Department of Public Health, Lansing, August 9, 1949, 24 pp., 5 tb., and 17 references. The data compiled by Mr. Menges was from the files of the Michigan State Department of Public Health. Mr. Menges was formerly assigned to the Division of Disease Control, Records and Statistics in the Michigan State Department of Public Health. The unpublished data on Rocky Mountain Spotted Fever in Michigan was loaned to this writer by Dr. Leeder on July 15, 1953.

66. Curtis W. Sabrosky. Occurrence of Malaria Mosquitoes in Southern Michigan. Michigan Agricultural Experiment Station, East Lansing, Technical Bulletin 202, 1946.

67. Alexander MacVittie. Notes on the Mosquito Survey in Michigan. Metropolitan Detroit Science Review 6 (December 1945), pp. 14-15, cont., p. 46.

68. Ibid.

69. Calvin E. Pederson. The Distribution of Michigan Mosquitoes. Unpublished Master of Science Degree Thesis. Michigan State College, East Lansing, 1947. 34 numb. leaves, 48 maps.

70. Fred S. Leeder. Michigan State Department of Public Health, Lansing. Oral communication, August 9, 1953.

Chapter X

1. Albert John Cook. "Remarks on Some Insects Injurious to Vegetation in Michigan." Seventh annual report of the Secretary of the State Board of Agriculture of the State of Michigan for the Year 1868. Lansing: Published by the State, 1868, p. 166.

2. H. L. Haller and Ruth L. Busbey. The Chemistry of DDT. Yearbook of Agriculture, 1943-1947. Science in Farming. United States Department of Agriculture, Washington, 1947, p. 616.

3. Albert Baldwin Cook, Senior. Son of Professor Albert John Cook and an 1893 graduate of the Michigan Agricultural College. (A resident of Newport, Michigan). Written correspondence, August 19, 1953.

4. Justus Gage. "The Colorado Potato Beetle."Eighth annual report of the Secretary of the State Board of Agriculture of the State of Michigan, for the year 1869. Lansing: Published by the State, 1869, p. 118

5. Albert John Cook. "Insects Injurious to the Farm. Garden, and Orchard." Thirteenth annual report of the Secretary of the State Board of Agriculture of the State of Michigan, for the year 1874. Lansing: Published by the State, 1875, p. 108.

6. __________. "Fruit or Insects - Which? Fourteenth annual report of the Secretary of the State Board of Agriculture of the State of Michigan, for the year 1875. Lansing: Published by the State, 1876, pp. 91-92.

7. __________. Insecticides. Michigan Agricultural Experiment Station, East Lansing, Bul. 58, 1890, p. 5.

8. Ernest G. Lodeman. The Spraying of Plants. New York. The MacMillan Company, 1916, p. 18.

9. Clarence M. Weed. Spraying Crops - Why, When, and How. New York: The Rural Publishing Company, 1892, preface.

10. Albert John Cook. The Codling Moth and bark louse. Michigan Agricultural Experiment Station, East Lansing. Bul. 14, 1886.

11. Roland B. Collis. Spraying and Dusting Equipment Dealer at Benton Harbor, Michigan, and former salesman for the Hardie Spray Pump Company, Hudson, Michigan. Written correspondence, July 17, 1953.

12. Ibid.

13. Charles F. Faker. Quoted from a letter written by Charles F. Baker to his father, Joseph S. Baker on April 21, 1891. This letter was loaned to the writer of this thesis by Mr. James S. Baker, nephew of Charles F. Baker, 433 Woodlawn Avenue, Glencoe, Illinois, July 14, 1953.

14. L. O. Howard. Fighting the Insects. New York: The MacMillan Company, 1933, p. 30.

15. Ibid, pp. 29-32.

16. Albert Baldwin Cook, Senior. Son of Professor Albert John Cook and an 1893 graduate of the Michigan Agricultural College. (A resident of Newport, Michigan). Oral communication, June 4, 1953.

17. Ernest G. Lodeman. The Spraying of Plants. New York: The MacMillan Company, 1916, pp. 65-67.

18. Albert John Cook and Gager C. Davis. Kerosene Emulsion, Some new insects. Michigan Agricultural Experiment Station, East Lansing, Bul. 73, 1891, pp. 4-6.

19. Ernest G. Lodeman. The Spraying of Plants. New York: The MacMillan Company, 1916, p. 68.

20. Ibid, p. 76.

21. Ibid, p. 105.

22. Gager C. Davis. Insects injurious to fruits. Michigan Agricultural Experiment Station, East Lansing, Special Bul. 4a, Part II, 1896, p. 65.

23. Andrew S. Wing. He Planted Fruit and Reaped Honor. The Country Home Magazine 60 (April 1936), p. 26.

24. Levi R. Taft. Report on the experiments made in 1889 in the treatment of apple scab in Michigan. Michigan Agricultural Experiment Station, East Lansing. Bul. 59, Part II, 1890, pp. 30-31.

25. Michigan Agricultural Experiment Station, East Lansing, Bulletin 121, pp. 558-559.

26. Roland B. Collis., op. cit.

Chapter XI

1. Jerry Krieger. Area's 'Mr. Sprayer' Retires. The News-Palladium. Benton Harbor, Michigan: The Palladium Publishing Company. Vol. 68, No. 25, January 30, 1953.

2. Roland B. Collis. Spraying and Dusting Equipment Dealer, The R. B. Collis Company, Route M-139, Benton Harbor, Michigan. Written correspondence, July 17, 1953.

3. - 9. Ibid.

10. F. C. Strong and E. J. Rasmussen. Airplane Dusting for the Control of Orchard Fruit Diseases. Seventy-fourth annual report of the Secretary of the State Horticultural Society of Michigan for the year 1944. Lansing: Published by the State, 1945, pp. 53-59.

11. Anon. First Helicopter Dusting in Michigan. Lansing State Journal. Vol. 91(No. 180), Oct. 26, 1945, pp. 1-2

12. Earl R. Van Leeuwen. Entomologist for the United States Bureau of Entomology and Plant Quarantine, Beltsville Research Center, Beltsville, Maryland, and former summer assistant at the Bureau of Entomology Field Station at Douglas, Michigan. Written correspondence, August 27, 1953.

13. A. G. Hammar, Life history studies on the codling moth in Michigan. United States Bureau of Entomology, Bul. 115, Part 1, 1912.

14. Earl R. Van Leeuwen, op. cit.

15 - 17. Ibid.

18. David G. Hall. In charge of the Division of Information, United States Bureau of Entomology and Plant Quarantine, Washington, D.C., Written correspondence, August 10, 1953.

19. Ibid.

20. E. H. Siegler. Entomologist for the Japanese Beetle Investigations Laboratory, United States Bureau of Entomology and Plant Quarantine, Moorestown, New Jersey. Written correspondence, August 19, 1953.

21. E. W. Scott and E. H. Siegler. Miscellaneous insecticide investigations. United States Bureau of Entomology, Bul. 278, 1915, p. 1.

22. Ibid.

23. Ibid, p. 43

24. E. H. Siegler, op. cit.

25. Ibid.

26. F. B. Herbert and M. D. Leonard. Observations on the Oil-Nicotine Combination for the Control of the Codling Moth and Other Apple Insects in the Pacific Northwest. Journal of Economic Entomology 22 (Feb. 1929), p. 72.

27. L. O. Howard. Report of the Entomologist, for the fiscal year ended September 19, 1918. Annual reports of the Department of Agriculture for the fiscal year ended June 30, 1918. United States Government Printing Office, Washington, 1919, p. 235.

28. __________. Report of the Entomologist, for the fiscal year ended June 30, 1905. Annual reports of the Department of Agriculture for the fiscal year ended June 30, 1905. United States Government Printing Office, Washington, 1905, p. 290.

29. __________. Report of the Entomologist for the fiscal year ended June 30, 1916. Annual reports of the Department of Agriculture for the fiscal year ended June 30, 1916. United States Government Printing Office, Washington, 1917, p. 230.

30. Ibid, p. 231.

31. George D. Shafer. How Contact Insecticides Kill. Michigan Agricultural Experiment Station, East Lansing, Tech. Bull. 11, 1911.

32. __________ Ibid, Tech. Bull. 21, 1915.

33. Charles Chandler Taylor. Owner and manager of the Ne-Hu-Bar Farm, Albion, Michigan, and former entomologist, field manager, and advertising manager (1909-1920 and 1922-1935) for the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky. Oral communication, July 13, 1953.

34. Ray Hutson. Professor of Entomology, Michigan State College, East Lansing, Michigan. Oral communication, April 8, 1954.

35. Walter S. Hough and A. Freeman Mason. <u>Spraying, Dusting and Fumigating of Plants</u>. rev. ed. New York: The MacMillan Company, 1951, p. 10.

36. Harold H. Shepherd. <u>The Chemistry and Action of Insecticides.</u> New York: McGraw-Hill Book Company, Inc., 1951, pp. 282-283.

37. Order Diptera, Family Trypetidae.

38. Rufus H. Pettit. "Entomology Extension Report." Sixty-sixth annual report of the Secretary of the State Board of Agriculture of the State of Michigan and the thirty-ninth annual report of the Experiment Station from July 1, 1926 to June 30, 1927. Lansing: Published by the State, 1928, p. 244.

39. From annual reports on the cherry fruit fly activities conducted by the Michigan State Bureau of Plant Industry, Lansing, 1929-1953. Mimeographs on file in the office of the Michigan State Bureau of Plant Industry.

40. This data was obtained from the files of the Michigan State College Department of Entomology. Permission for the use of such files was granted by Ray Hutson, Professor of Entomology and Head of the Entomology Department.

41. Rufus H. Pettit. Control of cherry fruit fly. Michigan Agricultural Experiment Station, East Lansing, Cir. Bull. 86, 1926, pp. 5-8.

42. This data was obtained from the files of the Michigan State College Department of Entomology.

43. Ibid.

44. Order Diptera, Family Trypetidae.

45. This data was obtained from the files of the Michigan State College Department of Entomology.

46. Ray L. Janes and E. C. Martin. 1953 Annual report for the extension project in entomology. Statistical summary of extension activities in insect control work in Michigan, December 1, 1952 through November 30, 1953. An unpublished manuscript, p. 22. This manuscript was loaned to this writer by the Michigan State College Department of Entomology.

47. Ibid.

48. The insects and related pests in this table are listed according to the arrangement of "The Subclasses and Orders of the Hexapoda" occurring in the publication "An Introduction to Entomology" by John Henry Comstock, 9th. rev. ed., Comstock Publishing Company, Inc., Ithaca, New York, 1947, p. 211.

49. Ray L. Janes and E. C. Martin., loc. cit.

50. Anon. History of co-operative extension work in Michigan, 1914-1939. Michigan Agricultural Experiment Station, East Lansing, Ext. Bull. 229, 1941, p. 58.

51. Ibid.

52. Ibid. pp. 58-59.

53. E. C. Martin. Extension Apiculturist, Michigan State College, East Lansing. Oral communication, February 15, 1954.

54. Anon. History of cooperative extension work in Michigan, 1914-1939. Michigan Agricultural Experiment Station, East Lansing, Ext. Bull. 229, 1941, p. 59.

55. Ibid.

56. Ibid, p. 61.

57. Ibid, summary of "Insect Control", pp. 61-64.

58. Ray L. Janes and E. C. Martin.,op. cit., pp. 22-23.

59. Ibid, p. 64.

60. Ray L. Janes and E. C. Martin., op. cit., p. 22.

61. Ibid.

62. Importance of the Extension Organization in Dissemination of Entomological Information. A mimeograph distributed by the United States Bureau of Entomology and Plant Quarantine, Washington, D.C.

63. Ibid.

64. Charles Chandler Taylor. Owner and manager of the Ne-Ru-Bar Farm, Albion, Michigan, and former entomologist, field manager, and advertising manager (1909-1920 and 1922-1935) for the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky. Oral communication, July 13, 1953.

65. Ibid.

66. Order Homoptera, Family Chermidae.

67. Charles Chandler Taylor., op. cit.

68. Horace A. Cardinell. Associate Professor of Horticulture, Michigan State College, East Lansing. (On leave of absence and serving with the United States Technical Cooperation Administration at the Instituto Agronomico do Sol, Pelotas, Rio Grande do Sol, Brazil, South America). Written correspondence, September 21, 1953.

69. Order Homoptera, Family Aphididae

70. Ibid.

71. Charles Chandler Taylor., op. cit.

72. - 77. Ibid.

78. Horace A. Cardinell., op. cit.

79. - 86. Ibid.

87. Charles Chandler Taylor., op. cit.

88. - 92. Ibid.

93. Ray Hutson. Professor of Entomology, Michigan State College, East Lansing. Oral communication, July 10, 1953.

94. Jessie A. Pettit. Widow of Rufus H. Pettit, former Professor of Entomology at the Michigan State College, (1906-1934). East Lansing. Oral communication, June 24, 1953.

95. J. H. Muncie and W. F. Morofsky. Results of spraying and dusting trials with fungicides and insecticides on potatoes, 1938-45. Michigan Agricultural Experiment Station, East Lansing, Tech. Bull. 204, 1947.

96. Crop Report for Michigan, January-February, 1946. Annual Crop and Livestock Summary. Michigan Department of Agriculture, Lansing, p. 28.

97. Crop Reports for Michigan, 1946-1953. Michigan Department of Agriculture, Lansing.

98. George C. Decker. Insects in the Economic Future of Man. Agricultural Chemicals 9 (Feb. 1954). pp. 38-39, cont., 111

99. Eugene F. Sharkoff, and others. The Compiled Laws of the State of Michigan II. Ann Arbor: Published by the State 1948, p. 5088.

100. Wilber M. Brucker. The Compiled Laws of the State of Michigan, 1929. Lansing: Published by the State, 1930, p. 1965.

101. W.C. Geagley. State Chemist, Bureau of Chemistry Laboratories, Michigan Department of Agriculture, Lansing. Oral communication, February 18, 1954.

102. Anon. History of cooperative extension work in Michigan, 1914-1939. Michigan Agricultural Experiment Station, East Lansing, Ext. Bull. 229, 1941, p. 64.

103. George C. Decker., op. cit., p. 113.

104. Ray Hurley. United States Bureau of the Census. United States Census of Agriculture: 1950. I. Counties and State Economic Areas, Part 6, Michigan. United States Government Printing Office, Washington, 1952, pp. 3 and 5.

105. Data on the history of the Wolverine Pest Control Association, Inc., was provided this writer by Mr. J. A. Watkins, Secretary-Treasurer of the Wolverine Pest Control Association. Written correspondence, August 15, 1953.

106. Data on the history of the Michigan Pest Control Association, Inc., was provided this writer by Mrs. Edward Van Core, wife of Edward Van Core, present Secretary-Treasurer of the Michigan Pest Control Association, Inc., Oral correspondence, April 27, 1954.

Chapter XII

1. Summarized from various reports on entomological activities issued by the Michigan Bureau of Plant Industry, Lansing 1929-1953.

2. C. A. Boyer. The Cherry Fruit Fly Control Project, 1944, and Accumulative Cherry Fruit Fly Data from 1931 to 1944, inclusive. Report issued by the Michigan Bureau of Plant Industry, Lansing, 1944, unpublished, no pagination.

3. __________. The Cherry Fruit Fly Control Project, 1949 and Accumulative Cherry Fruit Fly Data from 1939 to 1949, inclusive. Report issued by the Michigan Bureau of Plant Industry, Lansing, 1949, unpublished, no pagination.

Chapter XIII

1. M. R. Bailey. General Sales Manager of the American-Marsh Pump Company, Battle Creek, Michigan. Written correspondence, November 6, 1953.

2. L. O. Howard. The use of Steam Apparatus for Spraying. Yearbook of the United States Department of Agriculture, 1896. U. S. Gov. Printing Office, Washington, 1897, pp. 71-72.

3. Don C. Stewart. Executive Secretary of the Benton Harbor Chamber of Commerce, Benton Harbor, Michigan. Written correspondence, September 14, 1953.

4. Ernest G. Lodeman. The Spraying of Plants. New York: The MacMillan Company, 1916, p. 192.

5. J. C. Armstrong. Salesmanager of the Universal Metal Products Company, Saranac, Michigan. Written correspondence, September 30, 1953.

6. Vincent Santarelli. Manager and Owner of the Champion Sprayer Company, Detroit, Michigan. Written correspondence, September 15, 1953.

7. W. E. Richwine. Treasurer of the Universal Stamping and Machine Company, Plymouth, Michigan.

8. Richard S. Clarage. Acmeline Manufacturing Company, Traverse City, Michigan. Written correspondence, October 8 , 1953.

9. W. Lyle Palmer. President of the Hardie Manufacturing Company, Hudson, Michigan. Written correspondence, October 30, 1953.

10. Levi R. Taft. When and what to spray. Michigan Agricultural Experiment Station, East Lansing, Special Spraying Bulletin, 1895, p. 3.

11. Ibid.

12. Ernest G. Lodeman., op.cit.

13. David G. Knox. President of the Junior Chamber of Commerce, Hudson, Michigan. Written correspondence, October 28, 1953.

14. John D. Crummey. Chairman of the Food Machinery and Chemical Corporation (of which the John Bean Manufacturing Company, Lansing is a division) and grandson of John Bean. Written correspondence, July 24, 1953.

15. - 17. Ibid.

18. Walter S. Hough and A Freeman Mason. Spraying, Dusting and Fumigating of Plants. New York: The MacMillan Company, 1951, p. 13.

19. Arthur R. Lauder. Lansing Unlimited. New York: American Book-Stratford Press, Inc., 1947, p. 186.

20. - 22. John D. Crummey., op. cit.

23. Arthur R. Lauder., op. cit., pp. 100-104.

24. Frank T. Parmelee Sales Manager of the E-Z Flo Chemical Company, Lansing, Michigan. Oral correspondence, August 6, 1953.

25. Albert E. Deline. Technical Service Department, Michigan Chemical Corporation, St. Louis, Michigan. Written correspondence, October 1, 1953.

26. Thomas J. Page. Public Relations Department, Dow Chemical Company, Midland, Michigan. Written correspondence, September 23, 1953.

27. Owen R. Thorpe, Manager of Information Service, California Spray-Chemical Corporation, Richmond, California. Written correspondence, September 10, 1953.

28. N. H. Battjes. Secretary of the Tanglefoot Company, Grand Rapids, Michigan. Written correspondence, October 9, 1953.

29. Permanent catalog of the Parsons Chemical Works, Grand Ledge, Michigan, 1953.

Chapter XIV

1. Kent L. Pellett. A. J. Cook, 1842-1916. The American Bee Journal (1938), p. 545.

2. A bee journal published by the A. I. Root and Company, Medina, Ohio. This journal is still published.

3. Bulletin 96, Michigan Agricultural Experiment Station East Lansing, 1893.

4. R. L. Taylor. Work at Michigan's Experimental Apiary. The Beekeepers Review 8 (1895), p. 6.

5. From the files of the Michigan Department of Agriculture, Division of Apiary Inspection, and summarized records of the Michigan Department of Agriculture, Bureau of Agricultural Statistics.

6. George Steyskal. Entomologist, Grosse Ile, Michigan. Written correspondence, September 18, 1953.

7. - 8. Ibid.

B. General References

Anon
1864 Dr. Henry Goadby Dies. The Milwaukee Sentinel Vol. 21, p. 1, col. 8, April 2.

Anon
1876 Review of Cook's Manual of the Apiary. The American Naturalist 10, pp. 621-622.

Anon
1953 The Kellogg Gull Lake Biological Station of Michigan State College. News Bureau Release, Department of Information Services, Michigan State College, East Lansing, November 2.

Anon
1900 Walter Bradford Barrows. Educators of Michigan. Chicago: J. H. Beers and Company, pp. 208-209.

Anon
1904 Abstract of History of the Michigan Academy of Science. Sixth report of the Michigan Academy of Science. Lansing: Published by the State, pp. 7-8.

Adams, Charles C.
1908 List of Isle Royale Beetles. Michigan Geological Survey Report for 1908. Published by the State, pp. 192-203.

1952 Agricultural Statistics. Washington: United States Government Printing Office.

1906-1949 American Men of Science, eds. 1-8. New York and Pennsylvannia: The Science Press.

Andrews, A. W.
1911 Results of the Mershon Expedition to the Charity Islands, Lake Huron. Preliminary report on the Coleoptera. Thirteenth report of the Michigan Academy of Science. Lansing: Published by the State, pp. 168-170.

____
1915 Ibid.: Coleoptera. Michigan Geological and Biological Survey Publication 20, Biological Series 4, Ibid. pp. 67-108.

1859-1954 Annual catalogues of the Michigan State College of Agriculture and Applied Science, East Lansing, Published by the College.

1894-1920 Annual reports of the Michigan Academy of Science. Lansing: Published by the State.

1862-1954 Annual reports of the State Board of Agriculture of the State of Michigan. Lansing: Published by the State.

Bailey, Liberty H.
1909 The Experiment Station Movement in the United States. Cyclopaedia of American Agriculture, IV. New York: The MacMillan Company, pp. 422-427.

Barrett, Don P.
1949 Legislative History of Apiary Inspection. Inter-office Communication to Lawrence O'Neill from Don P. Barrett, State Apiarist, Michigan State Department of Agriculture (Written communication, July 25).

Barrows, Walter B.
1897 The present Status of the San Jose Scale in Michigan. United States Bureau of Entomology, Bull. 9, ns. Washington: Government Printing Office, pp. 27-29.

____
1900 Sketch of Manly Miles. Second report of the Michigan Academy of Science. Lansing: Published by the State, pp. 101-107.

Bonnell, Daniel E.
1942 Some Factors in the Development of Northwestern Entomology. Unpublished Ph.D. dissertation. Oregon State College, Corvallis, 259 numb. leaves.

Bradish, Alvah
1889 Memoir of Douglass Houghton Detroit: Published by the Author, 302 pp.

Bruner, Lawrence
1897 Grasshopper report for 1895. United States Bureau of Entomology, Bull. 7, ns. Washington: Government Printing Office, pp. 31-35.

____
1897 Grasshopper report for 1896. Ibid, pp. 36-39.

1931 Catalogue of the Officers and Graduates of the Michigan State College of Agriculture and Applied Science for the Years 1857 to 1930. Alumni Bulletin Vol. 25, no. 11. East Lansing: Published by the College. 246 pp.

Cook, Albert J.
1883 Experiments with Insecticides. Sixteenth annual report of the Ohio State Horticultural Society for the year 1882-83. Columbus: Published by the Society, pp. 138-140.

________ 1888 Ibid. Michigan Agricultural Experiment Station, East Lansing, Bull. 39, pp. 217-233.

________ 1889 Spraying with the arsenites. Ibid, Bull. 53, pp. 3-8.

________ 1889 Arsenical Poisons as Insecticides. Proceedings of the 10th annual meeting of the Society for the Promotion of Agricultural Science. Columbus: Published by the Society. pp. 27-32.

1924 Directory of field activities of the Bureau of Plant Industry. United States Department of Agriculture, Washington, Bureau of Plant Industry, Misc. Cir. 30.

1926 Directory of field activities of the Bureau of Entomology, Ibid, Bureau of Entomology, Misc. Cir. 80.

1930 Ibid, Misc. Pub. 83.

1935 Directory of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, Bureau of Entomology and Plant Quarantine, Misc. Pub. 220.

1937 Ibid, Misc. Pub. 220.

1940 Ibid, rev.

1953 Directory of the Bureau of Entomology and Plant Quarantine. United States Department of Agriculture, Washington.

DeKleine, William
1945 The use of DDT as a health measure. An unpublished manuscript used on a radio program sponsored by the Michigan State Department of Public Health. This talk was presented over Radio Station WKAR, Michigan State College on September 19.

DeLand, Charles J.
1925 <u>Public Acts of the Legislature of the State of Michigan Passed at the Regular Session of 1925</u>. Lansing: Published by the State, 862 pp.

1951 Digest of the 1951 conference on forest insect surveys in the Lake States. A mimeographed report from the United States Bureau of Entomology and Plant Quarantine Forest Insect Laboratory, Milwaukee, Wisconsin. 3 pp.

1952 Digest of the 1952 conference on forest insect surveys in the Lake States. Ibid, 3 pp.

1953 Digest of the 1953 conference on forest insect surveys in the Lake States. Ibid, 6 pp.

Dreisbach, Robert T.
1953 Chemist for the Dow Chemical Company, Midland, Michigan, and amateur entomologist (Written correspondence, September 10).

DuMond, Frank L.
1953 Director of the Grand Rapids Public Museum, Grand Rapids, Michigan (Written correspondence, October 5).

Essig, E. O.
1927 Charles Fuller Baker (Obituary). Journal of Economic Entomology 20, pp. 748-754.

____
1931 A History of Entomology. New York: The MacMillan Company, 1209 pp.

Flint, W. P.
1934 Codling Moth Control by the Use of Insecticides in Michigan, Ohio, Indiana, and Illinois. Journal of Economic Entomology 27, pp. 141-143.

Flynt, R. C. M.
1946 Student War Loans Program, Final Report. United States Office of Education, Bull. 1946, no. 14. Washington: Government Printing Office, 40 pp.

Forbes, S. A.
1909 Aspects of Progress in Economic Entomology. Journal of Economic Entomology 2, pp. 25-35.

Fuller, George N., ed.
1928 Geological Reports of Douglass Houghton. Lansing: The Michigan Historical Commission, 691 pp.

Gregory, John B.
1931 History of Milwaukee, Wisconsin. Vol. IV Chicago-Milwaukee S. J. Clarke Publishing Company, pp. 242-247.

Grover, Wayne C.
1953-54 United States Government Organization Manual. rev. July 1, 1953. Federal Register Division, National Archives and Records Service, General Services Administration. Washington: Government Printing Office, pp. 596-597.

Hammar, A. G.
1912 Life-history studies on the codling moth in Michigan. United States Bureau of Entomology, Bull. 115, Part 1. Washington: Government Printing Office, 86 pp.

Hankinson, Thomas L.
1908 Biological Survey of Walnut Lake, Michigan. Report of the State Board of Geological Survey of Michigan for the year 1907. Lansing: Published by the State, pp. 161-288.

Hatch, Melville H.
1924 A List of Coleoptera from Charlevoix County, Michigan. Papers of the Michigan Academy of Science, Arts and Letters 4. Lansing: Published by the State, pp. 543-586.

____
1928 A Geographical Index of the Catalogues and Local Lists of Nearctic Coleoptera. Journal of the New York Entomological Society 36, pp. 335-354.

____
1949 A Century of Entomology in the Pacific Northwest. Seattle: University of Washington Press, 43 pp.

Hatcher, Harlan
1944 The Great Lakes. New York: Oxford University Press, 384 pp.

Hedrick, Wilbur O.
1953 Professor Emeritus of Economics, Michigan State College. (Oral communication, August 9).

Hemans, Lawton T.
1906 History of Michigan. Lansing: Hammond Publishing Company, Limited, 278 pp.

Herbert, Frank B.
1931 History of the Oil and Nicotine Combination. Journal of Economic Entomology 24, 991-997.

Howard, L. O.
1911 Address at the Dedication of the Entomology and Zoology Building of the Massachusetts Agricultural College, November 11, 1910. Entomological News 22. pp. 97-107.

____
1930 A History of Applied Entomology. Smithsonian Miscellaneous Collection 84. Washington: The Smithsonian Institution, 564 pp.

Hubbard, H. G. and E. A. Schwarz
1878 List of Coleoptera Found in the Lake Superior Region. Proceedings of the American Philosophical Society 17, pp. 627-743.

____
1878 Contribution to a List of the Coleoptera of the Lower Peninsula of Michigan. Ibid, pp. 643-666.

James, Edmund J.
1910 The Origin of the Land Grant Act of 1862. University of Illinois, University Studies. Bulletin, Vol IV (no. 1) Urbana-Champaign: The University Press, 139 pp.

Kaye, Orin
1939 Cassidy Lake Resident Work Project. Chelsea, Michigan. Lansing: Michigan National Youth Administration, Division of Research and Publications, 12 pp.

Kelly, Fred J.
1952 Land Grant Colleges and Universities. United States Office of Education, Bull. 1952, no. 21. Washington: Government Printing Office, 27 pp.

______________ and Ella B. Ratcliffe
1941 Financial Aids for College Students. United States Office of Education, Bull. 1940, no. 11. Washington: Government Printing Office, 35 pp.

Knight, Paul
1928 The Development and Present Status of Entomological Courses in American Colleges and Universities. Journal of Economic Entomology 21, pp. 871-877.

Krieger, Jerry
1953 Area's 'Mr. Sprayer' Retires. The News-Palladium Benton Harbor, Michigan: The Pallidium Publishing Company, Vol. 68, no. 25, January 30.

Maris, W. Homer
1918 A Brief Study of American Entomology. Unpublished Master Degree Thesis. Oregon State College, Corvallis. 67 numb. leaves.

Martindale, Frederick C.
1909 Public Acts of the Legislature of the State of Michigan passed at the Regular Session of 1909. Lansing: Published by the State, pp. 173-174, cont., 329-330.

Mayhew, Ira
1858 Annual report of the Superintendent of Public Instruction of the State of Michigan, with accompanying documents for the year 1858. Lansing: Published by the State, pp. 11-62.

__________, and others
1859 The Agricultural College of the State of Michigan. Transactions of the State Agricultural Society of Michigan. Lansing: Published by the State, pp. 3-58.

McDaniel, Eugenia I.
1946 Rufus Hiram Pettit, 1869-1946 (Obituary) Journal of Economic Entomology 39, pp. 554-555.

____
1953 Former Associate Professor of Entomology at the Michigan State College, East Lansing. (Oral communication, August 11).

Mc Indoo, N. E., and others
1921 Effects of nicotine sulphate as an ovicide and larvicide on the codling moth and three other insects. United States Department of Agriculture, Washington, Bull. 938.

Merritt, James M.
1937 The toxicity of combinations of nicotine, under Michigan conditions, to the tree and to the codling moth, Carpocapsa pomonella, Linn. Michigan Agricultural Experiment Station, Tech. Bull. 154.

Metcalf, C. L. and W. P. Flint
1939 Destructive and Useful Insects 2nd ed. New York: McGraw-Hill Book Company, Inc., 981 pp.

1953 Michigan Agricultural Statistics, May, 1953. Lansing: Michigan Department of Agriculture, p. 13.

Monroe, C. O.
1947 The Early History of the South Haven-Casco Pomological Society. Seventy-sixth annual report of the Secretary of the State Horticultural Society of Michigan for the year 1946. Lansing: Published by the State, pp. 114-121.

Needham, James G.
1908 Notes on the aquatic insects of Walnut Lake with special reference to a few species of considerable importance as fish food. Report of the Michigan Geological Survey for 1907, pp. 253-271.

Osborn, Herbert
1937 Fragments of Entomological History. Columbus: Published by the Author and printed by The Spahr and Glenn Company, 394 pp.

____
1952 A Brief History of Entomology. Columbus: The Spahr and Glenn Company, 303 pp.

1921-1950 Papers of the Michigan Academy of Science, Arts and Letters. Ann Arbor: The University of Michigan; New York: The MacMillan Company, Vols. 1-36.

Parker, J. R.
1939 Grasshoppers and their control. United States Department of Agriculture, Washington, Farmer's Bull. 1828.

Parrott, P. J.
1914 The Growth and Organization of Applied Entomology in the United States. Journal of Economic Entomology 7, pp. 50-64.

Pellett, Kent L.
1938 A. J. Cook, 1842-1916. American Bee Journal 78, pp. 545-547.

Pettit, Jessie A.
1953 Widow of Rufus H. Pettit, former Professor of Entomology at the Michigan State College, East Lansing. (Oral communication, June 24).

1905 Public Acts of the Legislature of the State of Michigan Passed at the Regular Session of 1905. Lansing: Published by the State, pp. 523-524.

Quaintance, A. L.
1905 Some present-day features of applied entomology in America. United States Bureau of Entomology, Bull. 52. Washington: Government Printing Office, pp. 5-25.

__________ and Eugene W. Scott
1912 The one-spray method in the control of the codling moth and the plum curculio. Ibid, Bull. 115, Part 2, pp. 87-112.

1900-1921 Reports of the Entomologist. Annual reports of the United States Department of Agriculture. Washington: Government Printing Office.

1921-1928 Reports of the Entomologist. United States Bureau of Entomology, Washington, D.C.

1929-1934 Reports of the Chief of the Bureau of Entomology, Ibid.

1934-1954 Reports of the Chief of the Bureau of Entomology and Plant Quarantine, Ibid.

Rogers, J. Speed
1948 Report of the Director of the Museum of Zoology, University of Michigan, 1946-1947. University of Michigan Official Publications Vol. 49, no. 89. Ann Arbor: Published by the University, 40 pp.

Russell, I. C.
1904 Bela Hubbard. Fourth report of the Michigan Academy of Science. Lansing: Published by the State, 227 pp.

Ruthven, Alexander G.
1911 The Mershon Expedition to the Charity Islands, Lake Huron. Science 33, ns., pp. 208-209.

______
1912 Report of the Chief Naturalist of the Michigan Geological and Biological Survey. Fourteenth report of the Michigan Academy of Science. Lansing: Published by the State, pp. 42-44.

Sabrosky, Curtis W.
1953 Former Assistant Professor of Entomology at the Michigan State College, East Lansing, and presently Entomologist in the Division of Insect Detection and Identification, United States National Museum, Washington. (Written correspondence, September 4).

Say, Thomas
1824 American Entomology, or Descriptions of the Insects of North America. Philadelphia: Published by Samuel A. Mitchell, Philadelphia Museum, no pagination, 18 pl.

______
1825 Ibid, pls. 19-36.

______
1828 Ibid, pls. 37-54.

Schwarz, E. A.
1876 List of Coleoptera Collected in Michigan. Psyche 1, pp. 145-148.

____
1890 Notes on the Comparative Vitality of Insects in Cold Water. Proceedings of the Entomological Society of Washington 1, pp. 208-215.

Shortt, Adam and Arthur G. Doughty, eds.
1914 Canada and Its Provinces Vol XII. Edinburgh Ed. Toronto: The Publishers Association of Canada Limited, pp. 511-520.

____
1917 Ibid, Vol. XXIII, Ibid, pp. 327-328.

Smith, J. Edwards
1880 How to See With the Microscope. Chicago: Duncan Brothers, 410 pp.

Strong, F. C. and E. J. Rasmussen
1945 Cost Studies Show Airplane Dusting is Practical. Food Packer 26, pp. 63-64, cont., 66.

Stack, Joseph W.
1953 Director of the Michigan State College Museum, East Lansing. (Oral communication, July 15).

Stefferud, Alfred
1947 Yearbook of Agriculture, 1943-1947. Science in Farming. United States Department of Agriculture, Washington. 944 pp.

Strong, Lee A.
1937 Summary of season's scouting to obtain information as to the distribution of the Japanese Beetle. United States Department of Agriculture, Washington, Mimeo., 15 pp.

____
1938 Ibid, 12 pp.

Taylor, Alexander
1859 Grasshoppers and locusts of America. Annual report of the Smithsonian Institution for the year 1858. Washington: The Smithsonian Institution, pp. 200-213.

True, Alfred C.
1929 A History of Agricultural Education in the United States. 1785-1925. United States Department of Agriculture, Washington, Misc. 36.

Tuttle, Charles R.
1873 General History of the State of Michigan. Detroit: R. D. S. Tyler and Co., 730 pp.

Van Duzee, M. C., and others.
1921 The Dipterous Genus Dolichopus Latreille in North America. United States National Museum, Bull. 116. Washington: The Smithsonian Institution, 304 pp.

Weiss, Harry B.
1936 The Pioneer Century of American Entomology, New Brunswick, New Jersey: Published by the Author, 320 pp.

White, R. T.
1941 Development of Milky Disease on Japanese Beetle Larvae Under Field Conditions. Journal of Economic Entomology 34, pp. 213-215.

APPENDIX

A. A List of Theses for Entomology Degrees At the Michigan State College.

B. A Pictorial History of the Development of Spraying and Dusting Equipment Since 1883.

C. Biographies and/or Photographs

A. A List of Theses for Entomology Degrees*

At the Michigan State College.

Beltz, Harold Frank. A Comparison of Methods and Materials Used in Greenhouse Pest Control. M.S., 1952.

Bloomer, Arthur Warren. Effects of Various DDT Formulations on the Control of Insects Common to Potatoes and Beans. M.S., 1953.

Bradley, George Arthur. Some Common Sawfly Larvae Attacking Conifers in Northeastern North America. M.S., 1939.

Bray, Dale Frank. An Investigation of the Number and Volume of Aquatic Insects in Ponds in Relation to the Use of Fertilizer. M.S., 1949.

Cath, William Stanwood. Studies on Control of the European Pine-Shoot Moth, Rhyacionia buoliana (Schiffermiller). M.S., 1953.

Chapman, Harold Clyde. A Systematic Study of Aquatic and Semi-aquatic Hemiptera Occurring in Lower Michigan. M.S. 1953.

Chaudhry, Ghulam-Ullah. The Development and Fecundity of the Oriental Fruit Moth, Grapholitha (Cydia) molesta (Busck) Under Controlled Temperatures and Humidities. Ph.D., 1951.

Collins, William Erle. The Extension and Refinement of a Laboratory Technique for Evaluating Contact Insecticides. M.S., 1952.

Coppel, George Edward. The External Anatomy of Melanotus communis, Gyll M.S., 1948.

Costas, Luis Adolfo. Some Effects of Mass Parasitization of the Angoumois Grain Moth, Sitotroga cerealella, Oliv; by trichogramma. M.S., 1937.

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* Apiculture theses in the Horticulture Department are recorded at the end of this list.

Craig, Albert George. Relations of Insects to the Pollination of Pears and Apples. B.S., 1902.

Dibble, Charles Bradford. Life-history of the Hemlock Measuring Worm, Ellopia fiscelleria. M.S., 1927.

Dominick, Harvey John. Laboratory Comparisons of the Effects of Wheat Protectants on Stored Grain Insects. M.S., Spring, 1953.

Farleman, Merwyn Gale. Standards for Comparison of Insects Infesting Fruit in Michigan. M.S., 1930.

Farr, Thomas Howard. A Survey of the Insect Fauna of Goldenrod (Solidago spp.) M.S., 1948.

Fischer, Roland Lee. The Cicindelidae of Michigan. M.S., 1948.

Frank, J. Lyall L. A Study of the Comparative Efficacy of Various Louse Powders. M.S., 1922.

Gallum Robert Louis. Distribution and Economic Importance of Some Important Sawflies Attacking Conifers in Eastern North America. M.S., 1950.

Gleason, Gale Robert, Jr. A Winter Survey of Insects Infesting Polyporaceous Fungi in Four Southern Michigan Woodlots. M.S., 1951.

Guyer, Gordon Earl. A Quantitative and Qualitative Investigation of the Adult Midges of the Family Tendipedidae in Fertilized and Unfertilized Ponds, M.S., 1952.

Hanna, Murray K. Michigan Spittlebugs. M.S., 1951.

Harrison, Robert Doak. Control of Onion Maggot by Seed Pelleting with Insecticides. M.S., Fall, 1950.

Houk, Wallace Eugene. Studies on the Mineola moth (Mineola scitulella) and other Northern Michigan Fruit Insects. M.S., Fall, 1950.

Khan, Mushtag Ahmed. Control of the Common Ectoparasites Causing Damage to Hides and Skins in Pakistan. M.S., 1948.

Kuhn, Frederick Alfred. Key for the Identification of the More Important Fruit Insects of the Northern and Eastern United States. M.S., 1933.

Lee, Cecil Su-Sen. One Year's Hand and Trap Collection of Insects on the Michigan State College Grounds. M.S., 1941.

Lowe, Victor Hunt. The New York Plum Lecanium. M.S., 1898.

Lugthart, Garrit J. Jr. Studies of Lyctid and Scolytid beetles Infesting Seasoning Lumber. M.S., 1951.

Merritt, James M. A Study of the Development of the Angoumois Grain Moth on Various Foods. M.S., 1932.

______. The Toxicity of Combinations of Nicotine, Under Michigan Conditions, to the Tree and to the Codling Moth, *Carpocapsa pomonella*, Linn. Ph.D., 1936.

Milliron, Herbert Edward. A Study of Some Factors Affecting the Efficiency of *Encarsia formosa* Gahan, an Aphelinid Parasite of the Greenhouse White Fly, *Trialeurodes vaporariorum*. (Westw). M.S.,1938.

Morofsky, Walter Frederick. The Elm-leaf Beetle. M.S., 1930.

______. The Correlation of Bark Beetles and Wood Borers to Slash Disposal in Michigan. Ph.D., 1952*

Namba, Ryoji. The Trypetidae of Michigan. M.S., 1950.

Parmelee, Frank Thomas. A Study of Some Wood-boring Coleoptera Attacking Fire-killed Coniferous Trees in Michigan. M.S., 1940.

Pederson, Calvin Ernest. The Distribution of Michigan Mosquitoes. M.S., 1947.

Reed, Charles O. The Peach and Its Enemies. B.S., 1901.

Ries, Donald Timmerman. The Control of Insect Pests Injurious to Field Crops. M.S., 1926 (a minor thesis).

______. The Life-history, Habits and Distribution of the Apple Maggot. M.S., 1926 (a major thesis).

Shaw, William T. The Economic Importance of Insects Hibernating in Rubbish. M.S., 1901.

Shea, William. A Laboratory Comparison of the Phytotoxicity of Several DDT Formulations, and an Evaluation of the Method Used. M.S., Spring, 1953.

Simmons, R. D. A Study of the Species of Agrilus (Coleoptera) Infesting Michigan Raspberries. M.S., 1933.

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* This thesis actually was done as a project in the Department of Forestry, but its entomological nature and the fact that Walter F. Morofsky is a member of the Entomology Department warrants that it be included in this list.

Sone, Geary Masami. A Study of the Effect of Hydrogen-ion Concentration on the Toxicity of Certain Insecticidal Sprays. M.S., Fall, 1951.

Steele, Clara Mathilde. Some Coccidae of the Greenhouse. B.S. , 1898.

Toboada, Oscar. Some Effects of Radiant Energy on the Beetles, Tribolium confusum Duv; Sitophilus granarius (L) and Acanthoscelides obtectus (Say) M.S., Fall, 1953.

Tolles, Goodwin S. The Use of oils for Control of Insects. M.S., 1928.

Tuttle, Donald Monroe. A Study of the Insect Fauna of the Cultivated Blueberry, Vaccinium corymbosum, Linnaeus. M.S., 1947.

Wilkinson, Robert C. Jr. Some Factors Involved in a Method for Rearing the Boxelder Bug, Leptocoris trivittatus. Say. M.S., 1950.

Wilson, Bruce Vernon. Contributions to a Study of the Butterfly Fauna of Ingham County, Michigan. M.S., 1943.

Wong, Horne Richard. Sawfly Larvae of the Subfamily Nematinae Attacking Conifers in the Forests of the Canadian Prairies. M.S., 1950.

Zia-ud-Din. Studies on the Biology and Control of Lygus oblineatus (Say) Ph.D., 1950.

APICULTURE THESES IN THE HORTICULTURE DEPARTMENT

1. Jorgensen, Carl Jens Christian. Weather Factors Influencing Honey Production. M.S., 1945.

B. A Pictorial History of the Development of Spraying and Dusting Equipment Since 1883.*

* The following series of photographs was kindly loaned to the writer of this thesis, and permission given for their reproduction, by the John Bean Manufacturing Company, Lansing, Michigan (a division of the Food Machinery Corporation, San Jose, California.) No historical photographs of this kind could be secured from other commercial agricultural chemical application equipment manufacturers.

1912 Mother drove while father and son did the spraying with long bamboo rods and small nozzles. The Bean sprayer had wood tank, triplex pump which powered by a $2\frac{1}{2}$ H. P. engine delivered the spray material at 200 p.s.i.

1918. Powered by a 3 H.P. engine, the Bean Triplex Pump now delivers 8 g.p.m. at 250 lbs. pressure. The tank has been increased to 200 gallons and spray guns which came into general use that year have replaced the long bamboo rods and small nozzles.

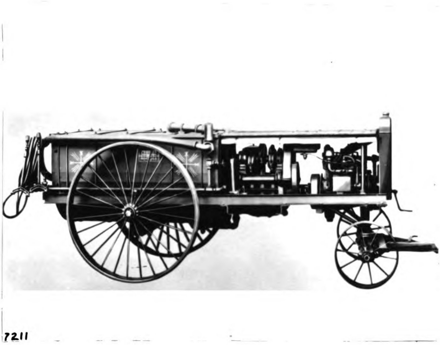
1920 There will always be small growers and they were not forgotten in 1920. This 5 g.p.m. pump and 1½ H.P. engine for 200 lbs. pressure, supplied from a 50 gallon barrel was designed to meet his needs.

1924. Using a light weight 6 H.P. engine for power, the Triplex Pump now delivered 12 g.p.m. at 300 - 350 lbs. pressure.

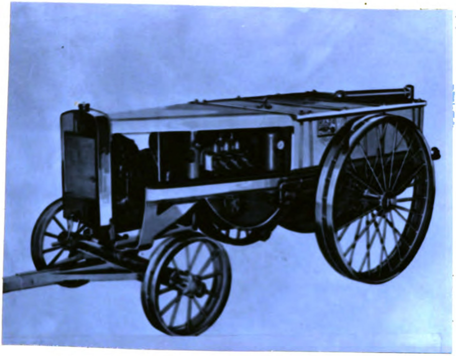
1925. This model had a $5\frac{1}{2}$ g.p.m. pump and a $2\frac{1}{2}$ H.P. engine for 250 lbs. pressure. The tank had 100 gallons capacity.

1927. One of the first attempts at a tractor power take-off sprayer. It was a standard four wheel outfit with a power take-off shaft.

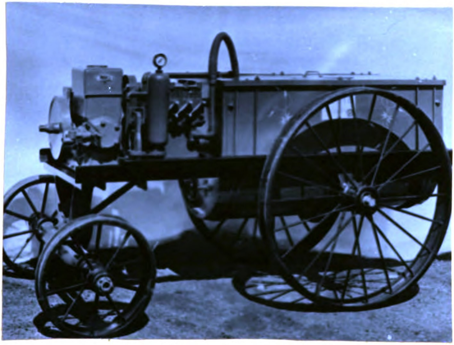
1928. Broom type guns came in that year. Here is one of the first six nozzle models.



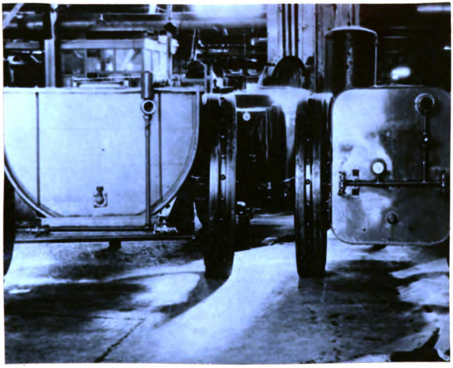
1930. Super Giant, 30 g.p.m. at 400 - 500 lbs. pressure, 4 cyl. 16 H.P. engine with option of 300 - 400 gallon tank.



1933. The advent of the Royal Pump and a very modern sprayer. A 20 g.p.m. Royal Pump and a 4 cylinder 12 H.P. engine for 600 lbs. pressure; 300 gallon wood tank on steel wheels with cut-under truck, mostly horse drawn.



1934. Featuring the enclosed Royal Pump which was introduced in 1933. This model 3208 was a popular model sprayer that year.



1935. The transition from wood to steel tanks. These two 1935 models, side by side, both have 400 gallon tanks and show the difference in compactness.

An engine powered cut-under armoured sprayer of that year has been modified for power take-off operation.

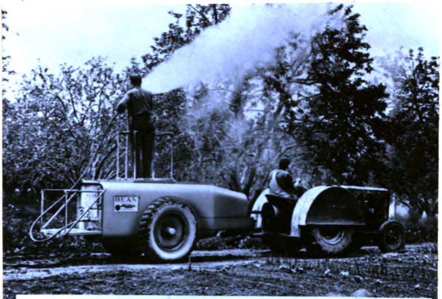
1934 This year the sprayer goes on rubber.

A wood tank sprayer on dual rubber tires is power take-off operated.

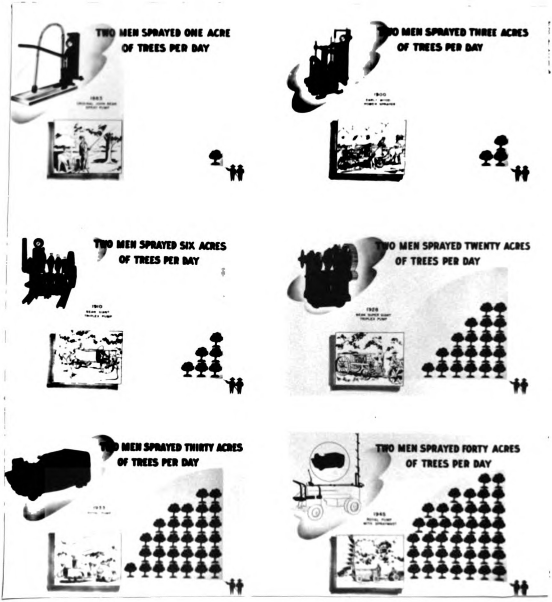
13. Speed Sprayer spraying peaches at rate of 8 acres per hour, 75 to 100 acres per day

1941. The first succesful airblast sprayer was used in Florida citrus orchards in 1937 but was not introduced in the Northern States until about 1941.

1-48 Harry Stockdale working with an early model spray mast, the first major step in many years toward taking the hard work out of spraying.



1947 Tractor power take-off sprayer, 35 g.p.m. pump for 600-800 lbs pressure.
The 600 gallon tank sprayer is mounted on large pneumatic tires.



Number of Acres Sprayed Per Day For the Years
1883, 1900, 1910, 1928, 1933, and 1945.

C. Biographies and/or Photographs

1. Henry Goadby
2. Manly Miles
3. Albert John Cook
4. Walter B. Barrows
5. Rufus H. Pettit
6. George D. Shafer
7. Eugenia I. McDaniel

Henry Goadby

Little is known about Henry Goadby. In 1849, he came to the United States from England where he had been "primary dissector of minute anatomy" at the Royal College of Surgeons, London. His journey to America was prompted by the need of rest and recuperation for his eyesight which had become impaired through extensive microscopical researches. Until 1858, when he was appointed to the faculty of the Michigan Agricultural College, Dr. Goadby spent considerable time giving lectures on anatomy and microscopy. In 1855, he presented several lectures in Milwaukee, Wisconsin. Between 1856 and 1858, Dr. Goadby was a resident of Detroit, Michigan. On June 10, 1858, he married Sarah B. Kinman of Jonesville, Michigan. While at the Agricultural College, Professor Goadby contributed numerous articles on insects to the "Michigan Farmer". He also helped edit the "Medical Independent", a monthly magazine published at Detroit. Professor Goadby's departure from the College in 1859 evidently was due to poor health. At that time, he went to Milwaukee to live with a daughter, and it was there that he died - on March 31, 1864. Professor Goadby was fifty-eight years old at the time of his death. He had been associated with the Linnean Society of London, Albany Institute of New York, and the Literary and Historical Society of Quebec.

Manly Miles

Manly Miles was born in Homer, New York on July 20, 1826. In 1837, he moved to Flint, Michigan and in 1850, obtained a medical degree at Rush Medical College, Chicago. While practicing medicine in Flint in 1859, Dr. Miles was appointed Assistant State Geologist of Michigan. In 1860, he became Professor of Zoology and Animal Physiology at the Michigan Agricultural College. In 1865, he was given the additional duties of "Professor of Practical Agriculture" and "Superintendent of the Farm". In 1869, Professor Miles began devoting all his time to the teaching of Agriculture at the College. His agricultural professorship of 1865 was the first of its kind given to anyone in the world. His scientific experiments in agriculture and his writings gave him a noteworthy reputation. The scholarliness and enthusiasm of Professor Miles made him popular with his students. In 1875, he left the Michigan Agricultural College. Until 1886, Dr. Miles occupied himself with the conducting of private scientific experiments and with teaching at the Illinois State University, Galesburg and at the Massachusetts Agricultural College, Amherst. In 1886, Dr. Miles returned to Lansing, Michigan where he did private researches until his death - on February 15, 1898.

For further details of Professor Miles' life, the reader is referred to the following reference: Barrows, Walter B. Sketch of Manly Miles. Second report of

the Michigan Academy Science. Lansing: Published by the State, 1900, pp. 101-107.

Professor Manly Miles

Albert John Cook

Albert John Cook was born at Owosso, Michigan on August 30, 1842. After graduating from the Michigan Agricultural College in 1862, he managed a fruit farm near Sacremento, California, and in 1867, returned to Michigan to teach at his Alma Mater. As Professor of Zoology and Entomology (1869 - 1893) and Entomologist for the Experiment Station (1888 - 1893) at the College, he made successful pioneering efforts in the teaching of economic entomology and in insect investigations. The latter pertained primarily to life-histories, insecticides, and bees. His entomological activities in Michigan made the State a leader in the field of entomology. In 1893, he left the Michigan Agricultural College to accept the Chair of Biology at Pomona College, Claremont, California. He remained in that position until 1911, at which time he was appointed California State Commissioner of Horticulture. Between 1911 and 1916, Professor Cook's entomological accomplishments in California brought him more national recognition. In 1916, poor health resulted in his return to his home in Owosso, and he died there on September 29 of the same year.

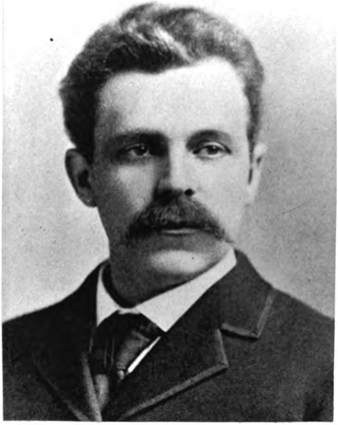
For further details of Professor Cook's life, the reader is referred to the following reference: Essig, E. O. A History of Entomology. New York: The MacMillan Company, 1931, pp. 578-581.

Professor Albert John Cook in 1888.
This Photograph was Loaned to This
Writer, and Permission Granted
for its Reproduction, by Albert
B. Cook, Jr. of Owosso, Michigan.

Walter Bradford Barrows

Walter Bradford Barrows was born at Wellesley Hills, Massachusetts in 1855. In 1876, he obtained a Bachelor of Science Degree in natural history at the Massachusetts Institute of Technology. Prior to his coming to the Michigan Agricultural College in 1894, Mr. Barrows had been employed for eight years as the "first assistant ornithologist" of the United States Department of Agriculture, Washington, D.C. While at the Agricultural College, Professor Barrows published a noteworthy book titled "Michigan Bird Life" (Lansing: The Michigan Agricultural College, 1912, 822 pp.). Professor Barrows died unexpectedly in East Lansing on February 26, 1923. At the time, he was yet Professor of Zoology and Physiology and Curator of the General Museum at the College.

For further details of Professor Barrows' life, the reader is referred to the following reference: Anon. Walter Bradford Barrows. Educators of Michigan. Chicago: J. H. Beers and Company, 1900, pp. 208-209.



Professor Walter B. Barrows

Rufus Hiram Pettit

Rufus Hiram Pettit was born in Baldwinsville, New York on January 11, 1869. He graduated from Baldwinsville Academy in 1887, and from Cornell University, Ithaca, New York in 1895. From 1895 to 1897, Rufus Pettit was employed as Assistant State Entomologist of Minnesota. He was appointed as an Instructor of Zoology at the Michigan Agricultural College on January 1, 1897. In 1906, Mr. Pettit became head of the Entomology Department at the College. Entomology itself had been made a separate Department the same year. Professor Pettit remained in charge of the Entomology Department until 1934 when illness forced his retirement from the College. He was a popular teacher and a recognized world authority on entomology. As "Entomologist of the Experiment Station", Professor Pettit did his utmost to aid the residents of Michigan with their insect problems. His private entomological interests concerned the scale insects, biological control of insects, and the preparation of insect illustrations. His ability at the latter was superb and many of his illustrations were used in entomological publications prepared at other places than in Michigan. In 1931, the College awarded Professor Pettit an honarary Doctor of Science Degree for his entomological accomplishments. Professor Pettit died in East Lansing on June 1, 1946.

For further details of Professor Pettit's life, the reader is referred to the following reference: McDaniel, Eugenia I. Rufus Hiram Pettit, 1869 - 1946 (Obituary) Journal of Economic Entomology 39 (1945), pp. 554-555.

George Daniel Shafer

George Daniel Shafer was born in Muncie, Indiana on December 25, 1874. He obtained a Bachelor of Arts Degree from Indiana University, Bloomington in 1900; a Master of Arts Degree at Stanford University, Palo Alto, California in 1906; and a Doctor of Philosophy Degree in Entomology at Cornell University, Ithaca, New York in 1908. He served as an Assistant Entomologist for the Michigan Agricultural College Experiment Station from 1908 to 1917. Between 1913 and 1917, his status was associate research professor. From 1918 to 1940, he taught entomology and animal physiology at Stanford University. In 1940, he retired from Stanford as a professor emeritus. Professor Shafer was a member of the Michigan Academy of Science (Sevretary from 1909 to 1912), American Association for the Advancement of Science, Naturalists Society, Entomological Society of America, Society of Experimental Biologists, Western Society of Naturalists, and the California Academy of Science. Professor Shafer presently resides in Palo Alto, California.

Dr. George D. Shafer

Eugenia I. McDaniel

Eugenia I. McDaniel was born in LaCrosse, Kansas on June 27, 1884. She graduated from the LaCrosse High School in 1902. In 1908, Miss McDaniel obtained a Bachelor of Arts Degree at the University of Kansas, Lawrence, and on April 10, 1910 was appointed to the staff of the Michigan Agricultural College Entomology Department as an instructor. Miss McDaniel served the College until July 1, 1949, at which time she retired. At her retirement, she held the rank of associate professor. Throughout the 39 years of her tenure, Professor McDaniel voluntarity devoted almost all her evenings (often late into the night) and weekends to the systematic work and "curatorship" duties of the Michigan State College Insect Collection. Considerable thanks must be given Miss McDaniel for her efforts and thoroughness in her work on the collection. Perhaps never again will the Entomology Department have as an industrious a worker as she. Professor McDaniel made numerous contributions to the fields of taxonomic and economic entomology. Her work on the Coccidae and Orthoptera brought her national recognition. Professor MaDaniel was a member of the American Association of Economic Entomologists, American Entomological Society, and the American Association for the Advancement of Science. Miss McDaniel presently resides in Kansas.

Professor Eugenia I. McDaniel

Ray Hutson

Ray Hutson was born in Salem, West Virginia on October 6, 1896. From 1917 to 1919, he served in the United States Navy. He obtained a Bachelor of Science Degree in Agriculture at West Virginia University, Morgantown in 1922, and a Master of Science Degree in Entomology at Rutgers Univversity, New Brunswick, New Jersey in 1930. From 1922 to 1928, he was an Assistant Entomologist for the New Jersey Agricultural Experiment Station, and as Associate Entomologist at the New Jersey Station from 1928 to 1930. From 1926 to 1930, Mr. Hutson was an instructor of entomology at Rutgers. In 1930, he was appointed to the staff of the Michigan State College Entomology Department as an associate professor of teaching and research. In 1934, Professor Hutson was placed in charge of the Michigan State College Entomology Department. He still retains this position. Professor Hutson is a member of the American Association for the Advancement of Science, the Entomological Society of America, and the Ontario Entomological Society.

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