IMAGE EVALUATION TEST TARGET (MT-3)

APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

© 1993, Applied Image, Inc., All Rights Reserved

**CIHM
Microfiche
Series
(Monographs)**

**ICMH
Collection de
microfiches
(monographies)**

Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1993

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

☒ Coloured covers/
Couverture de couleur

☐ Covers damaged/
Couverture endommagée

☐ Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée

☐ Cover title missing/
Le titre de couverture manque

☐ Coloured maps/
Cartes géographiques en couleur

☐ Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire)

☐ Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur

☒ Bound with other material/
Relié avec d'autres documents

☒ Tight binding may cause shadows or distortion
along interior margin/
La reliure serrée peut causer de l'ombre ou de la
distorsion le long de la marge intérieure

☐ Blank leaves added during restoration may appear
within the text. Whenever possible, these have
been omitted from filming/
Il se peut que certaines pages blanches ajoutées
lors d'une restauration apparaissent dans le texte,
mais, lorsque cela était possible, ces pages n'ont
pas été filmées.

☐ Additional comments:/
Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	14X	18X	22X	26X	30X
☐	☐	☐	☒	☐	☐
12X	16X	20X	24X	28X	32X

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

☐ Coloured pages/
Pages de couleur

☐ Pages damaged/
Pages endommagées

☐ Pages restored and/or laminated/
Pages restaurées et/ou pelliculées

☒ Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées

☐ Pages detached/
Pages détachées

☒ Showthrough/
Transparence

☒ Quality of print varies/
Qualité inégale de l'impression

☐ Continuous pagination/
Pagination continue

☐ Includes index(es)/
Comprend un (des) index

Title on header taken from:/
Le titre de l'en-tête provient:

☐ Title page of issue/
Page de titre de la livraison

☐ Caption of issue/
Titre de départ de la livraison

☐ Masthead/
Générique (périodiques) de la livraison

The copy filmed here has been reproduced thanks to the generosity of:

Library
Agriculture Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol ➡ (meaning "CONTINUED"), or the symbol ▼ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:

L'exemplaire filmé fut reproduit grâce à la générosité de:

Bibliothèque
Agriculture Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole ➡ signifie "A SUIVRE", le symbole ▼ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

FROM THE TRANSACTIONS OF THE ROYAL SOCIETY OF CANADA

SECOND SERIES—1895-96

VOLUME I.

SECTION IV.

GEOLOGICAL AND BIOLOGICAL SCIENCES

PRESIDENTIAL ADDRESS

Practical Entomology

By JAMES FLETCHER, F.L.S., F.R.S.C.

FOR SALE BY

JOHN DURIE & SON, OTTAWA; THE COPP-CLARK CO., TORONTO
BERNARD QUARITCH, LONDON, ENGLAND

1895

Secret

gener
ledge
ideas
favor
of de
unwi
study
know
learn

lines
every
with
devel
revolu
as we
attrac
crave
showi
scient
agricu
secret
best t
can te
advise
elemen
to the
remed
pagat
allied
are be
by sel
vegeta
treatm
Here a

1.—*Presidential Address: Practical Entomology.*

By JAMES FLETCHER, F.L.S.

(Read May 15, 1895.)

INTRODUCTORY.

Undoubtedly a noticeable feature of the last decade has been the general recognition of the value of science,—that is, accurate knowledge—in carrying on all the ordinary occupations of life. The foolish ideas that science is a sort of wonderland, not to be entered except by a favoured few, or that science as a study must not be popularized for fear of degrading it, are now only held by the ignorant or those who are unwilling to learn. Science is, merely, accurate knowledge in all branches of study, and the popularizing of science means only the rendering of such knowledge so simple or accessible as to be available to all who wish to learn.

Strenuous efforts are now being made by the leading thinkers in all lines of study, to give their investigations a practical application to the every-day affairs of life. In no direction have these efforts been attended with so much success as in what are called the natural sciences. Recent developments in the application of electricity may well be said to have revolutionized the whole systems of transportation and communication, as well as the lighting of cities and individual buildings, and offer a most attractive field for discussion by any scientific body. Perhaps I need not crave your indulgence for drawing your attention to a few instances showing how the agriculture of to-day is benefited by the investigations of scientific workers. The chemist is now thoroughly recognized by the agricultural classes as the magician who can unlock to them hidden secrets as to the true value of various crops; can tell them which are the best to grow for stock, to provide food, or as fertilizers of the soil; can tell them, after analysis, what constituents of a soil are lacking, and advise them as to the most economical way of replacing the required elements. The skill of the practical botanist is now being chiefly directed to the examination of parasitic fungi, with the object of devising suitable remedies for those species which attack cultivated vegetation, or of propagating the parasitic forms which destroy insect life. In the closely allied branches of horticulture and agriculture, numberless experiments are being carried on daily with the object of discovering and originating by selection and hybridization new varieties of flowers, fruits, grains and vegetables; the best methods of propagation and cultivation, the best treatment of the soil and the most effectual and economical fertilizers. Here also, in passing, reference may be made to the care, improvement

and treatment in health and disease of all farm stock. All of the above work comes under the head of scientific agriculture—provided that it is done accurately—and is of incalculable value to the country at large. In no branch of natural science, however, I believe, have such important results been obtained, when gauged by their effect upon the revenue of the country, as in that branch of zoology which treats of insects and their depredations on the crops of the orchard, the garden, and the farm.

HISTORICAL.

Practical or economic entomology may still be described as a new study, and in no part of the world can it be said to have been developed with such marked good results as in North America, where the work was only begun in 1841 by the publication of Dr. T. W. Harris's classical report on the injurious insects of Massachusetts. This remarkable building up in America of a new and more important branch of an old science, has been mainly due to the great knowledge and special abilities of Prof. C. V. Riley, for many years United States Entomologist at Washington, and his very able successor, Mr. L. O. Howard. A history of the science of entomology would probably be of interest, but would be out of place here. A few landmarks, however, may be pointed out. There is an excellent concise history of the progress of entomology by Mr. S. J. Capper in his presidential address to the Lancashire and Cheshire Entomological Society, 1892. He says: "The most ancient references to Entomology are in the works of the great Aristotle, who was born in Greece, B.C. 384. Pliny the Elder, who died A.D. 79, wrote many treatises on Natural History in which references to bees and other insects occur. It was not till the 16th and 17th centuries that much attention was paid to the lives and habits of insects, when the '*Theatrum Insectorum*' of Thomas Muffet was published at London, A.D. 1634. This was the first work ever issued as a separate volume on all orders of insects, and was a most careful work, referring to everything that had ever appeared upon entomological matters up to that time. More advance took place in the 17th century, John Ray and Francis Willughby being important figures. But the popular value placed on the study of insects at that day may be shown from the fact that the will of Lady Glanville was disputed on the ground of insanity because she was known to collect and study insects. Moses Harris in his '*Aurelian*,' published in 1779, says 'The Fly *Melittæa Cinzia*, the Glanville Fritillary, took its name from the ingenious Lady Glanville whose memory had like to have suffered from her curiosity? Some relations that were disappointed by her will, attempted to set it aside by acts of lunacy, for they suggested that none but those who were deprived of their senses would go in pursuit of butterflies. Her relations and legatees subpoenaed Dr. Sloan, the founder of the British Museum,

and Mr. John Ray, to support her character. The latter went to Exeter and at the trial satisfied the judge and jury of the lady's laudable inquiry into the wonderful works of creation, and established her will."

In the 18th century the great Linnaeus, 1707-1778, shines out as a bright luminary and may be drawn attention to here as the first economic entomologist, for his advancement and opportunities to do his magnificent zoological and botanical work were, it is said, largely due to his wisdom in recommending that the spars to be used as masts for the navy, which were lying in the royal dockyard at Stockholm, should be sunk in water to protect them from wood-boring insects. Réaumur, born in France in 1683, the inventor of the thermometer which bears his name; published between 1734 and 1742 his remarkable work "*Mémoires pour servir à l'histoire naturelle des insectes*," in which are detailed many original and accurate observations. He died in 1757.

Fabricius, 1745-1808, in Denmark, and Latreille, 1762-1833, in France, also did monumental work. In England, Curtis, the author of "*Farm Insects*," and Prof. Westwood, a most learned and voluminous writer, but best known by his "*Modern Classification of Insects*," were upholding the honour of their country.

In the article above referred to, Mr. Capper says: "In the beginning of the 19th century, Curtis's translation of '*Fundamenta Entomologie*' published in 1772, Yeaates's '*Institutions of Entomology*,' which appeared the year after, and Barbut's '*Genera Insectorum*,' 1781, were the only elementary works on entomology." Convinced that this fact was the chief obstacle to the spread of entomology in Britain, Messrs. Kirby and Spence resolved to do what they could to remedy the deficiency, and the publication in 1815 of the Introduction to the Study of Entomology did more to attract popular attention to entomology than any book before or since published. The chapters devoted to insects beneficial and injurious to mankind, with the best means then known for the encouragement of the one and the destruction of the other, were the first steps in the direction of economic entomology, the study of which has to-day become so important.

The Royal Agricultural Society of England was founded in 1840, and John Curtis, already well known as a writer on injurious insects, was invited to prepare each year a report on the injurious insects of crops. These reports ran from 1841 to 1857. They were afterwards consolidated and, with other matter added, formed his standard work on *Farm Insects* which appeared in 1860. By far the most important work which has been done in economic entomology in England, has been that of Miss Eleanor A. Ormerod, a public-spirited woman who much aided by her sister, Miss Georgina Ormerod, has given up the whole of her time to the collection of data and publishing at her own expense a series of illustrated reports, now seventeen in number, which are of inestimable value to the

farmers of Great Britain. Speaking of Miss Ormerod, in his annual address as president of the Association of Economic Entomologists, Mr. Howard says: "She has shown herself ingenious, careful and receptive to a degree, and at the same time possessed of an enthusiasm and an unlimited perseverance which are calculated to overcome all obstacles. She has studied many of the English crop enemies *de novo*, she has popularized the work of other English entomologists, and has made accessible to the agricultural class the work of John Curtis and Prof. Westwood, and has adopted and strongly advocated the adoption of measures found to be successful in other countries, particularly in America. The good which Miss Ormerod has accomplished, can hardly be estimated at the present time, but she will deserve, at the hands of posterity, canonization as the patron saint of economic entomology in England."

In addition to Miss Ormerod's work, a series of reports and bulletins has appeared from the pen of Mr. C. Whitehead, a practical farmer who also holds the position of technical adviser to the Board of Agriculture.

As stated above, great advance has been made on this continent, which is certainly due to the practical tendency of the majority of the people of North America to recognize what is useful when laid plainly before them; but also to the excellent nature of the work which has been done. It would be entirely out of the question to mention even the names of the many eminent economic entomologists of the United States, and only such will be cited now as are necessary in speaking of the few instances which I propose to lay before you, to illustrate a few of the heads of subjects embraced in a consideration of the practical use of the study of entomology.

In Canada, outside of the work done by the Dominion Entomologist's Department at Ottawa, founded in 1884, the development of economic entomology has been most intimately connected with that of the Entomological Society of Ontario, which issued its first report on injurious insects in 1870. Since that year these valuable reports have appeared regularly, and have supplied the farmers of Ontario with much information of incalculable value, which has certainly saved the country a great deal of unnecessary loss.

Special mention must be made of the classic work on "Insects Injurious to Fruits," by our fellow-member, Prof. W. Saunders. He and the Rev. Dr. Bethune, the present able editor of the "Canadian Entomologist," were both original members of the Entomological Society of Ontario, and have borne the brunt of the work of building up that thriving and useful organization which is now presided over by my esteemed colleague and co-worker, Mr. W. H. Harrington, who is now so well known in scientific circles all the world over for the care, accuracy and thoroughness of his work. The late Abbé Provancher published

much and did excellent work, but it was chiefly of a scientific and descriptive nature.

In the curriculum of the Ontario Agricultural College at Guelph, practical entomology is included, and Prof. J. H. Panton not only lectures on this subject to the students, but has also published several timely bulletins on injurious insects for the use of farmers. Besides the above, there have appeared some useful articles by Prof. A. H. Mackay in the "Educational Monthly" of St. John, N.B., and an excellent article on the Flour Moth by Dr. Bryce of Toronto. Useful notes on the occurrence of injurious insects have also appeared in the report of the statistician of the Department of Agriculture of British Columbia. In 1894 an Inspector of Fruit-pests was appointed for British Columbia in the person of Mr. R. M. Palmer, and doubtless good results will follow this step.

A fact which should never be lost sight of, in considering the progress and bearings of practical entomology in Canada, is the enormous advantages we enjoy from having so near to us the United States, with its army of trained entomologists and other officials at Washington and at the state colleges and agricultural experiment stations. Most of the insect enemies which are injurious in Canada occur also in some of the States of the Union, and it is mutually advantageous to entomologists here and in the United States to be able to study together, under slightly different circumstances, any new pests which may occur. In addition to this, of course, many of the insects which appear in Canada have already been studied out carefully in the United States before they reach our borders, and we have the benefit of all the experience of our neighbours to guide and help us in counteracting their attacks. In the case of some insects practical and effective remedies have been discovered before the insects invaded our borders. Notable instances of such insects are found in the Cattle Horn-fly, the Pear-leaf Blister-mite, and the Pear-tree Psylla.

GENERAL PRINCIPLES.

It does not require much observation to see that the annual losses due to insects are very great, and no good object would be served by attempting here to give in figures the estimated amount of such losses; but it may certainly be stated that at least one-tenth of all crops grown is annually destroyed by insects. Further than this, the life-histories of many of the species causing this loss have been so carefully worked out that there is no doubt that a large proportion of that percentage may be saved by practising some of the simple, cheap and effective remedies which have been recommended by entomologists. I hope it may not seem too redundant if I briefly draw your attention to some of the general principles, which probably to most of you are well known, by which the

attacks of injurious insects are met. All remedies are devised with regard to the nature or habits of the insects to be controlled. Insects can be divided into two large classes by the nature of their mouth parts: (1) Mandibulata, or Biting insects, and (2) Haustellata, or Sucking insects. The first of these can be destroyed by placing active poisons on their food-plants, so diluted as to be innoxious to the plant, but at the same time sufficiently powerful to destroy the insects. For the second class, insecticides which kill by mere contact with their bodies, are necessary. We have now standard active remedies which answer for both of these classes, and, in addition, many preventive measures may be taken by which injury is warded off. All these methods, together with the necessary apparatus, have been treated of with considerable detail in Bulletin 11 of the Central Experimental Farm series, copies of which are still available for all who apply for them; and I now propose, under a few heads, to speak as briefly as possible of some instances of good entomological work which demonstrate the practical value of a knowledge of economic entomology.

CONTROLLING BY REMEDIES.

Reverting now to the two classes of injurious insects—Biting insects and Sucking insects,—I will draw your attention to the value of the two standard remedies for these classes: 1. Paris green, which is an arsenite of copper containing about sixty per cent of arsenic, is almost an ideal material for the purposes to which it is applied by entomologists. Its characteristic green colour advertizes its poisonous nature, and prevents many accidents which might arise from carelessness; its insolubility in water and under most conditions to which it is likely to be exposed before it is applied, renders its use very simple. Its fine state of division makes its dilution, either with liquids or dry powders, very convenient. Moreover, its extreme virulence as a poison makes it possible to dilute it very much indeed without destroying its efficacy as an insecticide. The recent discovery that the admixture of an equal weight of fresh lime with the arsenite neutralizes its caustic effect upon vegetation, has removed the last drawback to the use of this material. This has also simplified immensely the question of the most suitable remedy for Mandibulate insects. Now, a standard strength of one pound of Paris green, one pound of quick-lime and two hundred gallons of water, may be recommended for use on all kinds of vegetation. Three years ago I had the honour of laying before this section some of the remarkably satisfactory results which had been obtained by spraying fruit-trees with Paris green to protect them against insect injury. Since that time I have lost no opportunity to bring this matter officially before the farmers of Canada, and to-day there is more spraying being done throughout the

country than has ever been previously the case over an equal area of territory, and during the present spring there is certainly an enormous increase in the number of fruit-growers and farmers who are adopting this useful method of protecting their crops from injury. This is to a large measure due to an excellent series of experiments carried on by my colleague, Mr. John Craig, Horticulturist of the Central Experimental Farm, in the fruit orchards of western Ontario last year. I have no doubt at all that the fruit-growers of Canada will reap a rich harvest for their pains, which will much more than repay them for the extra outlay and labour. The question of the combination of fungicides and insecticides, first prominently brought forward by Prof. Clarence M. Weed of New Hampshire, is now known to be an important one, and many of the agricultural experiment stations have issued spraying calendars in which this dual treatment is universally recommended.

2. Kerosene emulsion, the standard remedy for sucking insects, is simply an emulsion made by churning for five minutes two gallons of coal oil with one gallon of hot soap-suds containing half a pound of soap. This gives the stock emulsion, which may be reduced with water to any degree of weakness, and which may be used on most foliage with impunity, if mixed with nine times its volume of water. Moreover, it is a most effective destroyer of all insects upon which it may be sprayed. It is particularly effective against scale insects, a class of insects which are very difficult to treat. In the effort to eradicate the pernicious San José scale, recently detected in the eastern States, this was found to be a useful remedy. The occurrence of that scale east of California, and the vigorous, prompt measures adopted by the United States Entomologist, have obtained for that officer great credit among the fruit-growers of America.

Another of Mr. Howard's triumphs was the working out of the full life-history of the Cattle Horn-fly, a pest of horned stock, which of recent years has been the cause of much loss to dairymen. I happened to be in Washington at the time its first occurrence was announced in Virginia, and had the opportunity of going with Mr. Howard to the infested district, where he collected the first eggs of the fly, from which he successfully worked out the complete life-history, and proved that the maggots bred entirely and only in fresh cattle droppings. This indicated at once two remedies: one preventive, for protecting the cattle from the bites of the flies, for which kerosene emulsion, with a little carbolic acid added, is one of the best; and the treatment of the droppings so as to render them unfit breeding-places for the maggots.

CONTROLLING BY NATURAL ENEMIES.

One of the most remarkable instances of widespread benefit to a large district from the carefully thought-out plans of a competent entomologist is the celebrated case of the introduction into California by

Prof. Riley of the small Australian Lady-bird beetle (*Vedalia cardinalis*), with the object of destroying an injurious scale insect, which was working great havoc in the California orange-groves. The Fluted Scale, otherwise known as the "White" or "Cottony-cushion Scale" (*Iceryia purchasi*, Maskell), is, for its family, a large species, which was probably introduced into southern California about 1868, and, having reached the groves of citrus fruits, spread rapidly and increased so enormously that at the end of twenty years it not only had attracted universal notice by the extent of its injuries, but was the cause of great alarm. All efforts to control this insect seemed ineffectual, owing chiefly to its power both of living on a great variety of food-plants and of surviving for long periods without any food at all. Prof. Riley in 1886 directed his attention especially to the subject of discovering a practical remedy for this insect, and, having convinced himself that it was indigenous to Australia, and having also observed that it only occurred there in moderate numbers, he concluded that there must be in its original home some natural parasite which was keeping it in check there and preventing it from multiplying to the injurious extent to which it was occurring in California. A recognized rule in practical entomology is that when a foreign insect is introduced into a new home and increases excessively, this is due not only to the suitable conditions it finds in its new home, but particularly to the fact that its own special parasites are not as a rule imported with it. It is true that frequently the parasites of allied species of insects gradually acquire the habit of depredating upon the newcomer, but this takes some years, and may be only partially effective or not take place at all. It was noticed that some of the native predaceous Californian insects were attacking the Fluted Scale to some extent, but Prof. Riley urged that greater success would be secured by importing from Australia its own natural enemies. After much trouble, this plan was satisfactorily carried out, through the skill of Mr. Albert Koebele, who was sent to Australia by Prof. Riley in 1888, and succeeded in sending home safely to California several consignments of parasitic and predaceous enemies of the Fluted Scale. One of these, known as *Vedalia cardinalis*, a small Lady-bird beetle, has more than answered all the expectations of its introducers; for, in the short space of one year and a-half from its first introduction, it has practically cleared out the injurious Fluted Scale throughout the infested region. It increases with surprising rapidity, taking only a month from the time the eggs are laid until the perfect beetles appear. The females lay a large number of eggs, and, as far as is known, it feeds exclusively on the Fluted Scale. Prof. Riley, in relating the history of this experiment, says: "The expression of two well-known people may be quoted here to illustrate the general verdict. Prof. W. A. Henry, director of the Wisconsin Agricultural Experiment Station, who visited California in 1889, reported that the work of *Vedalia*

was the finest illustration possible of the value of the department to give the people aid in time of distress, and the distress was very great indeed." Mr. William F. Channing, of Pasadena, wrote, two years later: "We owe to the Agricultural Department the rescue of our orange culture by the introduction of the Australian Lady-bird, *Vedalia cardinalis*. The White Scales were incrusting our orange-trees with a hideous leprosy. They spread with wonderful rapidity, and would have made citrus growth on the whole North American continent impossible within a few years. It took the *Vedalia*, when introduced, only a few weeks absolutely to clean out the White Scale. The deliverance was more like a miracle than anything I have ever seen. In the spring of 1889 I had abandoned my young Washington Navel orange-trees as irrecoverable. Those same trees bore from two to three boxes of oranges apiece at the end of the season (or winter and spring of 1890). The consequence of the deliverance is that many hundreds of thousands of orange-trees of the finest varieties have been set out in southern California this last spring."

In other words, the victory over the scale was complete and will practically remain so. The history of the introduction of this pest, its spread for upwards of twenty years and the discouragement which resulted, the numerous experiments which were made to overcome the insect and its final reduction to unimportant numbers by means of an apparently insignificant little beetle imported for the purpose from Australia, will always remain one of the most interesting stories in the records of practical entomology." The results of all this may be summarized as follows:—An experiment, the cost of which was limited to \$2,000, has rendered the cultivation of oranges, lemons, limes and other citrus fruits possible in California, whereas but for this experiment the whole of that important and lucrative industry would inevitably have been entirely wiped out, thus involving the loss of hundreds of thousands of dollars. The same satisfactory results have also followed the introduction of the *Vedalia* into Cape Colony and Egypt.

CONTROLLING BY VEGETABLE PARASITES.

Closely allied with the subject of the utilization of the insect parasites of insects is the propagation and distribution, when required, of the contagious diseases of insects of a bacterial or fungous nature. In this direction careful investigations and extensive experiments have been carried on in Kansas by Prof. Snow, in Illinois by Prof. Forbes, and in Massachusetts by Prof. Roland Thaxter.

Prof. Forbes has recorded ('Insect Life,' V., p. 68) that several of the plant parasites of insect feed greedily on very common substances, and may consequently be kept in stock or made to multiply on occasion with enormous rapidity, and so scattered broadcast where and when most

needed. This is true of all the bacterial germs of insect disease thus far studied, and also of certain higher fungi infesting insects.

Extensive work has been done in France by Monsieur Alfred Giard on a species which he calls *Isaria densa* (*Botrytis tenella* of Prillieux and Delacroix), a fungus particularly destructive to species of White-grubs (*Lachnosterna*), and tubes containing the spores have been extensively advertised in Europe. In this country the fungus most extensively used in this work is known as *Sporotrichum globuliferum*. This has been carefully cultivated and much used as a means of checking the enormous hordes of the injurious chinch-bug which yearly do so much harm in the western States. A long and interesting account of Prof. Snow's work in this connection will be found in the Annual Report of the Entomological Society of Ontario for 1892. Prof. Forbes described the parasite as follows:—"This fungus, which springs from minute white spores or so-called *conidia*, penetrates the living insect and finally imbeds the dead body of its host in a thick felt of white fibres which becomes covered with myriads of white or slightly yellowish spores collected in globular heads. It does not form resting spores, belonging in fact to an order of fungi in which such spores have never been found, but it may nevertheless be preserved in a living state for many months—certainly over the winter—by simply drying out the ripe *conidia*. We have so preserved it in fact for an entire year, and have found by experiment that the vitality of its *conidia* is proof against at least ordinary winter temperatures and summer heat of 104 degrees F." "The fungus may be cultivated in large quantities very readily in disinfected fruit jars on corn meal soaked with beef broth, the growth forming a thick layer of dust-like spores on the surface, which may be brushed or scraped off and preserved for use in homeopathic vials plugged with cotton. This parasite is by no means uncommon in Canada and occurs upon several insects. The most remarkable epidemic of it which has come under my notice was in 1891 in Vancouver Island. For some years previous to 1891 the oaks on Vancouver Island had been annually defoliated in the spring by myriads of caterpillars of a moth known as *Ellopija somnaria*. In 1891 many diseased caterpillars were sent to me by Mr. W. H. Danby, of Victoria, and were found on examination to be infested with this fungus. The following year and up to the present time, the caterpillars have been so scarce that a single specimen can only be found with difficulty. It is true there were parasitic insects also at work; but I consider that the chief cause of diminution of the caterpillars was due to this disease.

Other fungi of interest which frequently do good work are the peculiar parasite of the White grub (*Cordyceps melolonthæ*) and an Empusa (*E. aphidis*), frequently abundant and destructive not only to myriads of the injurious plant-lice, but also to numerous other insects.

AGRICULTURAL TREATMENT.

A most necessary part of good agriculture which affects entomology, and which therefore an entomologist must study, is a comprehension of the principles regulating the rotation of crops, by means of which any insect attracted to a locality by a certain food-plant being grown there, will not have the same food-plant to feed upon the next year. It sometimes becomes necessary to change the time of planting or reaping crops, so as to present it to its insect enemies, at their regular time of appearing, in a condition in which it cannot be injured, or even to give up the cultivation of a crop for a length of time altogether, so as to starve the insects out. For the effective application of this latter remedy great care must be taken to have all hedges, waste lands and fence corners kept clean from weeds. Occasionally, the planting of a small strip of a more attractive food-plant round the outside of a field has had the effect of drawing off insects from the main crop. It is a common practice with some gardeners to plant a few radishes amongst their seedling cauliflower flowers in order to concentrate the attacks of root maggots; and in the same way mustard is planted with turnips in order to attract the flea-beetles: as mustard germinates sooner than turnips, the beetles are attracted to it, and then destroyed by dusting the plants with Paris green. Lately Prof. Howard E. Weed has practised this bait-trap method with mustard in order to collect the exceedingly injurious Harlequin plant-bug, which destroys cabbages in Mississippi and other southern States. When the strip of mustard has attracted the bugs, it is sprayed heavily with a strong kerosene emulsion.

As an instance of keen perception and useful grasp of a subject in this line, I will draw your attention to the remedy first suggested by Mr. L. O. Howard for the Clover-seed Midge, which every year so materially lessens the output of an important crop in Canada. In my report for 1885 to the Honourable Minister of Agriculture, I stated as follows: "Ontario in 1881 produced a crop of clover-seed worth \$648,600. Since that time the Clover-seed Midge has made its appearance, and its injuries have been so considerable that, instead of Canada exporting large quantities of this valuable seed, our farmers have now to import seed to sow their fields." I used every effort to make known widely the following treatment, which was adopted in many districts with most satisfactory results, and gradually the production of Canadian clover-seed has increased year by year.

Instead of cutting the first crop of clover at the end of June and leaving the second crop for seed in the fall, pasture the first crop until the middle or up to the 20th June, or cut it before the latter date, and then let the clover grow for the fall crop of seed; thus the grubs of this first brood (the eggs of which were deposited on the growing clover as

soon as the heads formed) are destroyed by the cattle eating them, or they dry up with the clover hay which has been cut before they were mature enough to leave the heads of clover and go into the ground to complete their stages. By leaving the clover standing in the fields till the end of June a sufficient time elapses for this latter process to take place, and the perfect flies emerge again just in time to lay their eggs in the opening flowers of the second crop. In this way, the seed of the second crop is destroyed as well as the first. The discovery of this practical remedy I formerly attributed to a Canadian farmer; but I find it, together with many other suggestions of great value in economic entomology, was undoubtedly first suggested by Mr. Howard.

SYSTEMATIC CO-OPERATION.

Finally, let me bring before your notice one instance exemplifying how combined systematic effort may work wonders even in an apparently hopeless case.

Of the many injurious insects introduced at various times from the old world, not one has, in as short a time, attracted so much attention, been so great a cause of anxiety, or has been so systematically fought as the Gypsy Moth, since it appeared in vast numbers in the state of Massachusetts in 1889. As a practical object lesson of the value of scientifically directed effort to overcome an insect enemy which had been allowed to increase unnoticed until it had assumed almost overwhelming proportions, the campaign which has been so successfully carried on for the last four years by the Gypsy Moth Department of the State Board of Agriculture of Massachusetts, is of very great interest to all economic entomologists.

Mr. L. O. Howard, the United States Entomologist, one of the best qualified to express an opinion, says, in his recent address as president of the Association of Economic Entomologists, as follows: "The work upon the Gypsy Moth which has been done by the State of Massachusetts since 1889, is one of the most remarkable pieces of work, judging by results, which has yet been done in economic entomology. The operations have been carried on by a committee of the State Board of Agriculture, and the means have been furnished by large appropriations by the State Legislature. Three hundred and twenty-five thousand dollars have already been appropriated. A territory comprising something over 100 square miles was infested by the insects, which occurred in such extraordinary numbers as to destroy many trees, and almost to threaten the ultimate extinction of living vegetation, not only within the infested territory, but in all localities to which it might spread. The infested territory has been reduced by one-half, and within the districts in which the Gypsy moth at present exists, it is, practically speaking, a comparatively rare species. The future of the insect is, however, problematical.

[FLETCHER]

PRESIDENTIAL ADDRESS

15

The continuance of sufficiently large appropriations from the State Legislature to enable the work to be carried on, on its present scale, is doubtful, and yet those in charge believe that still larger appropriations are necessary to bring about extermination. They are confident, however, that with sufficient means, the insect can be absolutely exterminated from the State of Massachusetts."

The few instances which I have given, will, I believe, show the great economic value of the study of entomology, and, as I have already taken up as much of your valuable time as is permissible on this occasion, I will not cite any more of the numberless cases which might be brought forward; but, in conclusion, let me state that, notwithstanding the enormous numbers of insects in the world, those particular kinds which generally every year attack farm crops, are comparatively few in number—not more than one hundred species.

The life-histories of most of these have been so well worked out that I think it is not too much to claim that, upon application to a competent entomologist, information is now available with regard to most of them, which will enable those inquiring for it, to lessen, mitigate or avert altogether the injury from injurious insects.