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Sixty-Third Annual Report

OF THE

Entomological Society of Ontario

1932

PRINTED BY ORDER OF
HON. T. L. KENNEDY, Minister of Agriculture

ONTARIO

TORONTO
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1933

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Entomological Society of Ontario

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Vice-President—Mr. W. A. Ross, Vineland Station, Ontario.

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ENTOMOLOGICAL SOCIETY OF ONTARIO

FINANCIAL STATEMENT

For the Year Ending October 31st., 1932.

Receipts		*Expenditures*	
Cash on hand, 1931	$ 658.06	Printing	$1,410.00
Subscriptions	505.65	Annual Meeting	87.80
Dues	173.87	Expense	45.60
Advertisements	155.00	Cuts	18.34
Back Numbers	98.21	Salaries	290.00
Government Grant	500.00	Cheques returned	8.15
Interest	4.92	Exchange	1.47
Exchange	52.29	Balance on hand	286.64
	$2,148.00		$2,148.00

Respectfully submitted,

Reg. H. Ozburn,
Secretary-Treasurer.

Auditors—L. Caesar, A. W. Baker.

Entomological Society of Ontario

REPORT OF THE COUNCIL

1931—1932

The Council of the Entomological Society of Ontario begs to present its report for the year 1931-1932.

The Sixty-eighth Annual Meeting of the Society was held at the Ontario Agricultural College, Guelph, Thursday, Friday and Saturday, November 19th, 20th and 21st, 1931.

The morning and afternoon sessions largely devoted to the reading of papers and their discussion, were held in the lecture room of the Department of Entomology.

On Thursday evening the members of the Society, their friends, and visitors enjoyed a Smoker held in the Faculty Club Room, Memorial Hall. During the early part of the Smoker some of the College students gave a few vocal and instrumental numbers, greatly adding to the enjoyment of the evening.

The Friday evening meeting was held in Memorial Hall, Dr. Detwiler, President of the Society, acting as Chairman. Dr. R. Harcourt, Professor of Chemistry at the College, extended a cordial welcome to the members and visitors. Dr. Frank E. Lutz, of the American Museum of Natural History, gave an exceedingly interesting illustrated lecture on "Our Ignorance Concerning Insects." Miss Pollard of Macdonald Hall and Miss McCarthy of the College Staff, contributed some pleasing vocal and violin selections.

During the course of the meetings the following papers were presented:

"Some Notes on the Cyclamen Mite, *Tarsonemus pallidus* Banks; a Pest of Strawberry Plants"—A. G. Dustan and W. G. Matthewman, Entomological Laboratory, Ottawa.

"The Orange Tortrix, *Tortrix citrana* Fern—a Greenhouse Pest in British Columbia"—Arthur Gibson, Dominion Entomologist, Entomological Branch, Ottawa.

"The Black Vine Weevil, *Brachyrhinus sulcatus* Fab. attacking Japanese Yew" —R. W. Thompson, Ontario Agricultural College, Guelph, Ont.

"The History of the Oriental Peach Moth in the Niagara Peninsula"—W. A. Ross, Entomological Laboratory, Vineland Station, Ontario.

"Chrysopids as a Factor in the Natural Control of the Oriental Peach Moth"—W. L. Putman, Ontario Agricultural College, Guelph, Ontario.

"Notes on the Grape Berry Moth"—W. G. Garlick, Entomological Laboratory, Vineland Station, Ontario.

"Control Measures for Apple-Tree Borers"—R. Hutson, Michigan State Agricultural College, Lansing, Michigan.

"An Observation on the Trapping of Apple Maggot Flies"—J. Marshall, Entomological Laboratory, Annapolis Royal, Nova Scotia.

"Some Notes on the Apple and Thorn Skeletonizer, *Simaethis pariana* Clerk"—L. Caesar, Ontario Agricultural College, Guelph, Ontario.

"The Status of Lubricating Oil Sprays in Ontario"—W. A. Ross, Entomological Laboratory, Vineland Station, Ontario.

"Some Entomological Interceptions on Imported Nursery Stock"—R. W. Sheppard, Plant Inspection Office, Niagara Falls, Ontario.

"The Black Vine Weevil, *Brachyrhinus sulcatus* Fab. Causing Injury to Strawberry Plantations in New Brunswick"—R. P. Gorham, Entomological Laboratory, Fredericton, New Brunswick.

"Notes on the Brown-headed Spruce Sawfly, *Pachynematus ocreatus* Harrington"—A. V. Mitchener, Manitoba Agricultural College, Winnipeg, Manitoba.

"*Dreyfusia (Adelges) picae* Ratz. and its Relation to 'Gout' Disease in Balsam Fir"—R. E. Balch, Entomological Laboratory, Fredericton, New Brunswick.

Colonization of *Collyria calcitrator* in Western Canada"—C. W. Smith, Entomological Laboratory, Belleville, Ontario.

"Further Studies upon the Parasites of the Oriental Fruit Moth in Ontario"—W. E. van Steenburgh, Entomological Laboratory, Belleville, Ontario.

"Some Apparatus Developed in Connection with Parasite Work"—A. B. Baird and G. Wishart, Entomological Laboratory, Belleville, Ontario.

"Observations on the Outbreak of Sod Webworm During the Season 1931"—G. M. Stirrett and A. Arnott, Entomological Laboratory, Chatham, Ontario.

"Notes on the Potato Stem Borer, *Gortyna* (*Hydroecia*) *micacea* Esp."—R. P. Gorham, Entomological Laboratory, Fredericton, New Bruswick.

"Some Experiments with Temperature, Moisture and Their Effects on Diseases of Red-backed Cutworm"—H. L. Seamans and R. W. Salt, Entomological Laboratory, Lethbridge, Alberta.

"A Co-operative Quantitative Investigation of the Relation between Summer-Fallow Methods and the Wireworms in Saskatchewan; a Progress Report"—K. M. King, University of Saskatchewan, Saskatoon, Saskatchewan.

"Notes on Life-history of *Euxoa detersa* Wlk."—H. F. Hudson, Entomological Laboratory, Strathroy, Ontario.

"Observations on the Outbreak of the Green Clover Worm attacking Beans during the Season 1931"—G. M. Stirrett, Entomological Laboratory, Chatham, Ontario.

"The Correlation of Sunspot Periodicity with Grasshopper Fluctuations in Manitoba"—N. Criddle, Entomological Laboratory, Treesbank, Man.

"The Sugar-beet Nematode: Observations on its First Appearance in Canada"—G. M. Stirrett, Entomological Laboratory, Chatham, Ontario, and R. H. Painter, Entomological Branch, Ottawa, Ontario.

"Notes on the Onion Maggot, *Hylemyia antiqua* Meigen"—E. W. Kendall, Jr., Ontario Agricultural College, Guelph, Ontario.

"Notes on *Taeniothrips gladioli* Moulton and Steinweden"—A. G. Dustan, Entomological Branch, Ottawa, Ontario.

"Notes on Control Substances for Sowbugs"—R. W. Thompson, Ontario Agricultural College, Guelph, Ontario.

"European Corn Borer Situation in Ontario in 1931"—L. Caesar, Ontario Agricultural College, Guelph, Ontario.

"Notes on Some of the More Injurious Insects of the Season 1931 in Canada":

Nova Scotia	Mr. F. C. Gilliatt
New Brunswick	Mr. R. P. Gorham
Quebec	Mr. G. Maheux and Mr. C. E. Petch
Ontario	Prof. L. Caesar and Mr. W. A. Ross
Manitoba	Prof. A. V. Mitchener and Mr. N. Criddle
Saskatchewan	Mr. K. M. King
Northern Alberta	Prof. E. H. Strickland
Southern Alberta	Mr. H. L. Seamans
British Columbia	Mr. E. R. Buckell

"Collecting Among the Snow Peaks of Vancouver Island"—J. B. Thompson, Victoria, British Columbia.

"A Preliminary Report on the Effect of Precipitation on the Emergence of *Cephus cinctus* Nort."—G. F. Manson, Entomological Laboratory, Lethbridge, Alberta.

"Recent Observations on the Behaviour of *Wohlfahrtia vigil* Walk."—Dr. Norma Ford, University of Toronto, Toronto, Ontario.

"Notes on Certain Myiasis-Producing Diptera"—A. A. Kingscote, Ontario Veterinary College, Guelph, Ontario.

"The Occurrence of the Moose, or Winter, Tick in the Maritime Provinces in 1931"—R. P. Gorham, Entomogolical Laboratory, Fredericton, New Brunswick.

"Local Variations in the Habits of *Hypoderma lineatum* Villers and *Hypoderma bovis* De Geer of Significance in Regard to Control Measures"—A. A. Kingscote,, Ontario Veterinary College, Guelph, Ontario.

"The Temperature Gradient of a Stream and its Effect on the Insect Fauna"—Fred P. Ide, University of Toronto, Toronto, Ontario.

"The Mouth Parts of Beetles of the genus Nemognatha"—G. J. Spencer, University of British Columbia, Vancouver, British Columbia.

"The Effect upon the Insect Head Capsule of Changes in the Position of the Mouth parts"—E. M. Walker, University of Toronto, Toronto, Ontario.

"The Uses of Cellulose Nitrate in Exhibition Work"—A. A. Wood. Entomological Laboratory, Strathroy, Ontario.

"Variations within the species of the Nemestrinid Fly, *Rhyncocephalus sackeni* Williston"—K. Graham, University of British Columbia, Vancouver, British Columbia.

The Canadian Entomologist, the official organ of the Society, completed its sixty-third volume in December last. The volume contained 296 pages, illustrated by 18 full page plates and nine original figures. The contributors to these pages numbered forty and included writers in Ontario, British Columbia, and also thirteen of the United States.

It is with deep regret that the Council records the passing of one of the founders of our Society in the person of Dr. C. J. S. Bethune who died at Toronto on the 18th of April. Dr. Bethune's work in entomology and especially his activities in connection with this Society are well known to all our members. The Council wishes, however, at this time to express the sorrow of our members in the death of Dr. Bethune and their appreciation of his great contribution in the organization and development of this Society. An account of Dr. Bethune's life appeared in the Canadian Entomologist for May, 1932.

It is also our sad duty to refer to the loss during the year of another of our members. The tragic death of Professor A. B. Klugh of Queen's University was a great shock to his numerous friends. Dr. Klugh had been interested in numerous phases of entomology. At the last Ottawa meeting he made one of the most interesting contributions to the programme. He also will be much missed.

REPORT OF THE LIBRARIAN

The usual additions have been made to the Society's library and a few new exchanges have been effected with foreign periodicals. The work of re-arranging and indexing the whole library has been continued.

REPORT OF THE MONTREAL BRANCH OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO

The 59th Annual Meeting of this Branch was held on May 14th, 1932, in the Lyman Entomological Room, Redpath Museum, McGill University, Montreal.

The usual eight meetings were held during the season, in the Lyman Room or at the residences of members. The average attendance was 13 per meeting. One public meeting was held in the Biological Building, McGill University, when Professor F. E. Lloyd gave an interesting lecture on the "Metallic Sheen in Insects and Birds." We again donated a prize for the best collection of insects at the Boys and Girls' Hobby Exhibition in the Central Y.M.C.A., and during the past season have made good progress with our collection of lantern slides.

The following papers were read during the year:—

"Review of Dr. A. D. Imms' Work, 'Recent Developments in Entomology' G. A. Moore

"The Pentatomid Genus *Euchistis,* particularly species *ictericus*..G. A. Moore

"Ravages of the Japanese Beetle, *Popillia japonica,* near Philadelphia" ...... H. Mousley

"Behaviour of Philanthid Wasps preceding a thunderstorm"........J. W. Buckle

"*Sirex cyaneus* at Tadoussac" ....A. F. Winn

"Review of a collection of Heteroptera-Homoptera taken by Mr. A. F. Winn at Tadoussac" ....G. A. Moore

"The Sound and Auditory Organs of the Cicada" ....G. H. Fisk

"An Aquatic Hymenopteron" ....G. Chagnon

"Strawberry Pests on the Island of New Orleans" ....J. I. Beaulne
"Malaria and the *Anopheles* Mosquito in Canada" ....G. H. Fisk
"Metallic Sheen in Insects and Birds" ....Prof. F. E. Lloyd
"Sand Wasps taken on a Railway Embankment" ....J. W. Buckle
"The Chrysomelid Beetle, *Haltica chalybea*" ....G. H. Fisk

The treasurer's report showed a balance on hand of $199.28.

The following were elected officers for the season: President, Albert F. Winn; vice-president, G. H. Hall; Secretary-treasurer, J. W. Buckle; council, G. A. Moore, G. Chagnon, A. C. Sheppard and G. H. Fisk.

J. W. BUCKLE, *Secretary.*

THE BALANCE SHEET OF ENTOMOLOGY

W. H. Brittain

Macdonald College, Quebec

As pointed out some years ago by a distinguished president of the American Association for the Advancement of Science, there must be, previous to the annual convention of every scientific society, one man who spends months worrying over the subject for an address and its mode of presentation—and this in spite of the fact that no one ever reads a presidenial address except the man who prepares it. Not only is this true, but, if any one ever did take the trouble to read through the presidential addresses given before any society that has existed as long as our own, he would find that everything had been said that could be said, or, at least, everything that custom decrees as suitable for such occasions. Though differing in subject, treatment, and point of view, they resemble each other in expressing ideas with which we can all agree.

Every year we come together to exchange ideas, to record achievement and to rejoice in the progress we have made. In studying the addresses of my predecessors, there appears, however, to be one element that, at least, has not been over-emphasized, namely, the element of self criticism. Accordingly, the thought occurred to me that, in attempting an evaluation of the present status of entomological science, a little more stress might, with advantage, be placed upon our shortcomings and upon our failures to achieve what we might have accomplished, had the fullest use been made of the opportunities presented. The present speaker is well aware of his lack of qualifications to perform such a task, but hopes that the mere attempt may be of value in provoking thought and preferably some disagreement, from which constructive discussion may be expected to arise.

Looking back over the past twenty-five years, which is a most significant period in the history of our science, it is easier to observe the positive achievements than the failures. At the beginning of that time the first established branch of entomology, viz., taxonomy, was already old and had many splendid achievements to its credit, along with much work that had better not been done. When a few more able men with sound fundamental training in morphology, together with a few skilled biologists, geneticists and mathematicians escape into the rich field of taxonomy their methods may have a fertilizing effect upon that sometimes sterile science and perhaps a greater amount of concern may develop to ensure that species are biologically as well as bibliographically accurate. We hope it is not too much to expect, also, that a larger proportion of our taxonomists may pause in their compassing of land and water in order to discover new species, to prepare those careful revisions of a genus, family or order, preferably one the members of which may conceivably have some economic importance, of which we have all too few.

At the opening of the period indicated we already had a number of classical papers in the field of morphology that have scarcely been surpassed and, when we consider such excellent sustained contributions as those of Snodgrass and the fundamental studies of our own Dr. E. M. Walker, we can only hope that their tribe may increase faster than the new nomenclature that certain others delight to create.

In insect biology, in its widest sense, we owe a great debt to a generation of inimitable observers who have all but passed away. Modern workers, with a new viewpoint, new concepts, new apparatus and new discoveries in sister sciences to aid them, are fast accumulating a mass of accurate experimental data that, in many cases, is not only supplying new facts, but giving us a new and better conception of fundamental principles underlying our science. One has only to read the presidential address of the late Dr. C. Gorden Hewitt, which dealt with insect physiology, before the American Association of Economic Entomologists in 1918, to realize what progress has been made even in that brief perid, and no one who has observed the present trend can doubt that work in this field will proceed with increasing acceleration. It is to be hoped, however, that in the modern preoccupation with experiments, in reliance upon apparatus and upon mathematical methods, we do not lose entirely that element that gave to the work of the older generation of naturalists its peculiar value.

In no way can the progress in entomology be more clearly observed than in the numerous well arranged, well written and well illustrated bulletins, that make so many of those of former years appear crude and unfinished. This is true of all entomological literature, but particularly to that relating to the economic phase of the subject. No one will pretend, however, that there is no need for further improvement in matters of form as well as in subject matter. It is a great pity that we cannot have more technical publications of a monographic character. We know of workers spending years upon a study in which countless difficulties have been encountered and overcome, and at the end the results are published in a six-page pamphlet. The data on which conclusions are based and the technique used, so important from the standpoint of the worker in the field and so essential for the progress of the science, are not mentioned.

Those who have much bibliographical work to do, as all research workers must have, find the multiplicity of series into which publications are classified a continual source of trouble and annoyance. We have research bulletins, press bulletins, technical bulletins, special bulletins, popular bulletins, extension bulletins, old and new series, circulars, special circulars, miscellaneous circulars, pamphlets, leaflets and what not in endless confusion, causing a constant rock of offence to the bibliographer, the filing clerk and the librarian. Surely all these categories are unnecessary. The taxonomic distinction between a circular and a pamphlet for example is difficult to discern.

Twenty-five years ago there were no separate departments of entomology in our colleges and universities and at only two institutions had it attained the dignity of a separate subject. Not more than ten years ago the Dean of a graduate school at a great Canadian university remarked to an applicant that surely he did not propose to spend his whole life time on such a trivial and narrow subject. A recent presidential address has outlined our progress in this field and further repetition is unnecessary.

Probably no one who is engaged in the teaching profession would look upon the present situation with any degree of complacency and all recognize the necessity of higher standards, sounder and longer training and improved equipment to keep pace with recent advances and discoveries. The present tendency is for a sounder background in the physical, mathematical and biological sciences and for the postponement of specialized training. There is recognition of the fact that for professional requirements the university course is not sufficient and that there is no substitute for laboratory and field experience in a student's training.

The instructor to-day who encourages a student to enter entomology as a life-work is incurring a grave responsibility. We must have a more careful selection of the human material, a better trained product and a drastic cutting down in numbers. It may be that we should train more entomologists as some have contended. Those of us who have to do with students, however, know that during the last two years there have emerged from our universities a larger proportion of able young men incomparably better trained for their life-work than those entering the field a generation ago, and that many of these have been forced to take non-entomological positions or have joined the great army of the unemployed. It seems to the present speaker that, for a long time to come, we must endeavour to follow also the line indicated rather than to strive for mere numbers.

Employers, however, should not indulge in unreasonable requirements. To expect finished products of two- or three-year students or even of graduates is asking too much. We constantly see advertised positions demanding the most highly specialized training in a certain narrow field and we often hear public men complaining that they have had to go to some other country to get the man with the specialized experience necessary and perhaps blaming the universities for not providing such men. Does not this reveal a defect in our methods of securing men? Perhaps the position referred to is the only one of its kind in the country. It might be necessary to train a score of men in order to select one capable of performing the task. Would it not be better to select a man with the native ability and bent for that kind of work, together with the basic fundamental training upon which to base specialization in that particular field. Such a man should very soon succeed in outdistancing one of lesser ability chosen because he chanced to have the particular specialized experience desired. If we also had a more flexible system that would allow men to develop problems and then to create positions for them, we would be more closely approaching the ideal.

From the standpoint of organization our progress has been so marked as to require little comment. The first official Provincial Entomologist was appointed in 1912 and a Dominion Entomologist only two years earlier. The highly developed organization we have to-day carries with it certain dangers, the greatest of which is in over-departmentalization. The present trend is for grouping workers around a problem rather than around a subject. Fortunately, there are signs that this idea is taking hold and it cannot be too strongly encouraged.

At the beginning of the period to which I have referred, we had, in economic entomology, scarcely emerged from the salt, wood-ashes and "pull up and burn" era. The impressive developments in chemical control were only beginning, while the utilization of the biological control method, of bioclimatic data in connection with economic outbreaks and distribution, the application of knowledge based on sense reactions and the whole technique of experimentation, is still in a state of rapid evolution. With all our progress there is still need for greater use of the discoveries made in other sciences, for the more general adoption of refinements in experimental technique in the working out of new methods. One does not have to make a fetish of the methods of mathematical analysis to observe that many entomological papers are often positively infantile in their disregard of what constitutes scientific evidence. In this respect we have fallen far behind the workers in other fields upon whom we used to look down as from a great height.

The past decade has shown a great expansion of so-called "plant quarantine" organizations, often overshadowing other services. Some legislation of this character that has been passed by national or local legislatures may have been wise, more has been futile and some vicious. There is more than a suspicion in some cases that such legislation has been seized upon as a weapon in the war of economic nationalism that is now sweeping the world. Those who have fostered this sort of thing have much to answer for. Whether the vast sums that have been expended on many of these projects might not, in many cases, have been put to a use that might have resulted in discoveries of basic significance and permanent value, is a thought that we cannot escape.

Dr. L. O. Howard once said that all entomology is economic and the late Dr. S. A. Forbes remarked that the economic entomologist is an ecologist whether he realizes it or not, working in that border land where the ecology of man and the insect is co-incident. Carrying this thought a step further we may say that any science that can be utilized in the control of insects is within the province of the economic entomologist.

Strange as it may seem, our most conspicuous success seems to have been in the field of extension work. Still regarded as a harmless nuisance a few years ago, the economic entomologist has now reached a place where he no longer has to apologize for his existence. Such organizations as "Spray Services" are known and valued by those who use them. It is doubtful if those departments who formerly regarded themselves as exclusively entitled to the adjective "practical" can show a like record.

I do not refer to the foregoing fact for purposes of congratulation, because I fear that our happy position in this field is jeopardized by much that is said and done in the name of "publicity", but which might better be termed propaganda. Publicity by the right sort may be allowable: it may even be necessary, but our own system of government does not practically force that sort of thing upon public servants as it does in certain other countries; neither is it necessary to indulge in gross exaggeration in order to scare the public into according the support for a needed appropriation. One constantly sees definite figures quoted of insect damage, based on the flimsiest of data and figures claiming enormous financial savings as a result of the efforts of certain individuals or organizations. It should be realized that this sort of thing undermines the scientific judgment and worse still the scientific integrity of those making such claims, so that, in the end, they come actually to believe the accuracy of their own "estimates". Since the Great War it has become the diversion even of eminent scientists, together with a host of lesser imitators, to draw, in apocalyptic language, vivid pictures of what the poor old world is coming to as a result of the insect menace, in line with the motif employed with such telling effect by Maeterlinck in the famous passage in which he describes insects as our "rivals in these later hours and perhaps our successors". Aside from the aesthetic pleasure derived from such glowing periods, I confess that they affect me somewhat differently than they appear to do some other readers. Being perhaps of an essentially irreverent disposition, being sometimes "moved to unseemly merriment where wiser men are impressed", it only calls to my mind a nursery rhyme that I learned long ago about a certain "little orphant Annie" and the stories she told of "goblins that will git you if you don't watch out".

Even though it may be as the voice of one crying in the wilderness, it seems necessary to point out that this type of exaggeration is likely to lose us that measure of public confidence we now enjoy and to express the thought that it is better to say what is true rather than what is merely striking, to understate rather than overstate and to make no claims at all that cannot be justified on the basis of sure fact, weighed, tested and approved.

If, however, entomology has not registered its maximum potential achievement during the past quarter of a century, the fault cannot be laid in its entirety at the door of the entomologists. Much has been due to the failure of those in authority to realize the needs of the situation. No one has ever suggested, for example, that the agronomists, the horticulturists, the animal husbandmen or geneticists should get along without living plants or animals to work with, and all the paraphernalia of caring for them. In a good many years experience with fruit and vegetable growers, I have never encountered any difficulty in securing all the land required for commercial tests. But is the same attitude shown by those in control of affairs at our experiment stations or agricultural colleges? **It is not,** and, until the necessity of the entomologists and their colleagues the plant pathologists of having under their own control land, plants and equipment, without having metaphorically to go down on their knees for them is recognized, we can never hope to accomplish our greatest usefulness.

Those who, ten years ago, thought that they saw entomological work assuming a dead level, have seen their fears proved groundless. Those who thought they saw us coming to the end of the problems that confronted us have seen new fields of usefulness and new methods of research constantly opening up. To-day there are countless problems vitally affecting the health, wealth and welfare of vast populations in all parts of the earth awaiting attention. The thought that I would like to emphasize in closing is that these problems can only be solved by those specially fitted by ability, temperament and training to do so.

INSECTS OF THE SEASON 1932 IN ONTARIO

L. Caesar, Ontario Agricultural College, Guelph, and W. A. Ross, Dominion Entomological Laboratory, Vineland Station.

Seasonal and distributional notes by Messrs. Hudson, Stirrett, Hall, Sheppard and Dustan of the Dominion Entomological Branch, are incorporated in this report.

Orchard Insects

Codling Moth (*Carpocapsa pomonella* L.)—The codling moth infestation, while still above normal, was not as serious as in the two preceding years. In most well sprayed orchards little or no difficulty was experienced in preventing serious sideworm injury.

San Jose Scale (*Aspidiotus perniciosus* Comst.)—The outbreak of San Jose scale in the warmer districts of the province was to a large extent brought under control by spraying and by cool weather conditions. Observations indicate that the scale population is back approximately to where it was in 1929.

APPLE MAGGOT (*Rhagoletis pomonella* Walsh)—The 1932 outbreak of apple maggot in Ontario was by far the most serious and widespread infestation in our experience. The unusually long, warm and moist autumn of 1931 and the exceptionally mellow condition of late varieties of apples no doubt were responsible for the building up of an abnormally large overwintering population, and the generous supply of rain this year probably facilitated emergence, prolonged the life of the flies and increased their fecundity.

ROSY APPLE APHID (*Anuraphis roseus* Baker)—This species, which in the early part of the season threatened to be unusually injurious, was responsible for considerable damage to the fruit in some apple orchards in different parts of the province, but in most plantings the injury was not sufficiently severe to justify the cost of spraying.

APPLE APHID (*Aphis pomi* DeG.)—In late July there was a local outbreak of this species on young trees at Vineland Station, but elsewhere in the province the insect was of little or no consequence.

EYE-SPOTTED BUDMOTH (*Spilonota ocellana* D. & S.)—With rare exceptions, but little damage was done by this insect.

WHITE APPLE LEAFHOPPER (*Typhlocyba pomaria* McAtee)—In almost all fruit districts this species was very abundant, and in some orchards was very injurious. Some growers now regard the hopper as one of the major pests of the apple.

APPLE AND THORN SKELETONIZER (*Hemerophila pariana* Clerck)—Although readily found on unsprayed trees in many parts of the province, this insect failed to appear in outbreak form anywhere. It is evident that there is a very great mortality of adults during the winter.

APPLE LEAF ROLLERS (*Cacoecia argyrospila* Wlk. and C. *semiferana* Wlk.)—In Norfolk county, leaf roller injury, generally speaking, was very light. In the vicinity of Trenton six orchards heavily stocked with eggs of the fruit-tree leaf rollers were very thoroughly sprayed with oil and serious injury was prevented.

EUROPEAN RED MITE (*Paratetranychus pilosus* C. & F.)—In spite of the unusual amount of rainy weather, there was conspicuous mite injury in the Niagara peninsula on plums, which were not sprayed with oil and on apples, notably Baldwins, which did not receive summer applications of lime sulphur. In other districts the mite was of little importance.

BLACK CHERRY APHID (*Myzus cerasi* Fab.)—Once again there was a serious outbreak of this aphid in sweet cherry orchards in the Niagara peninsula.

PEAR SLUG (*Eriocampoides limacina* Retz.)—About mid-June adults and eggs of this species were readily observed on nursery stock and unsprayed trees, and what unquestionably would have proved to be a serious and widespread outbreak was to a large extent prevented by spraying. Throughout western Ontario neglected cherry and pear trees were defoliated by the slug.

ORIENTAL FRUIT MOTH (*Laspeyresia molesta* Busck)—There was an increase in the moth population in the previously lightly infested area west of St. Catharines, and a marked decrease in the once heavily infested St. Davids-Queenston section. The imported parasite, *Macrocentrus ancylivora,* was quite abundant in the Niagara St. Davids-Queenston district and increased its range in other parts of the Niagara peninsula. *Glypta rufiscutellaris* was abundant over the whole infested area and was undoubtedly one of the major factors in natural control. Chrysopids were very scarce.

Pear Psylla (*Psyllia pyricola* Foerst)—The overwintering population of psyllas was somewhat smaller than usual, and in most commercial pear orchards the insect was readily controlled by a dormant application of oil.

Rose Chafer (*Macrodactylus subspinosus* Fab.)—As usual the rose chafer was troublesome in some of the sandy sections of the province, notably in Welland, Norfolk and Middlesex and York counties.

Black-Horned Tree Cricket (*Oecanthus nigricornis* Walk.)—This species was not only exceptionally abundant in 1931, but it must have been unusually partial to plants other than raspberries for egg-laying purposes. During the pruning season very many inquiries were received from fruit gowers in the Niagara peninsula about tree cricket egg scars on peach, plum, cherry, apple and grape as well as raspberry.

Buffalo Tree Hopper (*Ceresa bubalus* Fab.)—In many orchards throughout the province, young apple trees were severely injured by this insect. More than the usual number of inquiries were received from the Niagara peninsula concerning it.

Canker Worms—Canker worms were quite prevalent in orchards and on shade trees in the Niagara peninsula, but fortunately there was no serious outbreak of the insects.

Pear Leaf Blister Mite (*Eriophyes pyri* Pagnst.)—Injury from this species was very conspicuous on pear stock in a nursery near Beamsville, but elsewhere the mite was of little or no consequence.

Epitrimerus piri Nal.—This free-living mite was sufficiently abundant in the Niagara peninsula to cause a noticeable amount of russetting on the undersides of pear leaves. The variety Anjou appears to be particularly subject to this injury.

Tarnished Plant Bug (*Lygus pratensis* L.)—This bug was again destructive in nurseries. As usual it was most troublesome on peach stock, but it also caused some injury to pears and plums. On other plants, bug injury was about normal.

Bumble Flower Beetle (*Euphoria inda* L.)—This species was very common in September, but no complaints of appreciable damage to fruit from it were received.

Plum Curculio (*Conotrachelus nenuphar* (Hbst.))—This insect was abundant in unsprayed orchards in western Ontario.

Grape and Bush Fruit Insects

Grape Leaf Hoppers (*Erythroneura comes* Say. & *E. tricincta* Fitch.)—As anticipated there was a serious and general outbreak of these insects in graperies from the Niagara river to Stoney Creek, and the probabilities are that, if weather conditions had been similar to those of 1931, the outbreak would have been still more severe. Spraying experiments conducted by the Dominion Entomological Branch again demonstrated that, on account of the marked susceptibility of leaf hopper eggs to nicotine, it is practicable to check completely an outbreak of grape leaf hoppers in one year.

Grape Berry Moth (*Polychrosis viteana* Clem.)—There was a particularly severe outbreak of this species in the Beamsville vineyard which was infested last year. Elsewhere the moth caused but little injury.

Common Red Spider (*Tetranychus telarius* L.)—This mite was of no importance on raspberries. In an experimental plantation near Simcoe, a patch very subject to injury, red spider was very scarce throughout the season even on the check rows.

Strawberry Leaf Beetle (*Paria canella* Fab.)—In a strawberry plantation near Stoney Creek most of the plants were severely riddled, and fully 25 per cent. of them were killed in late summer by this series.

Black Vine Weevil (*Brachyrhinus sulcatus* Fab.)—A strawberry plantation near Port Dalhousie was severely attacked in early July by weevils, which migrated from an adjoining older patch which, after being ruined by the weevil grubs, had been ploughed under. Most of the plants at the end of the rows in the young patch were partially or completely defoliated and the strawberries farther in showed considerable ragging of the leaves. One application of the raisin-shorts-sodium fluoride bait, recommended by Downes, destroyed practically all weevils.

It is of interest to note that the injury in the older patch was mistaken for winter killing by the grower.

Blackberry Leaf Miner (*Metallus rubi* Forbes)—Local outbreaks of this species again occurred in blackberry patches in the Niagara peninsula.

Raspberry Cane Borer (*Oberea bimaculata* Ol.)—In many parts of the province raspberry plants were again severely attacked by this borer.

Currant Fruit Fly (*Epochra canadensis* Loew)—At Peterborough black currants were ruined by this pest, which rarely does any damage in Ontario.

Imported Currant Worm (*Pteronidea ribesi* Scop.)—In the vicinity of Strathroy red currants and gooseberry bushes were completely defoliated by this species.

Vegetable Insects

Greenhouse Leaf Tyer (*Phlyctaenia ferrugalis* Hb.)—After last year's experience, it is of interest to note that this species was of little or no importance on celery in 1932.

Corn Ear Worm (*Heliothis obsoleta* Fab.)—The ear worm attacked early tomatoes in the Leamington district, and later in the season it was abundant on and injurious to corn. It occurred practically all over the province, but was more destructive in western than in eastern districts.

It is of particular interest to record here that Mr. G. M. Stirrett found that the ear worm overwintered successfully in the vicinity of Chatham as pupae in the soil.

Squash Bug (*Anasa tristis* DeG.)—This pest was abundant in some localities.

Cabbage Maggot (*Hylemyia brassicae* Bouche)—As usual, untreated cabbages and cauliflowers were injured by this species, but in most districts it was somewhat less abundant than usual on these plants.

In 1931 and again this year, what appears to be this species, severely injured turnips in many places, especially in Wellington and Wentworth counties. The maggot so disfigured the surface of the turnips by burrowing that the turnips were unfit for export.

Carrot Rust Fly (*Psila rosae* Fab.)—Complaints of rust fly injury to carrots were received from only one county, viz. Prince Edward.

Asparagus Beetle (*Crioceris asparagi* L.)—This species occurred in large numbers in many localities west of Toronto.

Potato Flea Beetle (*Epitrix cucumeris* Harr.)—This flea beetle was very abundant on tomatoes, early potatoes and tobacco this spring. Dusting tobacco with barium fluoscilicate and talc, equal parts, gave good control in experiments conducted by W. R. Thompson in Norfolk county.

Spinach Flea Beetle (*Disonycha xanthomelaena* Dalm.)—The larvae of this insect were very numerous on sugar-beet leaves in western Ontario. This is the first time the flea beetle has been observed in any numbers on sugar-beets.

The insect also severely injured horse-radish plants in Middlesex county.

Colorado Potato Beetle (*Leptinotarsa decemlineata* Say.)—Potato beetles were abundant in western Ontario and were particularly injurious to early potatoes and tomatoes. In eastern Ontario the infestation was about normal.

Striped Cucumber Beetle (*Diabrotica vittata* Fab.)—In western Ontario this species was decidedly injurious to cucumbers, squash and pumpkins.

Cutworms—As usual in the early part of the season there was some injury to various crops from cutworms. However, the injury was slight in comparison with that of 1931.

Imported Cabbage Worm (*Pieris rapae* L.)—Cabbage worm butterflies were particularly abundant in western Ontario throughout the month of August, and the caterpillars attacked an exceptionally wide variety of garden plants.

Garden Springtail (*Sminthurus hortensis* Fitch)—In spring this insect was very abundant in the Ottawa district, where it seriously injured young seedling plants, such as melons, squash and cucumbers. Great numbers of springtails were found on young gladiolus plants during the month of June, but little damage resulted from their feeding.

Potato Aphid (*Illinoia solanifolii* Ashm.)—There was a rather severe local outbreak of this insect at the Central Experimental Farm, Ottawa. The infestation caused a certain amount of yellowing and dropping of the leaves.

Garden Slugs (*Limax* spp.)—Slugs were apparently unusually scarce.

Seed Corn Maggot (*Hylemyia cilicrura* Rond.)—This insect was very scarce.

Six-Spotted Leaf Hopper (*Cicadula divisa* Uhl.)—This leaf hopper was extremely abundant in a large field of lettuce near Ottawa. The insects caused a wrinkling and discolouration of the leaves and in some cases a dwarfing of the heads.

Field Crop Insects

European Corn Borer (*Pyrausta nubilalis* Hbn.)—In most counties in the province there was an increase in the corn borer infestation. A more detailed discussion of the borer situation is given elsewhere.

White Grubs (*Phyllophaga* spp.)—There was a serious infestation of white grubs near Oshawa. Heavy flights of June beetles were reported from Norfolk, Middlesex and Kent. A very severe outbreak of grubs in eastern Ontario is indicated for next year.

Hessian Fly (*Phytophaga destructor* Say)—A number of fields of wheat in several counties west of Toronto were injured more or less severely by the Hessian fly, and a serious outbreak was anticipated this fall, but up to the time of writing no complaints have been received from farmers.

Wheat Stem Maggot (*Meromyza americana* Fitch)—Specimens of the work of this maggot were received from Kapuskasing, Walkerton, Lorneville, Unionville and London. The insect was evidently much more abundant than usual.

Bean Weevil (*Mylabris obtectus* Say)—Beans infested with this insect were received from several places in Halton and Wentworth counties.

Wireworms—Wireworms were abundant and injurious to various crops. In western Ontario the intensity of the infestations was about the same as during 1931. In the east the infestation was about normal.

Sod Webworms (*Crambus* spp.)—In western Ontario the intensive outbreak of last year had completely subsided by the spring of 1932. One small infestation was found in a tobacco field, but no larvae were observed in lawns or pastures. During the fall, winter and spring the worms were reduced by a disease.

Green Clover Worm (*Plathypena scabra* Fab.)—The outbreak of green clover worm, which destroyed 25 per cent of the field bean crop last year in some areas in western Ontario, has completely subsided. Only a few insects could be found on beans this year.

Mexican Bean Beetle (*Epilachna corrupta* Muls.)—Although the scouts of the Division of Foreign Pests Suppression found this insect in numerous places during the season, very little damage was done by it in south-western Ontario. There was, however, an increase over last year in the number of individual infestations found.

Tobacco Worm (*Phlegothontius quinquemaculata* Haw.)—This insect was again abundant in tobacco and tomato fields in western Ontario and in Prince Edward county.

Spittle Insects—In Middlesex county these insects were extremely abundant. In certain fields from two to fifty per cent of the blades of timothy carried spittle.

Pea Weevil (*Mylabris pisorum* L.)—This weevil was decidedly injurious to field stock peas in Lambton and Middlesex counties.

Insects Injurious to Flowers and Ornamentals

Rose Twig Girdler (*Agrilus* sp.)—This girdler was injurious to *Rosa rugosa* in Chatham.

Sumac Jumping Beetle (*Blepharida rhois* Forst.)—Infestations of this insect occurred on sumac in Essex county. The species was also noticed in Kent, but the injury from it was not as extensive as in the former county.

GLADIOLUS THRIPS (*Taeniothrips gladioli* M. and S.)—The gladiolus thrips, although not nearly as destructive as it was last season, caused serious damage in many gladiolus patches. The infestation was apparently heavier in the eastern part of the province than in the west. Excellent results were secured in controlling the insect by treating corms prior to planting.

Antispila viticordifoliella Clem.—On the wild grape vines along the Niagara river gorge nearly 100% of the leaves were mined by the larvae of this species. Virginia creeper was also attacked to a lesser extent.

Nodonota tristis Oliv.—In Stamford township, Welland county, the foliage and flowers of rose bushes, raspberry plants and certain ornamental shrubs, especially dog-wood, were severely damaged and in some cases nearly defoliated by this leaf beetle.

Papilio philenor L.—The larvae of this species were quite injurious to the foliage of *Aristolochia sipho* at Glencoe in mid-July.

FOREST AND SHADE TREE INSECTS

EUROPEAN PINE SHOOT MOTH (*Rhyacionia buoliana* Schiff.)—In Humberstone township, Welland county, plantations of Scotch, Jack and Red pine were seriously infested by this insect. Lighter infestation extended throughout the Niagara peninsula in the counties of Welland, Lincoln, Haldimand and Wentworth. Trees in the vicinity of Niagara Falls were also severely attacked.

PINE BUD MOTH (*Exotelia dodecella* L.)—This insect does not appear to have increased to any marked extent since it was first discovered in the Fonthill district in 1928. This year it was present in most of the nurseries, parks and reforested areas of Welland county.

NANTUCKET PINE BUD MOTH (*Rhyacionia frustrana* Coms.)—In various parts of the province, injury by this species to the new growth of many Scotch pine trees has resulted in the development of bushy growth.

WALNUT CATERPILLAR (*Datana integerrima* G. & R.)—A very severe outbreak of this species took place. Numerous walnut trees throughout the western half of the province were wholly or partially defoliated by the caterpillar.

ELM LEAF MINER (*Kaliofenusa ulmi* Sund.)—Many elms at St. Catharines, Hamilton, Guelph, Port Hope and other parts of the province were heavily infested by this miner.

LILAC LEAF MINER (*Gracilaria syringella* Fab.)—Though not present in serious outbreak form, this miner was once again very much in evidence.

BIRCH SKELETONIZER (*Bucculatrix canadensisella* Chamb.)—This skeletonizer was again abundant, at least throughout the area from Muskoka to Guelph.

Neoborus amoenus Reut.—Adults and nymphs of this leaf bug occasioned severe damage to the foliage of a large white ash tree in the vicinity of Niagara Falls. In 1930 a leaf bug, most probably this same species, injured the foliage of ash trees in the Queen Victoria Park, Niagara Falls.

BRONZE BIRCH BORER (*Agrilus anxius* Gory)—This borer was again injurious to silver birch trees in the vicinity of Niagara Falls. Several trees which were weakened by it last year succumbed to its attack.

Spiny Elm Caterpillar (*Euvanessa antiopa* L.)—This species was reported as being injurious to elms in the vicinity of Ridgetown.

Sycamore Lace Bug (*Corythucha ciliata* Say)—A fairly heavy infestation of lace bugs occurred on sycamore trees in the Point Pelee National Park.

Spotted Willow Leaf Beetle (*Lina interrupta* Fab.)—Severe defoliation of swamp willows by this species was noticed near Elginfield north of London. Some fifteen acres of swamp were affected. The insect also occurred in many other swamps in the same region.

Fall Webworm (*Hyphantria cunea* Drury)—A rather intensive outbreak of fall webworm occurred during the late summer in the Rideau Lake district, near Chaffey Locks. The insects were so abundant as to completely defoliate the smaller trees, which were covered with the white webs. The most heavily infested area seemed to be restricted to a small, hilly district where the infested trees appeared to be sheltered by the type of country.

Household Insects

Webbing Clothes Moths (*Tineola biselliella* Hummel)—These insects are reported as being particularly injurious in Chatham.

Ants—Ants were especially troublesome this year in and around houses.

Fish Moths (*Lepisma saccharina* L.)—These insects were reported as damaging wall papers in houses in Middlesex and Kent and several other counties.

Bedbug (*Cimex lectularius* L.)—Mr. Stirrett reports that in the Chatham area more inquiries were received about bedbugs than in any previous year.

Stable Fly (*Stomoxys calcitrans* L.)—This pest was very abundant and troublesome along the shores of Lake Erie.

Stored Grain Insects

During the past two years very much more damage has been done by insects to stored grain, especially on farms, than in previous years. The following list of species responsible for the injury is arranged more or less in order of their relative importance.

Saw-toothed grain beetle (*Silvanus surinamensis* L.).

Confused flour beetle (*Tribolium confusum* Duval).

Granary Weevil (*Calendra granaria* L.).

Cadelle (*Tenebroides mauritanicus* L.).

Rice Weevil (*Calendra oryzae* L.).

Cathartus advena Walt.

Yellow Meal Worm (*Tenebrio molitor* L.).

Meal Snout Moth (*Pyralis farinalis* L.).

Typhaea fumata L.

Cartodere ruficollis Mrsh.

NOTES ON PEAR PSYLLA AND SAN JOSE SCALE CONTROL

W. A. Ross, T. Armstrong, D. F. Patterson, Dominion Entomological Laboratory, Vineland Sta., Ont.

In discussing the status of lubricating oil sprays* at the last annual meeting of the Entomological Society of Ontario, the senior author pointed out that there is an abundance of evidence that by far the most economical and effective method of combatting the pear psylla is to apply a three per cent lubricating oil spray in late March or early April after the adults have emerged from their winter quarters, and that in the average season the one application of oil will prevent appreciable psylla injury, *provided the spray is completed prior to egg-laying.* In that proviso lies the one weakness in our present control recommendations, because in some seasons and in some orchards ground conditions are not fit for spraying operations until egg-laying is well under way. To make this weakness clear, it should be restated here that the oil kills many of the adults; that it prevents egg deposition by the survivors; but that it is of little or no value as an ovicide. It is evident, therefore, that in order to control the psylla economically in orchards where pre-oviposition spraying is not possible, a combination ovicide-oil spray is required. As lime sulphur is a very effective ovicide, as it is compatible with calcium caseinate oil emulsions, and as tests made in 1931 indicated that a three per cent oil spray in lime sulphur 1-9 could be used with safety on pear trees, we decided to conduct in 1932 some preliminary laboratory and orchard experiments with this mixture.**

Laboratory Experiments:—To determine the deterrent value of the oil-lime sulphur mixture, gravid psylla adults—six pairs per test—were confined in celluloid cages with sprayed and unsprayed pear twigs, and were left undisturbed for eleven days. As shown in Table No. 1, a goodly number of eggs were laid on all the check twigs, but none was deposited on the wood sprayed with three per cent oil or three per cent oil in lime sulphur 1-9, indicating that, under the conditions obtaining in the experiments, oil-lime sulphur is as effective as the standard Ontario oil spray in preventing oviposition.

TABLE NO. 1

EFFECT OF OIL AND OF OIL-LIME SULPHUR SPRAYS ON EGG DEPOSITION

3% Lubricating Oil Spray

Cage No.	Treatment of Twigs	Eggs on Sprayed Twig	Eggs on Unsprayed Twig
A1a	1 sprayed; 1 unsprayed	0	207
A1b	2 sprayed	0 0	
A1c	2 unsprayed		119 177 } 296
A1d	1 sprayed; 1 unsprayed	0	181
A1e	2 sprayed	0 0	

**Lubricating oil	3 gallons
Water	3 gallons
Calcium caseinate	6 ounces

The above amount of stock emulsion is diluted in 100 gallons of lime sulphur 1-9.

*"The Status of Lubricating Oil Sprays in Ontario," Rept. Ent. Soc., Ont., 1931, pp. 49-57.

3% Lubricating Oil in Lime Sulphur 1-9

Cage No.	Treatment of Twigs	Eggs on Sprayed Twig	Eggs on Unsprayed Twig
A2a	1 sprayed; 1 unsprayed	0	172
A2b	2 sprayed	0 0	
A2c	2 unsprayed		158 104 } 262
A2d	1 sprayed; 1 unsprayed	0	342
A2e	2 unsprayed	0 0	
A2f	2 unsprayed		84 105 } 189

To compare the ovicidal value of the lime sulphur-oil mixture with that of the regular psylla spray, batches of eggs at different stages of incubation were sprayed with the two materials, and as shown in Table No. 2 the eggs proved to be very susceptible to the combination spray, and altogether too resistant to the oil emulsion.

TABLE NO. 2

EFFECT OF OIL AND OF OIL-LIME SULPHUR ON PSYLLA EGGS

Stage of Incubation When Treated	Total No. of Eggs	Eggs Which Hatched	Per cent Mortality
3% Lubricating Oil Emulsion			
1-2 days old	348	265	23.9
3 days old	298	242	18.8
4 days old	211	152	28.0
6-7 days old	503	378	24.9
8 days old	355	304	14.4
3% Oil in Lime Sulphur 1-9			
1-2 days old	358	15	95.8
3 days old	209	10	95.2
4 days old	358	17	95.3
6-7 days old	574	14	97.6
8 days old	451	21	95.3
Check			
	663	593	11.5

Orchard Experiments:—About three weeks after growers commenced the regular psylla application, and when the buds of Kieffers were beginning to break, a block of pear trees near Beamsville was sprayed with 3% oil in lime sulphur 1-9, and the experiment was duplicated by Mr. Paul Fisher in one of his orchards at Burlington. At the time of spraying, adults and eggs were not present in as large numbers as we had hoped for, nevertheless, they were sufficiently abundant to make the experiment well worth while. The mixture caused no injury to the trees, even to the Kieffers, and both at Beamsville and Burlington proved to be as effective as the standard oil spray in combatting the pear psylla. In other words both treatments, without extra summer sprays, gave excellent commercial control.

If further orchard experiments corroborate this year's results, and we have too much respect for the psylla to be too optimistic on the basis of one season's experience; the oil-lime sulphur will be a great boon to pear growers in seasons, when, because of very wet and soft soil conditions, it is not possible to apply the lubricating oil spray at the proper time.

San Jose Scale: In Ontario the San Jose scale was almost wiped out by the winter of 1917-18, and during the next ten years it fluctuated up and down to a slight extent, but apparently made little headway until 1929, when it again became sufficiently abundant to force itself on our attention. Following 1929, the insect, favoured by two mild winters and two unusually long growing seasons, forged ahead until by the fall of 1931 it was present in serious outbreak form in very many apple orchards in the Niagara peninsula and in other warm sections of the province. In view of the severity of the infestation, and in view of the fact that some growers, who had used lubricating oil emulsions in 1930, expressed themselves as being sceptical about the efficacy of such sprays against San Jose scale, we undertook some control experiments.

Laboratory Experiments:—During late winter scale infested apple twigs were brought in to the greenhouse and some of them were thoroughly sprayed with (1) lime sulphur 1-7; (2) 3% lubricating oil emulsion; (3) 4% lubricating oil emulsion; (4) 3% lubricating oil emulsion in Bordeaux mixture (3-6-40); (5) 4% lubricating oil emulsion in Bordeaux mixture (3-6-40) and others were left untreated as a check.

Examinations of the scale insects were made 12, 18, 24 and 31 days after spraying, and the living (including all doubtful cases) and the dead were recorded with the following results:

TABLE NO. 3
SAN JOSE SCALE CONTROL—LABORATORY TESTS

	Per cent Mortality after			
Materials Used	12 days	18 days	24 days	31 days
3% lubricating oil	100	99.5	100	100
4% lubricating oil	100	100	100	100
3% oil in Bordeaux	81.2	94.4	99.5	100
4% oil in Bordeaux	86.3	99.1	99.5	100
Lime sulphur 1-7	56.0	44.0	85.0	97.7
Check	22.5	8.0	9.6	17.5

Orchard Experiments:—In these experiments an orchard of old apple trees at Vineland was divided into five plots. The trees were scraped and the sprays were applied before the buds burst. On May 16, May 30 and June 13 random samples of wood were taken from each plot and the percentages of mortality shown in Table No. 4 was determined on the basis of an examination of 500 scales per examination per plot. Furthermore, at picking time large numbers of apples from each plot were carefully examined and the percentage of scale-infested fruit presented herewith were recorded.

TABLE NO. 4
SAN JOSE SCALE CONTROL—ORCHARD EXPERIMENTS

		Examination of Twigs Per cent Mortality			Examination of Fruit Per cent of
Plot	Materials Used	May 16	May 30	June 13	Infested Fruit
1	Lime sulphur 1-7	87.4	94.0	93.6	0.43
2	3% lubricating oil in Bordeaux (3-6-40)	96.4	98.2	99.4	0.96
3	3% lubricating oil	98.4	99.6	100.0	0.09
4	4% lubricating oil in Bordeaux (3-6-40)	99.6	98.0	100.0	0.00
5	4% lubricating oil	99.0	99.0	99.4	0.05
Check—orchard poorly sprayed with 4% oil			78.8		8.29

As no unsprayed orchard was available at Vineland Station, we had perforce to use as a check an orchard which had been poorly sprayed with a 4% lubricating oil emulsion. In examining random samples of twigs from this orchard, the most striking feature noticed was the great variation in scale mortality, which ran from 47 per cent. to 100 per cent., depending on the amount of oil coverage.

The mortality data shown in Tables No. 3 and 4, demonstrate that 3 and 4 per cent. oil emulsions are very effective and that the oil sprays kill more quickly than the lime sulphur, but the dead scale counts by themselves certainly do not afford us satisfactory evidence that the emulsions are more efficient. As it has been observed by others, the examination of scales some considerable time after spraying does not tell the whole story about the action of lime sulphur. Newcomers and Yothers have pointed out that many of the female scales, which are not directly killed by the spray are rendered sterile by it,* and this residual effect of the lime sulphur no doubt accounts for the fact that excellent control was secured in plot 1 as well as in plots 2, 3, 4 and 5.

It should be mentioned that seasonal conditions this year were not favourable for the building up of a large scale population. As shown in Table No. 5 there was in comparison with 1931 a pronounced temperature deficiency in 1932, and this unquestionably explains why the scale-infested fruit did not run higher, particularly in the so-called check; and it also explains, I am afraid, the absence of complaints from fruit growers this year about the failure of spray mixture to give satisfactory results.

TABLE NO. 5

MEAN TEMPERATURE IN 1931 AND 1932

	1931		1932		
Month	Mean	Diff. from Normal**	Mean	Diff. from Normal**	Diff. from 1931
April	44.9	+1.6	41.0	—2.3	—3.9
May	55.6	+1.6	56.7	+2.7	+1.1
June	66.1	+1.4	65.5	+0.8	—0.6
July	75.1	+4.1	68.2	—2.8	—6.9
August	70.8	+1.2	69.9	+0.3	—0.9
September	68.3	+4.7	62.9	—0.7	—5.4
October	55.7	+4.4	52.9	+1.6	—2.8

STUDIES ON THE EFFECT OF BURYING AND OF CULTIVATION ON LARVAE OF THE ORIENTAL FRUIT MOTH

By Thomas Armstrong, Entomological Laboratory, Vineland Station, Ontario.

Studies on the effects of burying and of cultivation on the larvae of the oriental fruit moth, *Grapholitha molesta* Busck., were carried out in 1930 and 1931 at Vineland Station. The insects, larvae spun up in corrugated paper, were placed on well drained light soil and were confined by means of wire screen cages, 3 feet square and 1½ feet high. Four series of experiments were conducted, namely:

* Jour. Econ. Ent. 22: 821. 1929.
**Normal based on 17 years records.

1. The effect of burying larvae in the late autumn.
2. The effect of burying larvae in the early spring.
3. The effect of burying larvae in the late spring.
4. The effect of cultivation on the overwintering larvae in and on the soil.

Fall Burial Experiments:—In early November definite numbers of larvae were buried 2, 4 and 6 inches respectively, and others were placed on the surface. They were then covered with cages, and the following spring the moths which emerged were removed and counted. The results obtained are presented herewith in tabular form.

Location	Larvae Placed	Moths Emerged 1930	Moths Emerged 1931	Per cent Mortality 1930	Per cent Mortality 1931
Larvae on surface	300	105	68	65.0	77.3
Larvae buried 2 inches	300	58	69	81.7	77.0
Larvae buried 4 inches	300	42	34	86.0	88.7
Larvae buried 6 inches	300	6	20	98.0	93.3

The most striking feature of the experiment is the number of moths emerging from the buried material. From the 900 larvae buried each year in the ground, 106 adults emerged in 1930, and 123 moths in 1931. How is this emergence performed? From a study of the larval habits we have learned that spun-up caterpillars do not take kindly to having a weight of earth placed on them. If the temperature is suitable for activity, buried larvae will leave their cocoons and gradually make their way to the surface, where they will wander around in search of favourable places in which to spin up, such as in clods of earth (Fig. 2), in trash, in hollow stems of grasses or on the sides of the cages.

As was to be expected, mortality increased as the larvae were buried deeper and deeper. Based on the moth emergence, larvae buried 2 inches showed a mortality of 77 per cent.; buried 4 inches, the death rate was 88.7 per cent.; and 6 inches, 93.3 per cent.

In order to check up on the wandering habit of the larvae, overwintering material was buried at various depths in soil placed in pots and battery jars, kept in the insectary, and observations were made on the larval migration. In

Fig. 1.—Wire screen cages used in the burial and cultivation experiments, 1930, 1931, at Vineland Station.

the fall of 1929, 3, 13 and 12 larvae had spun up in corrugated paper strips on the soil surface in pots, in each of which 50 individuals had been buried 2, 4 and 6 inches respectively. Duplicating the experiment the following year, 32, 8 and

7 per cent. of the larvae were to be found in cocoons on the surface where larvae had been buried 2, 4 and 6 inches. Without doubt others had used the soil at the surface with which to construct their winter cocoons, for threads of silken webbing were noticed around the edges of the jars.

Early Spring Burials:—In these experiments burials were made on April 19 in 1930, and April 14 in 1931, before the spring pupation had commenced. The emergence records for the two years are appended below.

Location	No. of Larvae		Moths Emerged		Per cent Mortality	
	1930	1931	1930	1931	1930	1931
Larvae on surface	400	300	351	264	12.2	12.0
Larvae buried 2 inches	400	302	123	134	69.2	55.6
Larvae buried 4 inches	400	303	103	70	74.2	76.9
Larvae buried 6 inches	400	304	82	38	79.5	87.5

From the records given it is obvious that burying larvae in the early spring does not destroy all of them. As was shown with the fall burials, they leave their old cocoons, migrate to the surface and rebuild the shelters. In 1931 approximately one-half of the larvae buried two inches gave rise to adults, about 25 per cent. of the caterpillars buried four inches produced moths, and even when placed at a depth of six inches close to one-eighth of the material emerged.

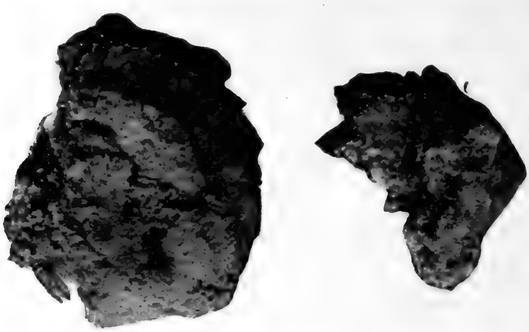

Fig. 2.—Pupal cases protruding from pieces of soil taken from the burial cages.

Late Spring Burials:—Material spun up in corrugated paper was also buried beneath similar cages to those used for the other tests. These burials were made, however, when particularly all the larvae had pupated. In 1931 about 80 per cent. had gone into the pupal stage, but in 1930 the work was done a little earlier and it is very possible that the percentage of pupation had not reached that given for 1931. The emergence records are tabulated below.

Location	No. of Insects		Moths Emerged		Per cent Mortality	
	1930	1931	1930	1931	1930	1931
Insects on surface	400	300	284	264	29.0	12.0
Insects buried 2 inches	400	301	49	8	87.7	97.3
Insects buried 4 inches	400	306	22	6	94.5	98.0
Insects buried 6 inches	400	305	5	2	98.7	99.3

The overwintering material was buried on May 6, in 1930 and on May 11 the next year. Very likely, therefore, the increase in number of moths appearing in 1930 was due to the fact that more larvae were in a suitable condition to migrate than was the case in 1931. Where pupae are buried no emergence is possible, but if caterpillars are present, migration will take place. The mortality records given show that if the insects are buried late in the season and closer to the time of emergence there will be a far greater number of deaths than where burials are carried out earlier in the spring or in the fall.

Verification of the results in the field was secured by the pot method in the insectary. The total number of moths emerging from 150 larvae buried in the early spring, 2, 4 and 6 inches was 44, whereas but one moth was recovered from 300 individuals buried in the late spring when pupation was nearly completed.

Cultivation Experiments:—The small scale experiments on orchard cultivation were performed in conjunction with the burial experiments, making use of similar cages and working with larvae cocooned in corrugated paper. The work was divided into three divisions, namely:

1. The digging of larvae into the ground to 4 or 5 inches and cultivating by hand at weekly intervals.
2. The digging of larvae into the ground to 4 or 5 inches and leaving uncultivated.
3. Subjecting larvae to regular orchard cultivation.

The object of digging and cultivating by hand was to simulate as closely as possible the regular orchard practice of ploughing and cultivating at intervals. Digging only could be compared to ploughing. When regular orchard cultivation is referred to in the third division of the project, the ground was double-disced with a tractor outfit at weekly intervals.*

It might be well to give the results in tabular form before going into any discussion. The treatments were commenced on April 19 in 1930, and April 14 in 1931.

Treatment	No. of Larvae 1930	1931	Moths Emerged 1930	1931	Per cent Mortality 1930	1931
Larvae dug to 4-5 inches and hand cultivated weekly	800	609	105	78	86.9	87.3
Larvae dug to 4-5 inches and left uncultivated	400	305	108	87	73.0	71.5
Larvae subjected to regular orchard cultivation	800	617	5	0	99.9	100.0
Larvae on surface	400	300	351	264	12.2	12.0

From the amount of emergence recorded, digging and hand cultivation at weekly intervals afterwards, whether or not it is comparable to orchard cultivation, is not a means of destroying larvae spun up in or on the ground. The mortality in 1930 was 87 per cent. and the following year was approximately the same. One is able to get a clearer idea of the results when it is stated that out of 800 caterpillars placed, over 100, or 105 to be exact, gave rise to adults, and when one considers that but a few moths in the early spring will build up a considerable population by fall after three generations of breeding, this type of soil treatment is of little value.

*In 1930 the discings were performed on May 1, 9, 16, 21, 31 and June 7. Normal spring emergence was,—First, May 4; Maximum, May 15; Last, June 13.

In 1931 the discings were performed on April 18, 29, May 6, 15, 21, 29 and June 9. Normal spring emergence was,—First, April 22; Maximum, May 16; Last, June 18.

In 1932 the discings were performed on May 2, 16, 23, 31, June 7, and 16. Normal emergence was,—First, May 15; Maximum, May 26; Last, June 22.

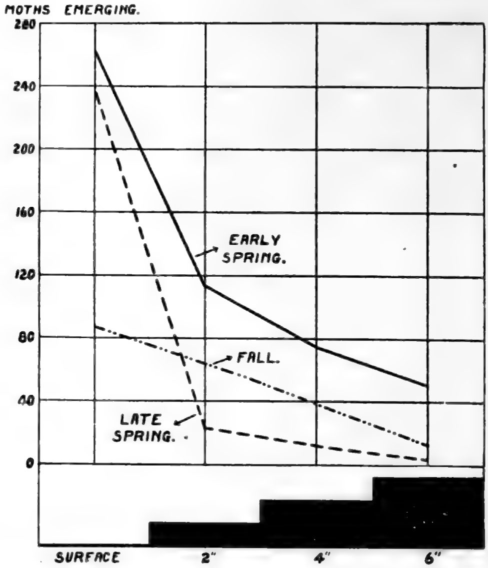

Fig. 3.—Graph to show the moth emergence in the fall, and early and late spring burial experiments, based on 300 larvae in each test.

Just digging the soil to a depth of 4 to 5 inches was less than one-half as effective as where cultivation followed the turning of the soil.

Glancing at the figures secured from the regular orchard cultivation tests we see some encouraging results. In the two years, 1,417 larvae were placed and only five moths were removed from the cages, thus the mortality was 99.9 per cent. It might be well to state that this tractor discing would spread and scatter the material beyond the confines of these small cages, and in this way some records may have been lost.

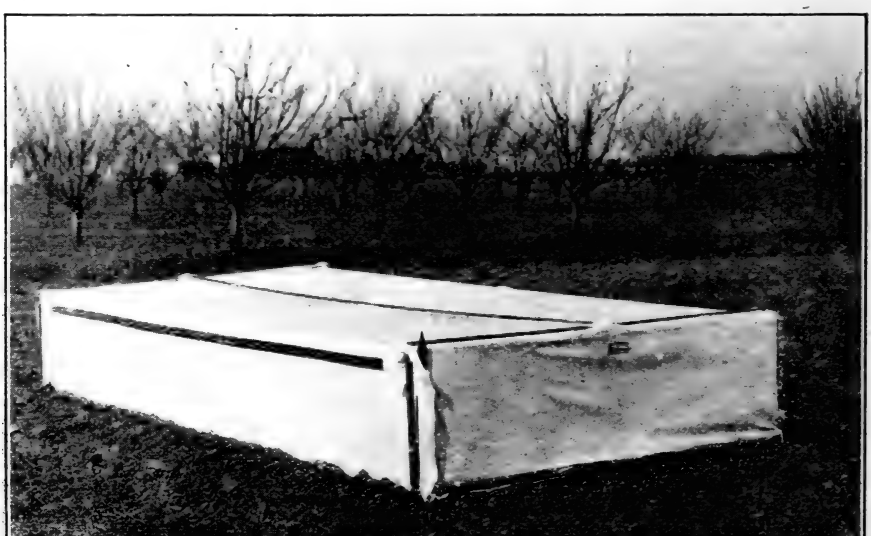

Fig. 4.—Large cage used in the cultivation experiment in 1932.

In 1932, in order to limit the loss of material due to the scattering action of the discs, a large cage was used. This cage measured 14 feet by 6 feet by 2 feet high, and very successfully covered the cultivated area. Out of 500 larvae placed on this tractor-disced area only four moths were taken, a mortality of 99.2 per cent. The check showed a death rate of but 11.7 per cent., as 266 moths emerged from 300 overwintering larvae placed. To see this cultivation being performed one could hardly imagine a single individual surviving the pulverizing action of the discs.

OBSERVATIONS ON THE RELATION OF TEMPERATURE AND MOISTURE TO THE ORIENTAL PEACH MOTH

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This paper presents in a very brief form some of the data accumulated during the past few seasons on the effects of temperature, moisture and light on the seasonal behaviour of the oriental peach moth in the Niagara peninsula. The study of these factors forms a part of the ecological investigations now being carried out in an attempt to account for the marked peach moth population differences in different seasons and in various sections of the infested area.

The Effect of Temperature on Spring Pupation and Length of Pupal Period: —Peach moths overwinter as mature larvae spun up in various locations on the trees, soil, fruit containers, etc. The time and rate of pupation in the spring are both affected greatly by temperature. For example, in 1928 the first pupation was noted on March 23 and the maximum pupation for one day was two weeks later, on April 6. This maximum pupation occurred during a period of unseasonably high temperatures between April 4 and 7, as illustrated by the following short table giving the pupation records of three continuous 5-day periods from March 29 to April 12, with the temperatures for each period.

TABLE NO. 1

Periods — 1928	Number of Pupations	Temperatures Maximum	Minimum	Average
March 29 to April 2	14	47.0	21.5	32.0
April 3 to April 7	435	81.5	40.5	59.8
April 8 to April 12	48	56.0	25.0	35.2

These data illustrate the large amount of pupation during the extremely warm spell and the rapid falling off in pupation when the temperature dropped. During this warm spell between April 6 and 8, practically 50% of the wintering material pupated, while on one warm day (April 6, with an average temperature of 65 degrees F.) 256 pupae formed out of a total of 823. Similar data for 1930 are given in the following table, illustrating again the marked influence of temperature on pupation.

TABLE NO. 2

3-day periods — 1929	Number of Pupations	Temperatures Maximum	Minimum	Average
April 3 to April 8	109	66	30	45.8
April 6 to April 8	431	79	39	61.4
April 9 to April 11	49	58	34	41.3

Duration of Pupal Stage:—The records of pupation in relation to temperature were taken from overwintering material kept in the insectary and subjected to temperatures which would run very close to those recorded on the thermograph. It was found that the length of the period varied from 53 days at an average temperature of 48.5 degrees F. to as low as 12 days at an average temperature of 68.7 degrees F. The close correlation between temperature and the length of period is clearly shown in the following table, which includes pupal periods of various lengths and the mean daily temperature during each period.

TABLE NO. 3

Date of Pupation	No. of Pupae	Average Length of Pupal Stage in Days	Mean Temperature for Period
April 7	1	53.0	48.5
April 19	2	41.5	50.7
April 24	8	37.6	52.1
April 28	2	35.5	52.2
May 2	2	32.5	53.1
May 6	3	30.0	54.5
May 11	22	28.1	56.0
May 16	2	26.0	56.1
May 21	3	23.3	58.5
May 26	2	20.0	60.1
June 4	1	16.0	62.9
June 9	1	14.0	67.8
June 10	1	12.0	68.7

Sunlight is a very important factor in indirectly influencing the rate of development of pupae and is responsible for considerable fluctuation in the length of the stage among pupae in different locations. For example, those on the south side of trees are subjected, during periods of sunshine, to a higher temperature than that of the surrounding air or of the north side of the trees, and consequently develop more rapidly. The following records show that temperatures taken in weather shelters are often misleading when applied directly to field records. Two observations from a group having a southern exposure, and two from a northern exposure, have been chosen to illustrate this. The mean temperature in each case was calculated from thermograph records taken in the shade similar to that on the north side of a tree.

TABLE NO. 4

Location	Date of Pupation	Date of Emergence	Period in Days	Mean Temperature in Shade
South	April 10	May 1	21	41.9
North	April 30	May 21	21	57.4
South	April 12	May 7	25	46.9
North	April 19	May 14	25	51.6

The above data show that for the 21-day period on the north side, the mean shade temperature was 57.4 degrees F., whereas for the 21-day period on the south side the mean shade temperature was only 41.9 degrees F. This shows that the actual mean temperature of the surface of the southern exposure was considerably higher than that of the air in the shade or of the surface of the northern exposure.

The Relation of Temperature to the Spring Emergence of Moths:—The spring generation emergence is directly affected by temperature conditions prevailing during the pupal period. In 1929 moths of the overwintering generation started to emerge on April 28, or 8 days earlier than in 1928. The average daily temperature from the first pupation to first emergence (March 19 to April 28) in 1929 was 44.1 degrees F., and for the same period from first pupation to first emergence in 1928, we find it to be 40.6 degrees, which was a drop of 3.5 degrees. If we take the average temperature for the 8-day longer period from first pupation to first emergence in 1928 we find it to be 43.4 degrees which approximates fairly closely the average temperature for the similar period in 1929.

As previously mentioned, insects hibernating in southern exposures develop more rapidly than those facing towards the north. The records show that the maximum emergence of material facing south was over two weeks earlier than that in northern locations, and that emergence in the former location was completed in from three weeks to nearly a month ahead of the rest.

Material kept in a covered insectary was delayed considerably in developing to the moth stage, the first emergence occurring 25 to 31 days after adults commenced to appear in the field. The lack of sun with the consequently lower temperature was responsible for this delayed emergence. Caterpillars which wintered in or on the ground were also slow in developing, although more rapid than those kept in the insectary. Without doubt the spring warming-up process would be slower on the wet ground than in trees. The variations in time of emergence are shown in the following table, and also in Figure 1.

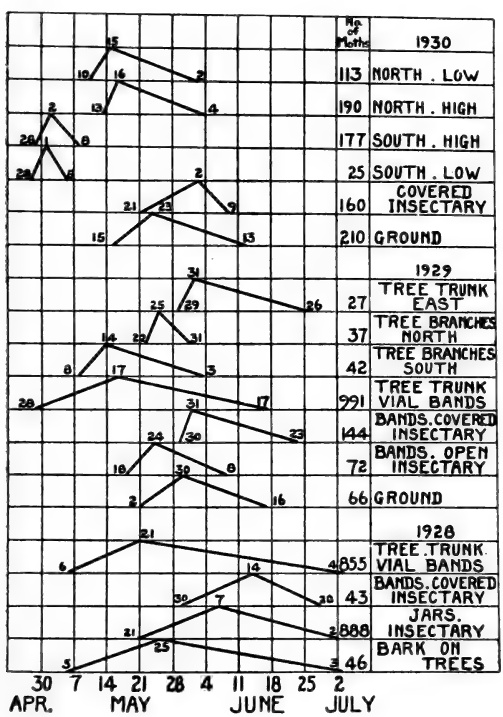

Figure 1.—Emergence of the oriental peach moth in various locations. Vineland Station, 1928, 1929, 1930.

TABLE NO. 5

Position of Larvae	No. of Larvae Placed	No. of Adults Reared	Date of Emergence First	Maximum	Last
Northern exposure, 5 feet from ground	236	190	May 13	May 16	June 4
Northern exposure, *at* the ground	255	113	May 10	May 15	June 2
Southern exposure, 5 feet from ground	279	177	April 28	May 1-2	May 8
Southern exposure, *at* the ground	233	25	April 28	May 1	May 5
Covered insectary, in complete shade	228	160	May 21	June 2	June 9
On soil surface	600	210	May 15	May 23	June 13
Burlap bands around tree trunks	66	42	May 4	May 15	May 25

Influence of Temperature and Moisture on the Adults

Field observations have shown that this insect, like its near relative the codling moth, has a very marked daily flight period and that this coincides with the oviposition period. It occurs during the late afternoon from three hours before to one hour after sunset. During this relatively short period, approximaely 98% of the daily total of eggs are generally laid, as can be seen by referring to Figure 2 and to the following table, which give the hourly distribution of 21,062 eggs during periods in the summer of 1929. The hour of maximum deposition is that starting two hours before sunset. The small remaining part of the daily lay takes place during the morning and early afternoon and seems to be somewhat influenced by clouds and humidity. It was found that no eggs are laid later than one hour after sunset, at which time the last glow from the sunset has just disappeared.

TABLE NO. 6

SHOWING THE HOURLY DISTRIBUTION OF EGGS THROUGHOUT THE DAY—1930

Hours from Sunset	Date / Time of Sunset: July 10 8:00	July 11 8:00	July 17 7:57	Aug. 3. 7:27	Aug. 22 7:12	Aug. 27 7:04	Sept. 5 6:49	Sept. 26 6:00	Total Eggs Laid: Total	Average per cent
16 to 12 before	......	......	......	......	......	......	......	......	......	......
11 "	......	......	......	......	......	......	......	3	3	.01
10 "	......	......	......	......	......	......	......	2	2	.009
9 "	......	......	......	......	......	......	......	......	......	......
8 "	......	......	......	......	......	......	......	......	......	......
7 "	......	......	......	......	......	1	......	......	1	.004
6 "	......	......	......	......	6	3	......	......	9	.04
5 "	2	1	5	1	1	1	2	......	13	.06
4 "	21	1	5	15	41	15	24	4	126	.6
3 "	653	141	37	718	997	140	499	491	3676	17.6
2 "	2050	337	1632	1164	3979	1072	892	478	11604	54.6
1 "	376	304	1742	858	440	731	306	35	4792	22.9
1 after	67	30	278	115	32	184	75	26	807	3.8
2 "	......	......	......	......	......	......	......	......	......	......
3 to 8	......	......	25	3	......	......	......	1	29	.13
Total	3169	814	3724	2874	5496	2147	1798	1040	21062	100.0

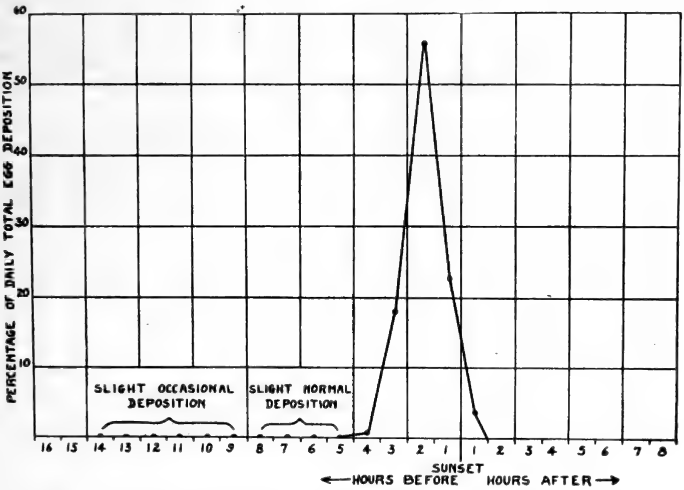

Fig. 2.—Hourly distribution of oriental peach moth eggs.

Observations strongly indicate that light is the chief stimulating factor limiting egg deposition, and that a weak light such as we have in the late afternoon offers optimum conditions. In support of this statement we have the following facts,— (1) that the time of occurrence of the daily egg-laying period is influenced by the length of day, *i.e.*, it occurs earlier in the day as the days shorten; (2) that on certain cloudy days we may sometimes have a greater proportional deposition during the early part of the day than on clear days; (3) that under artificial conditions we have been able to stimulate egg-laying both by decreasing the light on bright days and by increasing the light at night; and (4) that total darkness completely stops egg laying.

Space does not permit the inclusion here of all the available data to support the above statements so only a few abbreviated tables are given.

TABLE NO. 7

STIMULATION OF EGG DEPOSITION BY REDUCING LIGHT ON A BRIGHT DAY

Time	Number of Eggs Partially Shaded Cage	Number of Eggs Check Cage
1 to 2 P.M.	82	0
2 to 3 P.M.	34	0
Total	116	0

NOTE:—The darkened cage was covered with roofing paper and the check cage left uncovered on a bright day. Eggs were laid in both cages later in the day.

TABLE NO. 8

STIMULATION OF OVIPOSITION BY INCREASING LIGHT AT NIGHT

Time	Number of Eggs Cage Exposed to Light	Number of Eggs Check Cage in Dark
7:45 P.M.	0	0
8:30 P.M.	2	0
9:00 P.M.	9	0
Total	11	0

NOTE:—The cage producing eggs was exposed to a 60 W. Mazda bulb at a distance of from 1 to 2 feet. Moths in both cages had laid a large number of eggs before dark.

Temperature plays a very important part in limiting the activity and oviposition of the moths, especially in the early part of the summer and late fall. Considerable emphasis has been placed by some workers on the fact that low evening temperatures will stop egg-laying of the codling moth for considerable periods in the spring, and consequently affect the population of succeeding broods. These workers found that when the temperature was below 65 degrees F. codling moth egg-laying was scant and below 62 degrees F. stopped completely.

The minimum effective temperature for peach moth oviposition is between 57 and 58 degrees, *i.e.*, egg laying may take place at or above this temperature but not below. The method of determining this consisted of placing twigs in and removing them at short intervals from well stocked oviposition cages, on days when the afternoon temperature was falling near 60 degrees. By recording the temperature and oviposition it was possible to arrive at the temperature below which oviposition ceased. The experiment also showed that when the temperature dropped below 65 degrees the activity of the moths, and also egg-laying, were greatly retarded. When the temperature was below 60 degrees the moths showed very little activity, remaining in one position on the cage or crawling an inch or two. In order to obtain eggs below 60 degrees F. it was found necessary to place the moths directly on the foliage otherwise they would not leave the wire side of the cage.

TABLE NO. 9

LOWEST TEMPERATURES AT WHICH EGGS WERE OBTAINED IN CAGES—1930

May 27		June 8		June 9		June 10	
Temp. °F.	Eggs	Temp. °F.	Eggs	Temp. °F.	Eggs	Temp. °F.	Eggs
.... to 61	72	.... to 62	21	.... to 62	288	.... to 61	149
61 to 60	13	62 to 60	10	62 to 60	45	61 to 59	13
60 to 57	5	60 to 59	10	60 to 59	6	59 to 58	12
		59 to 58	0	59 to 58	9	58 to 57	14
		58 to 54	0	58 to 57.5	0	57 to 56	0

An analysis of the temperature records for the past six years showed that, on the average, low temperatures totally prohibited oviposition during the normal daily egg-laying period on 15 days each spring—the maximum number being 18 days in 1927, and the minimum 10 days in 1930. These records, combined with population studies, indicate that these low temperatures do not have any great effect in influencing the final population from year to year, as many of these cool days occur early in May before emergence has progressed far. They do, however, affect the peak points of egg distribution by spring brood moths, and consequently influence indirectly the peak points of later generations. Low temperatures shortly after emergence has started may, in fact, favour the peach moth, in that the moths will live longer and lay their eggs later, at a time when the twigs are further advanced and more able to support the resulting larvae.

Field observations indicated that the highest temperatures recorded during the egg-laying period were the most favourable for oviposition and flight. A few experiments, performed under more or less controlled temperatures in battery jars, showed that the optimum temperature for oviposition is probably between 90 and 94 degrees F., but that heavy deposition may take place, other conditions being favourable, between the range of 65 and 94 degrees.

TABLE NO. 10

EGGS LAID IN BATTERY JARS BY EQUAL NUMBERS OF FEMALES UNDER CONTROLLED TEMPERATURES

(Summary from several experiments)

Range of Average Temperature °F.	No. of Eggs
96.3 to 94.5	4
90.8 to 88.8	135
85.4 to 79.3	114

Moisture:—A study of the effects of relative humidity on insects is rather a difficult problem unless expensive apparatus is available, so the data obtained are chiefly from field observations. The effects of a lack of moisture, in liquid form, can easily be studied, and it was found that when caged moths were not supplied with moisture their lives were shortened by approximately one half, and their egg production reduced by slightly over three-quarters. In all regular oviposition experiments we kept the caged moths supplied with moisture by means of a moist strip of dental cotton, and by adding water daily to the sand on the bottom of the cage. In order to determine the effects of a lack of moisture we kept several cages perfectly dry (except for dew) and supplied the check cages with moisture. The summarized results are given in the following table.

TABLE NO. 11

EFFECT OF MOISTURE ON LONGEVITY AND FECUNDITY OF MOTHS

	Check Cage—Moist			Dry Cage		
Experiments	No. of Females	Eggs Per Female	Maximum Life of Females	No. of Females	Eggs Per Female	Maximum Life of Females
1. Aug. 20—Sept. 3, 1930	300	35.2	14 days	300	3.3	7 days
2. June 6—July 25, 1931	89	33.7	15 days	89	7.2	*12 days
3. July 7—July 21, 1931	100	25.2	15 days	100	14.7	7 days
4. June 12—Aug. 25, 1931	510	27.6		510	8.8	
5. July 11—Aug. 2, 1932	130	22.8		130	3.0	
Total and averages	1129	29.3	15 days	1129	7.15	12 days

*One moth lived for 12 days,—others lived only 7 days.

TABLE NO. 12

DAILY DISTRIBUTION OF EGGS IN MOIST AND DRY CAGES

Days After Emergence of Females	Check—Moist Cages No. 1	Check—Moist Cages No. 3	Dry Cages No. 1	Dry Cages No. 3
1	0	0	0	0
2	75	390	193	590
3	532	292	223	635
4	1109	64	33	88
5	12	290	0	2
6	1169	340	180	161
7	2306	240	366	0
8	1730	155	17	0
9	1385	320	0	0
10	790	230	0	0
11	469	128	0	0
12	361	66	0	0
13	314	10	0	0
14	222	2	0	0
15	105	0	0	0

These results lead to the question whether moths in the field during a week or ten day period without rain would be as adversely affected as those in dry cages. If this is the case, dry periods in summer, especially if they occur at a time of maximum moth abundance, will have a marked effect in reducing the population. Dew seems to be of little importance as it is rarely present on peach foliage during the summer. It formed naturally on the foliage in the dry cages, (if present at all) but seemed to have no effect in increasing egg production. Similar results were produced when we artificially moistened the foliage daily in an otherwise dry cage. It is not known what other sources of moisture may be available to moths in the field during a dry spell, but it is reasonable to suppose that during such a time they would be adversely affected, although perhaps not to as great an extent as under the conditions of the dry cages. The fact that during the comparatively dry summers of 1930 and 1931 the peach moth population was generally low over its eastern range gives added support to this theory.

No definite data are available with regard to the effects of relative humidity conditions on the adults. However, an analysis of the daily temperature, relative humidity, and egg-laying data at least indicated that a rising humidity may stimulate oviposition.

It was found that almost invariably on the clear days when observations were made, the hour during which the first appreciable egg deposition for the day took place, was the hour during which the relative humidity stopped falling and started to rise. The table below illustrates this point for three days only as space does not permit the inclusion of more data. It is interesting to note that during observation No. 3, appreciable egg deposition started one hour later than usual and that the first rise in relative humidity was also one hour later. However, it is realized that this rather close correlation between rising relative humidity and egg deposition may be just a coincidence. Experiments under controlled conditions would be necessary to prove this point.

TABLE NO. 13

SHOWING CORRELATION BETWEEN EGG LAYING AND RELATIVE HUMIDITY

Hours From Sunset	Per cent Relative Humidity	Relative Humidity Difference	Per cent Lay
Observation No. 1			
13—11	50	—15	
11— 9	35	— 8	
9— 7	27	— 4	
7— 5	23	— 3	.06
4	20	0	.66
3	30	+10	20.6
2	50	+20	64.6
1	58	+ 8	11.8
1	56	— 2	2.1
Observation No. 2			
13—11	53	— 3	
11—19	50	— 4	
9— 7	46	0	
7— 5	58	+12	.12
4	61	+ 3	.12
3	65	+ 4	19.7
2	71	+ 6	41.4
1	75	+ 4	37.3
1	80	+ 5	.3

Observation No. 3

Hours From Sunset	Per cent Relative Humidity	Relative Humidity Difference	Per cent Lay
13—11	57	— 9	
11—19	48	—13	
9— 7	35	— 5	
7— 5	30	— 1	.13
4	29	— 2	.13
3	27	0	.9
2	30	+ 3	43.8
1	55	+25	46.7
1	67	+12	7.5

The Effect of Temperature on the Length of the Incubation Period:—Temperature plays a big part in regulating the length of the incubation period. In the heat of the summer, eggs hatch in from 4 to 7 days, but in the spring and autumn we find eggs requiring 10 to 15 days, and when cold days of October arrive the incubation period jumps to 20 and as high as 34 days. From the records of 1927, 1928 and 1929, groups of eggs were chosen where the incubation periods varied from 4 to 34 days. The mean daily temperature, calculated trom the thermograph records taken in the insectary, was also determined for separate egg periods. By taking averages wherever possible the short table below demonstrates in summarized form the effect temperature has on the length of time taken for peach moth eggs to hatch.

TABLE NO. 14

INCUBATION PERIOD

Incubation Period in Days	Average Daily Temperature °F.	Incubation Period in Days	Average Daily Temperature °F.
4	77.2	15	54.9
5	70.8	16	54.4
6	68.4	16.5	55.0
7	66.6	18	54.1
8	63.1	19	53.2
9	61.2	20	51.8
10	60.3	21	51.9
11	58.5	22	51.0
12	56.0	24	51.4
13	56.6	31	47.6
14	53.8	33.5	45.6

It will be noticed that there is a regular decreasing temperature as the incubation periods increase in length. It must be borne in mind that the eggs were not kept under controlled conditions. The temperatures in the insectary would closely approximate the records on the thermograph, but at certain times during the day (early morning and evening) the sun would strike some of the containers where the eggs were incubated, thus some would receive the benefit of this added heat while others would not. There was also a difference in the period of egg duration for those kept on the inner portion of the benches compared with those located towards the outside screening. The eggs in the more shaded and protected spots took longer to hatch.

An attempt has been made to show the correlation between temperature and the length of the incubation period by plotting the results in figure 2. The parabola indicates the logarithmic trend constructed from the formula a + bx

+ c log x equals y. It will be seen that the actual data follow the curve fairly closely.

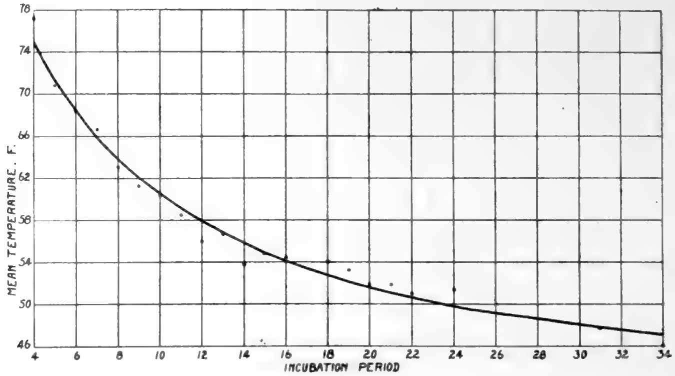

Figure 3.—The relation of temperature to the length of the incubation period. Logarithmic parabolic trend.**

The Effects of Temperature on the Length of the Larval Feeding Period:—In correlating temperature with the length of the feeding period certain other influencing factors have to be considered, *e.g.*—the type and amount of food. Rearing experiments have shown that when larvae were fed on year-old (storage) apples the length of the feeding period was greatly increased, but that it was approximately the same for larvae fed on either fresh apples or peaches. The length of the period is inclined to be somewhat shorter when the larvae feed in peach shoots.

TABLE NO. 15

Type of Food	Average Length of Feeding Period	No. of Larvae	Average Temperature Degrees F.
Storage Apples	28 days	367	66.5
Peach Shoots	20 days	55	65.3

When large numbers of caterpillars are fed in a single fruit the average length of the feeding period will be longer than if a plentiful supply of food had been available.

Although other factors cannot be neglected, it is quite evident that temperature is the most important regulator of the feeding period. During warm spells in mid-summer larvae have completed their feeding in as short a period as nine days when the average daily temperature for the period was 76 degrees F. In contrast with this, some caterpillars required from 80 to 92 days to complete their feeding period when the average daily temperature was 46.5 degrees F.

The accompanying graph (figure 4) has been compiled by a random selection from a large number of records of larvae reared in green peaches and fresh apples under insectary conditions.

The graph shows clearly the increase in the length of the feeding period as the mean daily temperature decreases.

**Full particulars of data used in constructing graph will be furnished by authors on request.

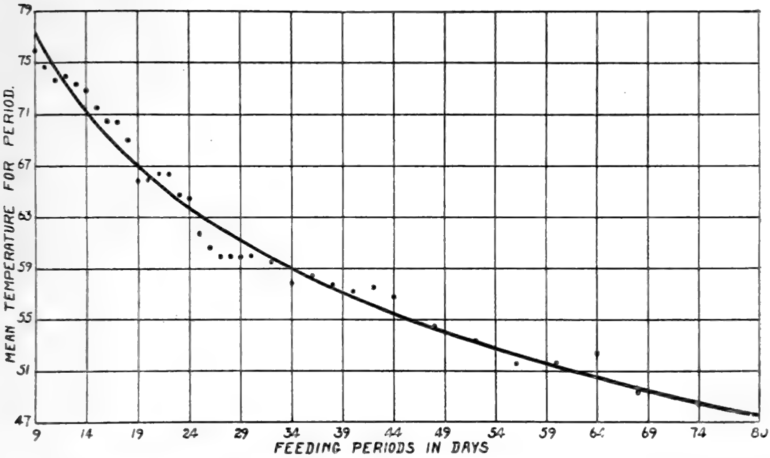

Figure 4.—Temperature correlated with the length of the larval feeding period. Logarithmic parabolic trend.

RECENT DEVELOPMENTS IN THE CORN BORER PARASITE SITUATION IN EASTERN CANADA

By Geo. Wishart and I. E. Thomas

Dominion Parasite Laboratory, Entomological Branch, Belleville, Ontario

This is the tenth year in which work with the parasites of the European Corn Borer, *Pyrausta nubilalis* Hubn., has been carried on in Canada. It is, therefore, fitting that some statement be made concerning what has been done during this period, the status of the work at the present time, and what may be anticipated in the future in the way of economic results.

The species of parasites first obtained by us have not proven, as yet, to be of much value on this continent, but the later importations have shown considerable promise and in the United States, where first introduced, they have already effected a very significant measure of control. The species included in the earlier introductions will probably prove of value in certain areas, if suitable conditions are presented, and for this reason work with them is being continued.

When the search for parasites in Europe was first initiated, none were known to occur and the early years of work there produced only small numbers of a few species. Attempts were made to propagate these artificially, and a few of the individuals received in America were used as breeding stock for mass production where possible, and the remainder liberated. Continued exploration in Europe showed parasites sufficiently abundant in certain areas to allow of large scale collection for direct liberation in America. The larger numbers received made possible a change in the general policy of the work in this country. The work in Canada has been carried on in close co-operation with the United States Bureau of Entomology, and our liberation policy has been largely determined by the numbers and type of parasites made available through their courtesy. This has resulted in a natural division of the work into three periods.

The first period covers the years 1923 to 1926. During this time nearly three million adults of two external parasites, *Exeristes roborator* and *Microbracon brevicornis,* were liberated in a comparatively restricted area in Western Ontario. These were obtained by laboratory propagation from a few individuals received from the United States Bureau of Entomology. From these liberations only a small number of recoveries of very doubtful value have been secured.

The second period, from 1927 to 1931, shows a somewhat different procedure being followed. Laboratory propagation of *Exeristes roborator* and *Microbracon brevicornis* was continued but several internal parasites, both hymenopterous and dipterous, were added. All were liberated over a wide area, in fact, in 1930 and 1931 attempts were made to cover all the important corn growing areas which were seriously infested with the corn borer. The two most encouraging instances, as a result of this, may be cited. At Chateauguay, P.Q., where a small number of *Inareolata punctoria* adults were liberated, 20 per cent. of the corn borer larvae, collected the following autumn, were parasitized, and recovery of this species was made the succeeding year without further liberations having been made. At Chatham, Ont., several hundred *Chelonus annulipes* were taken in a conservation cage the summer following liberation at that point, and a year later adults in numbers were again recovered without recolonization. The two species mentioned above, and also *Masicera senilis,* were recovered at a number of other points, but not in sufficient concentration to indicate that economic results could be expected in the near future.

In the third period, which is that covered by the season of 1932, there was chosen for liberation an area in which there has been, for some time, a comparatively heavy infestation by corn borer, and where, in spite of clean-up measures, there has been a steady increase in corn borer population. In this area, comprising Prince Edward county and the immediately adjoining mainland, all available parasites were concentrated with the expectation that a parasite population would be built up which would give results of economic importance in a relatively short time. This expectation was based upon results secured in the New England area of the United States where, under somewhat similar conditions, concentrated liberations were made.

As stated previously, this somewhat extensive program of liberations has been made possible by the generosity of the United States Bureau of Entomology, through their laboratory at Arlington, Mass. From this source, during the season of 1932, we received 98,682 adults of imported species, and also cocoons of two species, which yielded an additional 5,927 adults. These parasites originated from three sources, there being ten species from Europe, eight species from the Orient, and three species from material collected in the New England area but originally of European origin. In addition to the above, 24,125 adults were liberated from material bred in the laboratory at Belleville.

Approximately eighty farms were used in the liberation program, and one to several species put out in each location, depending on the numbers of parasites available and the condition of the corn. The first shipment of parasites from Arlington was received on June 30th and the last on September 2nd. The liberation of laboratory bred material and adults emerging from imported cocoons was carried out throughout approximately the same period.

The recovery program has been as complete and comprehensive as has been possible with the time and assistance available. Collections of approximately one hundred host larvae were made at all points where liberations were made. In addition, collections were made from fields at varying distances from liberation points to secure some indication as to spread. Part of each collection was dissected and the remainder is being reared. In the case of most species the dissections will give an accurate basis for determining percentage parasitism. The species *Macrocentrus gifuensis,* however, winters as an undeveloped egg within the host, and this egg is so small that it cannot be found except with magnification higher than it is possible to use where several thousand dissections are to be made. The parasitism reported for this species is based only on collections and rearing, and is probably smaller than will eventually be shown when all the parasites have completed their development.

The results thus far compiled indicate an average parasitism by all species, in all fields where liberations were made, of 9.5 per cent. The highest parasitism in any one field was 37 per cent, with several other locations giving parasitism of around 35 per cent. *Inareolata punctoria* was the most promising species, giving an average parasitism of 8 per cent in all fields where liberated, with a parasitism of 37 per cent in the highest field. *Chelonus annulipes* gave an average parasitism of 2 per cent, with a maximum of 16 per cent. Dipterous parasites gave an average of 2.5 per cent, with a maximum of 19.5 per cent. *Macrocentrus gifuensis,* mentioned above as only showing partial results, gave an average of 2 per cent, with a maximum of 16 per cent. *Cremastus flavoorbitalis* gave an average of 8.5 per cent, with a maximum of 13 per cent.

Some valuable information regarding the effect of dates of liberation will also be secured when all the data are available. Thus far it appears that for the 1932 season, in the Belleville area, the first three weeks of July gave best results for *Chelonus annulipes,* which attacks the egg, and the period from July 22nd to August 10th was best for species attacking the immature larvae. Corn borer development was exceptionally late in the above area during the present season, and the dates given are doubtless affected by this, but the trend shown indicates the value of definite consideration of such points in attempting parasite establishment.

One very encouraging feature of the recovery work lies in the fact that most of the parasites recovered have been in the hibernation stage. In the case of *Inareolata punctoria,* from several hundred recoveries, only two parasites which had passed the hibernation stage were found. This gives promise of a splendid survival and gives every assurance that there will be a large parasite population present in these areas next spring.

It appears, therefore, that our hopes of ten years ago are gradually being realized and the future of corn borer control looks brighter than at any time since this pest was discovered in this country in 1920.

THE CORN BORER SITUATION IN ONTARIO IN 1932

By Prof. L. Caesar

Ontario Agricultural College, Guelph

The Clean-Up in the Spring

The heavy corn crop of 1931 caused many farmers that fall to cut their corn higher than usual and to leave more corn refuse in the fields and around the barns. This state of affairs, along with wet weather in May, made it difficult to get a good clean-up last spring. Nevertheless the inspectors finally succeeded in getting about as good a job done as in the average year.

Results

As usual we were not able to make a survey this fall of all the counties under the Act, but did survey the majority of them, including almost all those west of Toronto. The results on the whole were not encouraging, for in most counties there was an increase of approximately 10% to 100% in the number of stalks infested compared with last year. There were, however, some exceptions which helped to brighten the picture. In Essex and Kent, where corn is a much more important farm crop relatively than in any other area, the borer, according to our figures, remained stationary in numbers in Essex and increased slightly in Kent, and according to the figures obtained by the Federal scouts, decreased in Essex from 29.4% in 1931 to 21.3% and in Kent from 27.6% to 26.7%. Both of these counties had again this year, as last, a good crop of corn with few fields very seriously damaged by the borer and none, so far as I know, ruined. The heaviest infestation we found in 100 fields inspected was 75% and even this field had fewer than four borers per stalk—a great contrast to 1926, when not one but hundreds of fields had 100% of the stalks infested and an average of twenty borers per stalk.

Another exception this year to the increase was the joint county of Lennox and Addington, where there was a decrease of at least 25%. The main corn growing area in this county in 1931 was the heaviest infested in the province. The county was brought under the Act last fall for the first time, hence it was gratifying to obtain a reduction the first year.

Comments on the Results

The increase in the majority of the counties compared with a decrease or standstill in the minority, cannot be accounted for by the assumption that there was a much poorer clean-up in the counties where the borer increased than in the others; for this was not the case. Some of the counties where the number of borers was almost doubled were among the best cleaned up last spring. So far as I can see the true explanation of the differences in results is that the weather in the counties where the borers failed to increase was less favorable to them than in the other counties. From our own observations in Ontario, and also from the observations of entomologists in the United States and Europe, I believe I am quite safe in stating that years will occur from time to time in which the weather will be so favorable to the borer that no practicable clean-up can prevent an increase. This I think will hold true in any county under the Act. What the clean-up does in such years is to prevent the increase from being very much greater. If we are to judge by the results obtained in the great majority of the counties that have been under the Act since it was put into force, a period of six years, specially favorable seasons for the borer are not likely to occur often enough to prevent our making progress in bringing it under control; for in spite of setbacks like this year and to a lesser extent last year, there are not nearly so many borers today in most of the counties under the Act as there were in 1926, the year before it was put into force. In fact sufficient progress in control had been made up to last year in some counties to cause many farmers to feel that the time had now come for relaxing the regulations by not requiring so thorough cleaning of corn fields. If, however, we get three such seasons as 1932 I fear that many of the farmers will become discouraged and think that the Act is useless. We had something of that feeling shown last spring in Prince Edward county.

The Situation in Prince Edward County

In Prince Edward county for some reason which I cannot explain fully, we have not been able to make a reduction in the degree of infestation and there are today more borers there than in the year 1926.

It is possible that part of the explanation may be the close proximity of water to a large part of the corn growing areas. Seeing that the county is really an island with several deep bays, the proximity of the water would mean a larger amount of relative humidity in the air and consequently more dew at night for the moths to feed upon and also more humid conditions for the young larvae. The importance of humidity to both moths and larvae will be pointed out later.

Another partial explanation may be that owing to the shallow soil, the large numbers of small stones and the narrow-base plows used by many farmers, plowing may not destroy nearly so many larvae as in the average county. Under such conditions the plow does not bury the larvae so deeply and many more stubbles will be merely covered. This and the presence of numerous stones in the soil would make considerable difference in the air conditions for the larvae in the buried stubble and debris and might result in a much larger percentage remaining in the stubble and later emerging safely as moths, instead of the larvae being forced to come to the surface where they perish before they can pupate.

The situation in Prince Edward county has caused me some anxiety. A large number of the farmers, misled by certain leaders who know very little about the insect and less about results obtained by large and careful control experiments, believe that the Act is useless and simply an imposition, especially county in which there seems to be any real opposition and I have no proof that in these hard times. Hence they want it repealed. This, however, is the only the opposition will increase to such an extent as to interfere much with our work there next year.

Parasites

Because of the situation in Prince Edward county, I was much pleased with the action of the Entomological Branch and Mr. Baird in choosing this county for a large scale test of all the more promising parasites available. Mr. Baird has told me that the freed parasites prospered during the season and increased. If these survive the winter and establish themselves throughout the county they may soon have sufficient effect to enable us to get the upper hand of the borer in Prince Edward.

Weather as a Factor in Control

Before concluding I think it will be of interest to those of you who have not been closely linked up with corn borer investigation, if I were to devote a little time to outlining how weather conditions exert a great influence upon the corn borer and very largely determine whether a decrease or an increase will take place in any particular year in districts where artificial measures are enforced.

When an insect pest comes to us from across the ocean, it usually comes without the biological factors which help to control it in its native home. We all know this, but what we often fail to remember is that the new insect has still to face that complex factor known as weather—a factor that does much more to control some or probably most of our worst insects than any or all biological factors. In Europe the corn borer has, as its natural control factors, not only parasites, predators and disease, but also weather. In Ontario, weather is much the greatest natural controlling factor, though birds and predaceous insects play some part.

By far the most critical period in the life cycle of the corn borer is not the winter, for our winters kill a very small percentage of them, but is the month of June or July and the first week or so of August. This is a time when the moths are present and laying their eggs, when the eggs are hatching and when the young, delicate and unprotected larvae are trying to work their way from the leaves where they hatched into some part of the main plant where they will find not only plenty of moisture and succulent food, but also protection from the elements which threaten their existence. If the weather during July and early August is moist and either warm or moderately warm without violent storms, it affords approximately optimum conditions for all the above stages and we can be almost certain that that year there will be an increase of the borer in spite of the best clean-up we can make. On the contrary if the weather during the above period is dry and hot there will be, almost without fail, a reduction of the insect. The explanation is apparently as follows.

(1) The food of the moths is water, therefore if there is drought or very little rain and also as a result, very little dew in July, the moths will be unable to get the water they need and will live less than half as long as they would under optimum weather conditions and will lay fewer eggs than normally. In 1925 Marshall and I, in experimental tests, found that under protected conditions in cages, the moths lived less than half as long as where they had an abundance of moisture and that they laid less than one-tenth as many eggs. This same thing doubtless holds true of many other insects. Dustan found it true of the Oriental peach moth and I feel practically sure it is true of the apple maggot; hence this influence of weather, even upon the moths alone, determines to a large extent the number of borers there will be in any particular year at the end of the season.

(2) It has been observed that in a drought a considerable percentage of the egg clusters are loosened and drop from the leaves. Very few such masses will hatch and, if any do, the vast majority of the young larvae will perish before reaching and entering the plant. On the contrary, in a moist season, practically all egg clusters remain on the leaves and hatch.

(3) Hot, dry weather has also a great effect upon the newly hatched larvae and has been found to destroy a very high percentage of them before they can work their way from the leaves into the plants and find not only protection, but also moisture and succulent food. In 1925 we had a drought and over 90% of the young larvae perished, all or almost all of them being apparently in their first instar. The same thing happened in the dry season of 1930 and I am informed happened again this year in parts of Ohio where there was a drought in July. On the other hand, if we have plenty of moisture and at least moderately warm weather without violent storms, the young larvae find optimum conditions for establishing themselves in the plant and their mortality may be as low as 40%. This means that in seasons unfavorable to them, 10 larvae, or fewer, from every 100 eggs, may be left to grow to maturity, compared with 60 larvae in seasons that are favorable to them, that is six times as many may survive in a moist season as in a dry season; hence the effect of weather upon the larvae is a very great factor, probably the greatest, in determining whether there shall be an increase or decrease of the borer in that particular year.

I have discussed two very opposite types of season, the dry and the wet, but there may be many seasons that cannot be classed as either and in most of these we should be able to get a reduction of the insect. In such seasons a lot depends upon such things as low temperatures, heavy winds, driving rain storms and heavy downpours of rain, any of which, if coming at a critical time, may do much to lessen egg-laying and to destroy young larvae.

It seems to me that if a thorough study of the influence of temperature, moisture, light, and wind were made we could predict fairly accurately the part the borer will play in almost any area in North America. I am of course speaking of the single brooded strain, not of the double brooded.

Ecological studies will probably not help greatly in control measures, but they will at least explain our apparent failures and prevent our becoming unnecessarily discouraged, by results obtained in years like the present.

THE GRASSHOPPER CAMPAIGN IN MANITOBA IN 1932

By Prof. A. V. Mitchener

Department of Entomology, University of Manitoba, Winnipeg.

During the summer of 1932 Manitoba experienced an extensive and severe outbreak of grasshoppers. This outbreak was not unexpected, since in 1931 grasshoppers had done considerable damage and had deposited many eggs throughout a wide territory. The last previous outbreak in this province occurred during the years 1919, 1920 and 1921 with smaller, minor, scattered infested areas appearing until 1924. The experience gained in this former period proved to be of great value during the outbreak of the summer of 1932.

Three species of grasshoppers occurred in outbreak form. In the eastern part of the infested area the clear-winged grasshopper (*Camnula pellucida* Scudd.) was most abundant. Associated with this species was the two-striped grasshopper (*Melanoplus bivittatus* Say) which, although not so abundant, occurred in great numbers in places. In the western part of the infested area the lesser migratory grasshopper (*Melanoplus mexicanus* Saussure) was most destructive. All three species might be found in many fields throughout the territory involved.

Early in the year arrangements were made for the campaign. The provincial government was to supply the ingredients used in the bait. These were bran, sawdust, salt and some form of arsenic. The distribution of the supplies was placed in the hands of the Extension Service, Department of Agriculture, Winnipeg. Each municipality was a unit with the reeve and councillors in charge of local arrangements. Later, mixing stations were established at strategic points in the municipality or at the most central point in that area if one station was deemed sufficient. The local expenses, such as the cost of the mixing machine, rentals, cost of hauling, labor, etc., were borne by the municipality. Farmers obtained their poisoned bait ready mixed at a mixing station and scattered this bait where required on their farms.

The poisoned bait used commonly during the campaign consisted of the following:

Bran	50 lbs.
Sawdust, bulk equal to bran	(Approx. 2½ bushels)
Liquid sodium arsenite	2 qts.*
Salt	2 lbs.
Water	10 to 12 gallons

*The two quarts of liquid sodium arsenite contained a total of 2 lbs. of As_2O_3.

This bait gave excellent results. In future the liquid sodium arsenite will likely contain 8 lbs. As_2O_3 per gallon as the handling charges will be less per unit of poison. Some dry sodium arsenite and some Paris green were used effectively during the campaign but only under emergency conditions or where it was impractical to forward the liquid sodium arsenite. Several car loads of malt sprouts were used to replace bran. They were cheaper and quite as good if not better than bran.

During the summer of 1931 and 1932 experimental work with various killing agents, with and without salt as an attractant, mixed with different carriers was undertaken with grasshoppers in the Department of Entomology. Without going into the detail of these poisoning experiments some of the results may be of interest. In all of these experiments treated Red River water from the taps at the Manitoba Agricultural College was used. The use of salt in the various baits appeared to be of relatively little value. No attractant appeared to be essential to obtain a good kill if the proper insecticide was used. Sodium fluosilicate gave an average kill of 78% and gave better results without salt than with it. In limited work with calcium arsenate and with sodium fluoride excellent results were obtained with a kill of over 90% in each case. Calcium fluosilicate appeared to have very little toxic effect upon grasshoppers. The carrier for the poison may be bran, bran and sawdust, malt sprouts, malt sprouts and sawdust, brewer's grains or brewer's grains and sawdust to obtain good killing results. Liquid sodium arsenite as given in the bait above seemed in our experiments to be the most effective and economical poison used.

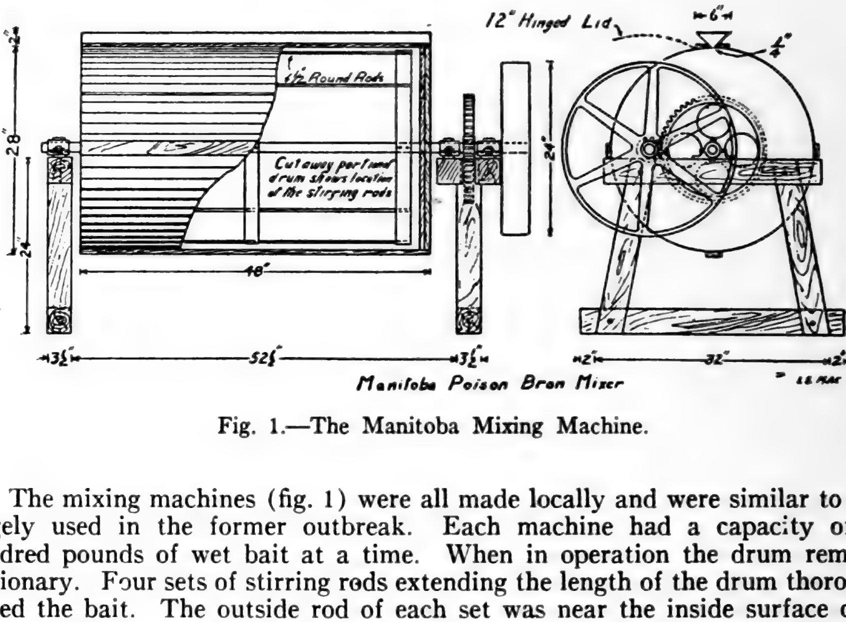

Fig. 1.—The Manitoba Mixing Machine.

The mixing machines (fig. 1) were all made locally and were similar to those largely used in the former outbreak. Each machine had a capacity of two hundred pounds of wet bait at a time. When in operation the drum remained stationary. Four sets of stirring rods extending the length of the drum thoroughly mixed the bait. The outside rod of each set was near the inside surface of the drum. Each mixing machine was run by a gasoline engine. Full details concerning the construction of the mixing machine are contained in Extension Bulletin No. 98, Manitoba Department of Agriculture, Winnipeg.

Farmers came to the mixing station and took the required sacks of bait home where it was scattered by hand. No mechanical device has as yet been demonstrated which will spread the bait as well as the human hand and arm. Broadcasting the bait thinly as one would scatter seeds gave best results. It is difficult to get the farmers to scatter the bait thinly enough. Heavy applications are wasteful, dangerous to stock and productive of poor results.

The grasshopper outbreak of 1932 was the most extensive ever experienced in Manitoba. The map shown in fig. 2 prepared from records of the actual amounts of materials supplied to the respective municipalities indicates the extent of the outbreak and the approximate relative density of the grasshopper population of each municipality.

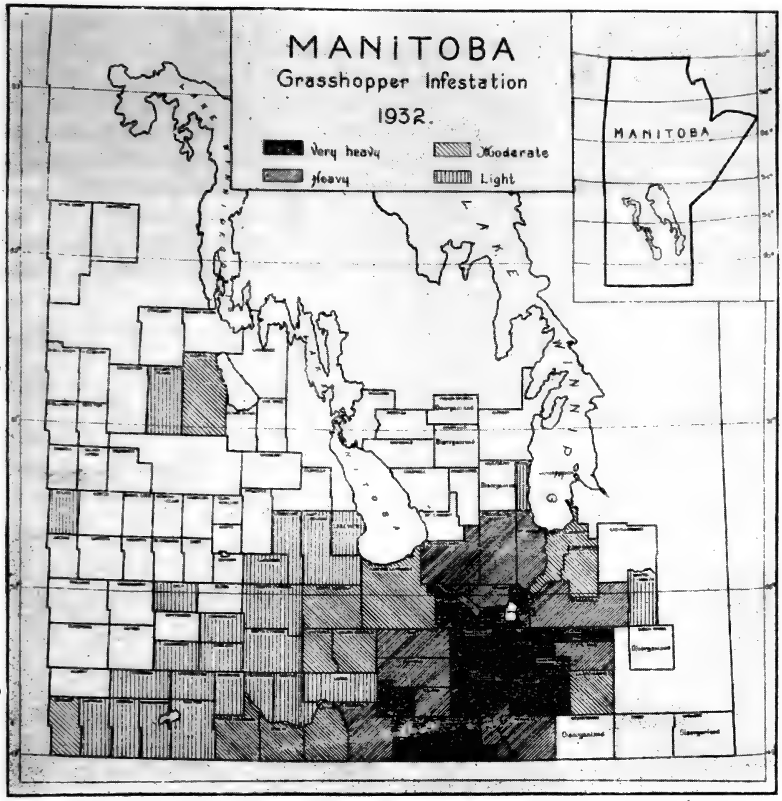

Fig. 2.—Relative infestations are based upon the total amounts of prepared bait actually used during the season. In the municipalities indicated as having very heavy infestations more than 4,000 pounds of prepared bait were used per section of taxable land. Where heavy infestations occurred from 2,000 to 4,000 pounds of bait were used, where moderate infestations occurred from 500 to 2,000 pounds of bait were used and where light infestations are indicated less than 500 pounds of prepared bait were used per section of taxable land.

The first bait used was on May 13, but poisoning did not become general before the last week of May. The majority of the mixing stations closed down between July 4 and July 10, although an occasional station mixed bait until the first week of August. Applications of bait made early in the season were much preferred. Much more stress was placed upon timely application of the poisoned bait than ever before. We strongly urged that prepared baits be held on the farms until the proper weather conditions prevailed.

Materials used in the campaign included approximately 4,651 tons of bran, 310 cars of sawdust (70 cu. yds. per car), 204 tons of salt, 76,235 gals. (each gallon containg 4 lbs. As_2O_3) liquid sodium arsenite and 14 tons dry sodium arsenite and Paris green. Approximately 16,660 tons of prepared bait were made during the season at a cost of approximately thirty-five cents per one hundred pounds of prepared bait for materials. An additional cost of approximately seventeen and one-half cents per one hundred pounds of prepared bait was incurred in the preparation of the bait. The total cost of the ingredients for the campaign approximated $115,770.25.

Many farmers, particularly those in the very heavily infested areas, stated that had they not used the poisoned bait they believed that their crops would have been destroyed completely by grasshoppers. Using the estimate of crop yields for the various crop reporting districts of Manitoba, published by the Manitoba Department of Agriculture for the year 1932 it is estimated that the control campaign undertaken by the provincial government saved the farmers of Manitoba approximately 11,000,000 bushels of wheat, 8,000,000 bushels of oats and 5,000,000 bushels of barley. By virtue of the use of poisoned bait greater yields of forage crops, wild hay, rye, flax, roots, etc., were obtained in the infested areas. Many gardens, including market gardens, were protected either in whole or in part by the use of the bait. In addition the campaign reduced the egg deposits available for hatching in 1933.

The writer wishes to acknowledge the aid of Mr. H. E. Wood, Assistant Director, Extension Service, Dept. of Agriculture, Winnipeg, who was in charge of supplies, for providing the data relating to the cost and distribution of the bait used in the campaign.

Mr. Norman Criddle and Mr. R. H. Painter, Dominion Entomological Laboratory, Treesbank, Manitoba, rendered valuable assistance during the progress of the campaign.

THE CONTROL OF THE LOCUST BORER BY FOREST MANAGEMENT

By A. H. MacAndrews

N.Y. State College of Forestry, Syracuse, New York

The locust borer (*Cyllene robiniae* Forst) is our worst enemy of black locust and in some sections of the East it is almost impossible to grow locust free from borer attack. The injury is so common that the forester has reached the stage where he more or less accepts the injury as a matter of course and doesn't attempt to do anything about it. Locust is in demand because of its lasting qualities when in contact with the soil. It is a hard, durable wood, grows rapidly and is a good sprouter.

The control for the insect in the past has been based on the assumption that the beetles are sun lovers and by creating shade either by close planting or under planting the tree will be protected from attack, or at least the attacks will be greatly reduced in number. This method has not given very good results however. It has also been stated that as the beetles are pollen feeders and seem to like the golden rod, the eradication of golden rod in the vicinity of a locust stand would deprive the beetles of their food supply. Unfortunately the beetles are not dependent upon the golden rod for their survival and its removal doesn't seem to make much difference.

In Ohio enough interest was created in the problem to induce the Federal government to place Dr. R. C. Hall, Forest Entomologist of the Ohio Experiment Station, on the project. After establishing a series of experimental plots, he came to the conclusion that the suppressed trees in the stand were chiefly responsible for the trouble in locust stands. Working on a co-operative basis, we established a plot at Syracuse and the following paper summarizes our results to date. I do not wish to convey the impression that we consider our results as conclusive. They are interesting enough, however, to make it seem worth while to continue the study.

During the summer a sanitary cutting was made on about 1½ acres of sprout growth locust. The original stand was so badly injured by the borer that it was clean cut in 1921 and the present growth is all sprout growth since that time. With the appearance of the new stand, the beetles reappeared and all of the trees have been injured and some killed. The highest attack ran 45 to a tree and the average for the stand in all-crown classes was 17.1. The average number of attacks per crown class was very nearly the same but we found that a high larval mortality occurred on the codominant trees. Over 2,000 of the 3,000 trees on the plot were cut. Accurate data was taken on 767 of the felled trees, which were grouped as follows—130 codominant; 233 intermediate; and 404 suppressed. The diameter, crown class, height and number of attacks were recorded for each tree. When the notes were summarized it was found that a very enlightening graph could be made which I will show you with the lantern. In the small diameter classes the attacks on all three crown classes ran about the same but above the 2½ inch diam. class there was a noticeable difference. In the suppressed class, trees with a diameter of 2½ inches or greater, had an ever increasing rate of attack, while the attacks on the intermediate trees began to decrease in number after the 3-inch diam. class was reached. In the codominant classes the attacks decreased noticeably on trees over 3″ in diam. This is strikingly brought out in the graph.

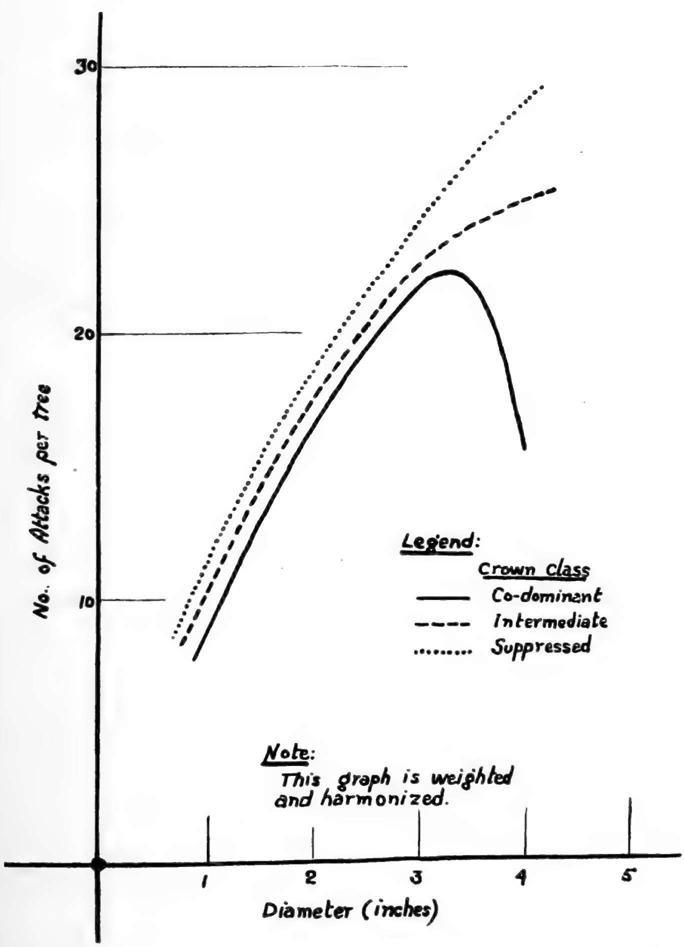

Fig. 1.—Graph showing distribution of locust borer attacks by crown classes.

The number of attacks do not give a true picture of things, however, so 117 sections of black locust were peeled and examined, the attacks being recorded as successful or unsuccessful, depending on whether the larva succeeded in entering the wood and completing its gallery. Out of the 1,158 attacks recorded, 711 were failures and only 447 were successful. The majority of the unsuccessful attacks were on the larger codominant trees. The 2-inch suppressed tree seems to be the best breeding ground. Under 1-inch the attacks are not very successful and this is also true of the limbs 1-inch in diam.

The data collected points to the possibility of removing the suppressed and intermediate trees as a means of controlling the locust borer. It would appear as though certain trees in the stand were acting as brood trees year after year and releasing large numbers of beetles that spread to the surrounding trees. In opening up the stand by the removal of the 2,000 trees, we have done just what shouldn't be done, according to the popular conception of the problem. I would like to point out, though, that the crowns of locust are small and irregular in shape and do not cast the shade that other trees of a similar size would cast. In fact, before we opened up the stand the sunlight filtered through to the trunks of the trees on nearly all the trees at some time of the day at least. We believe, however, that the increased growth rate and vigor of the trees which will be promoted by the thinning is going to be the big factor in determining the fate of the tree.

One parasite was reared (*Ichneumon irritator* Fab.). This large parasite was found in the larval stage feeding on the larvae of the locust borer. About 21 of them were reared, the adults appearing about a week before the peak of the emergence of the locust borer.

The first locust borer appeared on August 4th but the peak of the emergence did not occur until the first week of Sept. The first eggs were found the last of August and required about 6 days to hatch. Adults were still laying eggs on Oct. 1st and stray beetles were found until Oct. 28th. As I show the lantern slides, I will point out the interesting features of the life cycle.

INSECTS INFESTING GRAIN IN FARMERS' GRANARIES IN SOUTHWESTERN ONTARIO

By Geo. M. Stirrett and David A. Arnott

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During the present widespread outbreak of insects in grain stored in farmers' granaries, the writers have studied the problem looking toward its solution in some practical control measure. The investigations are as yet far from complete, but the following preliminary observations and discussion are presented at this time.

Beginning in 1930 and continuing up to the present time, grain insects have been very troublesome and injurious in grain stored in farmers' granaries. The greatest losses occurred during the years 1931 and 1932.

The outbreak has been largely limited to the area south of a line from Sarnia to Stratford and Hamilton, although reports have also been received from other parts of the province. The worst infestations have been found throughout Essex and Kent counties.

The amount of damage, although difficult to estimate, has been considerable. In 1930, the laboratory received records of 10,000 bushels of grains which were unfit for use and which had to be fed to hogs. Most of it would not even make good hog feed. In the same year a large malting company lost about 100,000 bushels of barley which became unfit for malting purposes through insect activity. The known losses are, we are sure, only a fraction of the amount of grain subjected to injury.

The writers have not determined all of the causes contributing to the outbreak. It is believed, however, to be largely due to the holding by growers of quantities of grain for long periods in granaries improperly built for long-time storage. The mild winters of the past four years must, also, have had some effect, although just how much we cannot say at this time. From January, 1929, to February, 1932, the mean monthly temperature of every winter month, except January and December, 1929, and January, 1930, has been above normal. Our winters have been warmer. Growers not being accustomed to holding grain and not being familiar with insect work, have neglected to look at their grain at frequent intervals and, hence, have allowed grain to become badly damaged before it was known to be infested. The practise by growers of taking home the screenings from the elevators has also increased the infestations on the farms as in many cases these are infested.

The following insects have been found in grain in farmers' granaries: *Sitophilus oryzae* L., rice or black weevil; *Sitophilus granaria* L., granary weevil; *Oryzaephilus surinamensis* L., saw-toothed grain beetle; *Tribolium ferrugineum* Fab., rust-red flour beetle; *Laemophloeus minutus* Oliv., flat grain beetle; *Cryptolestes ferruginous* Steph., rust-red grain beetle; *Cathartus advena* Waltl., foreign grain beetle; *Tenebroides mauritanicus* L., cadelle; meal worms, species undetermined; Psocids, species undetermined; mites, species undetermined; *Alphitophagus bifasciatus* L., two banded fungus beetle; *Typhaea fumata* L.

Of these, the most important and most injurious species are the rice and granary weevils, saw-toothed grain beetle and rust-red flour beetle. Psocids are found abundantly in the granaries in the autumn, but their true economic status is unknown as is also the status of some of the other insects listed. The two beetles *Alphitphagus bifasciatus* and *Typhaea fumata* are primarily saprophytic.

In the vicinity of Chatham, wheat is generally threshed in July or early August. Formerly a large part of the grain was sold from the threshing machine, but recently most of it has been stored. From the machine it is hauled to the granary or bins. After a period of time, ranging from one month to many months, insects become numerous and finally if unnoticed by the owner, and no control measures are undertaken, the grain heats, becomes mouldy, and in really bad cases, sprouts. Grain has been seen that was in a heated condition and heavily infested with insects one month after it had been threshed. Generally, however, a much longer time is required. Sprouting grain in bins is probably more frequent during late winter or early spring, although it has been seen at all seasons of the year. Infested grain is refused by buyers or bought at a discount.

Several factors may cause grain to heat, such as improper storage conditions, high moisture content, and insects. In many cases it is difficult to determine which factor or set of factors initiated the heating process. Very few bins of grain have been found to heat from moisture which did not contain insects. Generally, heated grain contains large numbers of insects and these have to be killed or taken out before the grain will cool. Once insects are numerous they will maintain the high temperature of the grain by their activity even during the winter months.

Control Practices

There are several methods of dealing with insect infested grain. The methods adopted will depend on the circumstances and the attitude of the owner as well as upon the time of the year at which the condition is noticed. The owner may sell at once, accepting whatever price he can get for his grain. Generally, it is necessary to clean the grain before a buyer will accept it.

Moving or turning grain delays insect activity and often, especially if the weather is cold, will kill a large number of the insects. To kill many insects, the temperature would have to be considerably below zero, or else kept at low temperatures for long periods of time. Chapman ($_1$) records that adults of *Tribolium confusum* die in a few weeks at 44.6°F., while Cotton and Back ($_2$) state that granary weevil which is more resistant than the rice weevil to cold, will live for 111 days at 40-45°F., 14 days at 15-20°F., 7½ hours at 5°F., and five hours at 0°F. The eggs are killed when exposed to 30°F., for twenty-eight days and the larvae die after being exposed to the same temperature for forty-four days. Under the weather conditions which have existed at Chatham during the past three winters, it would appear, therefore, that the winters' cold killed very few insects. It has been our experience that even where grain did not heat the insects remained alive throughout the winter.

When the temperature of the grain is around 45°F., very little insect activity is encountered and the grain is safe until the higher temperatures of spring, when activity again develops. Nearly all insects are dormant at 43°F.($_3$). When the grain is heated the turning process will do very little good unless during the process or immediately after the turning the grain cools to that temperature normal for the season.

If the grain is put through a fanning mill at the time it is being turned a large number of adults and larvae will be eliminated. This will reduce the infestation and delay its progress towards further damage. The stages of rice and granary weevils within the wheat kernels will, however, not be affected and the grain must be watched carefully for further activity.

Our work with fumigants has not been as extensive as we would like, but is being continued. The main reason for failure in fumigations is that the bins and granaries are simply not made for this type of work. Farmers and others in future should consider the necessity of fumigation and build their storage houses in such a way that they can be fumigated. To be successful, the fumigant must kill the insects and the grain, if heated, must lose its high temperature.

Carbon bisulphide has been the most common fumigant for a long number of years. The writers have had good results with this material when used at the rate of one pound to fifty bushels of grain. However, complaints of failures from farmers and others have been so numerous that we have ceased to recommend it for use in granaries as they are constructed in our district, as when left to himself the owner simply will not take the required amount of care in preparing the bins or granary for fumigation.

In the United States carbon bisulphide is used at the rate of one pound to twenty-five bushels of grain. The writers have not conducted fumigation at this strength as the cost, at local prices per pound of carbon bisulphide, would be about fourteen dollars per 1,000 bushels of grain. Carbon bisulphide can, however, be purchased in 100-pound lots at a cost of eight and a half cents per pound and at this price it might pay to use the material. Further tests are being made in the immediate future.

Fumigations with a mixture of carbon bisulphide, carbon tetrachloride and sulphur dioxide have been given good results when used at the rate of two gallons to 1,000 bushels of grain at a cost of approximately nine dollars.

A typical fumigation in a granary with this material is described below:

The bin contained some 352 bushels of barley in a heated condition and alive with insects. Carbon bisulphide, carbon tetrachloride and sulphur dioxide mixture was used at the rate of two gallons per 1,000 bushels, this rate having been found necessary for adequate kill by previous experimentation.

In preparation for fumigation, the windows and doors were made tight with glued newspapers and all cracks were filled with moistened newspapers. A large canvas was spread over the bin so it would be in place after the material was applied. It was necessary to cover the grain in order to hold the concentration of gas long enough for a kill to be effected. The proper amount of liquid was then poured directly on the grain, under the canvas and distributed as evenly as possible so that all parts of the grain received its share of the fumes. The temperature of the grain should be as high as possible, and not below 70°F., for the best results.

In this particular fumigation the temperatures were as follows; (degrees, Fahrenheit) outside air temperature 60°; surface temperature of grain 54-58°; one foot depth 68-70°; two foot depth 87°; three foot depth 86°.

The door was closed and sealed as well as was possible and 24 hours allowed to elapse. A count made before fumigation showed that practically all the insects were alive. The following is the result of the fumigation:—

COUNTS OF DEAD AND LIVING INSECTS AFTER FUMIGATION. NUMBER OF INSECTS IN ONE QUART SAMPLES

TWENTY-FOUR HOURS AFTER FUMIGATION

Location in Bin	Rice Weevils		Rust-red Flour Beetle		*Alphitophagus bifasciatus*		Granary Weevil	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
Surface	200	44	7		5		1	
1 foot	158	1	74		1			
2 feet	22	0	102					

TEN DAYS AFTER FUMIGATION

Location in Bin	Rice Weevils		Rust-red Flour Beetle		*Alphitophagus bifasciatus*		Granary Weevil	
	Dead	Alive	Dead	Alive	Dead	Alive	Dead	Alive
Surface	206	4	9		37			
2 feet depth	92	1	115		0			

Besides these records, small vials covered with wire gauze were placed at different depths in the grain, each containing approximately thirty insects. All insects in such locations were killed, except on the surface of the grain.

The temperature in the bin fell gradually until it became stationary at about 44°F., about three weeks after the fumigation. Since, it has fluctuated slightly. This fumigation is typical of several others carried out under varying conditions. It gave a satisfactory commercial kill and the temperature of the grain was lowered so that the living insects became dormant.

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SODIUM FLUORIDE AS A CONTROL FOR CATTLE LICE

By R. W. Thompson

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Experiments conducted in the vicinity of Guelph, and also in the United States by F. E. Guyton,* of Auburn, Alabama, have shown that both the sucking lice, *Haematopinus eurysternus* and *H. vituli,* as well as the small red biting lice, *Trichodectes scalaris* are easily controlled with sodium fluoride. The experiments conducted by the writer have been carried on over a period of four years, starting in the spring of 1927 and continuing until the spring of 1931. During that time over two hundred cattle of varying ages and breeds have been treated and in every case the treatment has been satisfactory. In order to test the possibilities of injury from its use, sodium fluoride was applied to a five-day-old calf. No injury resulted.

The chief advantage of treatment with this substance is that it requires only one application, if that application is thorough. Sodium fluoride may be purchased at almost any drug store and the cost is relatively small, the amount necessary for treating a mature animal being not more than three cents. The application may be made in January or February, or whenever the lice become abundant enough to be noticed. If other animals are being brought in from infested herds from time to time, these should be treated as soon as they are brought in.

Method of Application

Sodium fluoride may be applied as a powder, without any diluent, or if preferred, may be mixed thoroughly with an equal amount of corn starch. A can with a perforated top, similar to a salt shaker with enlarged holes serves very well for the application of sodium fluoride as a powder. About one ounce of the substance will suffice for each animal, and should be applied to the head, neck, shoulders and along the back of the tail-head. *Trichodectes scalaris,* as a rule, is more common behind the shoulders and along the back, whereas, *Haematopinus eurysternus* and *H. vituli,* prefer the fore-shoulder, neck and head, especially around around the eyes. In rough-coated or heavy-coated breeds the powder or dry form of application has been found the more satisfactory, but with the smoother coated dairy breeds it is somewhat hard to get the powder to stay on the hide and hair, particularly in the head regions. For this reason, it is better to dissolve the sodium fluoride in water, at the rate of one ounce to a gallon of tepid water, and apply the solution with a sponge, rag, or even an oil can. The reason for using tepid water is to avoid the risk of chilling animals that are being treated, more especially milch cows. Whichever method is used, the hair should be opened up with one hand so that the sodium fluoride will reach the hide, where the lice are feeding. The object in mind should be to get an even coating of sodium fluoride on the hide and thus bring it in contact with the lice.

*F. E. Guyton, Journal of Economic Entomology, Vol. 19, August, 1926, pp. 602-603.

Comparison With Other Control Substances and Methods

The following list of materials was tried in comparison with sodium fluoride as controls for cattle lice. As will be noted a number of these controls are commonly in use on the average Ontario farm at the present time.

1 Newly Purchased Sabadilla Powder.
2 Two-year-old Sabadilla Powder.
3 Derris Powder.
4 Pulvex Powder.
5 Sodium Fluosilicate.
6 Calcium Fluosilicate.
7 Barium Fluosilicate.
8 Flowers of Sulphur and Soil—equal parts by volume.
9 Used Crank-case Oil.
10 Used Crank-case Oil and Coal Oil—equal parts.
11 Raw Linseed Oil and Coal Oil—equal parts.

In comparison with both old and newly purchased Sabadilla powder, sodium fluoride is preferable because it costs only about 50 cents instead of 75 cents a pound which is the common price for sabadilla. Less material is necessary when sodium fluoride is used and also, for treatment of sucking lice particularly on the head, the sabadilla is too coarse in texture to work into the hide. This was clearly demonstrated in the case of one steer where the infestation was in the form of a heavy ring around one of the eyes. Sabadilla powder, newly purchased, was applied as best it could be and examinations made every week. At the end of three weeks the infestation seemed to be worse and therefore an application of sodium fluoride powder was made. All lice were dead at the end of two weeks and the steer remained free from lice during the rest of the stable season.

Sodium fluoride does not deteriorate with keeping as does sabadilla. Tests were made on four animals with as nearly equal degree of infestation as could be found in the stable. Newly purchased sodium fluoride and sabadilla powder were applied to one of each of the animals and the other two were treated, one with sabadilla powder that had been on hand for two years, and the other with sodium fluoride that had also been on hand for at least two years. In the case of the animals treated with both kinds of sodium fluoride and with new sabadilla powder the kill was complete, but in the case of the old sabadilla powder there was considerable survival of both types of lice at the end of four weeks.

The mortality obtained with sodium, calcium and barium fluosilicates in comparison with sodium fluoride was about the same in each instance, and no injury resulted from the use of any of these materials. Sodium fluoride is, however, much more readily obtainable generally than are any of the fluosilicates and for that reason is preferable to them.

In comparison with derris and pulvex powders, sodium fluoride appears to kill more quickly than either in the case of the biting lice, and pulvex will not apparently control sucking lice. In addition sodium fluoride is more common on the market than either of these other substances.

The owner of an Angus herd, in the neighbourhood of Guelph, uses flowers of sulphur and soil mixed in equal quantities, all the time. In comparison with sodium fluoride this mixture has several drawbacks. The application of this material is made every week, except towards the end of the stable season, whereas the sodium fluoride needs but one application. In any but black-coated animals there would be discoloration from the soil, a condition which does not occur when sodium fluoride is used.

The oil treatments are disagreeable to apply and do not always give a complete control of either types of lice. In addition to this they leave undesirable discolorations and at times cause the hair to fall out and the hide to become scaly. One bull which was included in the experiments was considerably injured on the neck and shoulders from the use of raw linseed oil and coal oil, mixed in equal quantities.

Precautions

For people who are susceptible to nose irritants the solution method of using sodium fluoride would probably be the better in all cases, because the sodium fluoride is a very fine powder and when applied in the powder form, has a tendency to enter the nostrils. It is possible that this might lead to later developments, although the writer was not affected in any way beyond a little sneezing.

While no injury to cattle was noted in the United States or Canada from the use of sodium fluoride, one case of apparent injury to goats was reported to the writer. There was no opportunity to investigate this case.

SOME NOTES ON THE BIOLOGY AND LIFE-HISTORY OF PSOCIDS

By L. R. Finlayson

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The object of this paper is to call attention to the potentiality of psocids as pests in the laboratory rearing of insects. It will be recalled that the group Psocida or Copeognatha contains about 650 species, and that most of these are alate forms, living on and under the bark of trees.

The small book-louse, *Liposcelis* (*Troctes*) *divinatorius,* is, of course, the most commonly observed psocid, and may be found almost anywhere. It often becomes abundant in habitats which suggest the common names, book-louse, dust-louse, and cabinet mite. Here it feeds on paste and glue, bits of dead animal and vegetable matter, and fungi. Sometimes herbaria and insect collections are attacked. This species, while its habitat is almost exclusively the inside of buildings, in some seasons may be found under the bark of trees.

During the summer of 1932, at the Belleville Parasite Laboratory, we had a very striking example of the rapidity with which the book-louse can increase under some conditions. One room had been set aside for the propagation of *Sitotroga,* our laboratory host for *Trichogramma.* The room contained sixty-four bushels of soft wheat, divided among thirty-two boxes, and spread on trays within these boxes. Temperatures between 75°F. and 85°F., and relative humidity of 75 to 90 per cent obtained in the room outside the boxes. The temperature inside the boxes was often higher and the relative humidity probably lower. This room was apparently free from the book-louse at the beginning of 1932, when the infestation of *Sitotroga* was started. It was first observed in the room toward the latter part of March, but at that time only a few were seen on the outside of one of the boxes.

General spraying with a pyrethrin spray in the room and on the outside of the boxes greatly reduced those book-lice which came to the outside surfaces, but by May their numbers were so great that any killed by spraying were immediately replaced by others from inside the boxes. They had now spread to all parts of the room. The rate at which they increased was strikingly illustrated by a very sudden reduction of a heavy fungus growth on the collecting cones of the boxes, this being eaten by the book-lice. Until this time the growth of the fungus kept well ahead of the depredations of the insects.

By August huge numbers were present. The boxes of wheat were literally covered with them, inside and out, and practically every wheat kernel which had been pitted by the grain insects, contained several adult psocids. Many of these grains also harboured immature stages, including eggs. The estimated population at this time was in excess of two hundred million.

Our *Sitotroga* population, which had been increasing since the first of the year, was very heavy by the middle of April. After this time the numbers were greatly reduced, and continued more or less at this reduced level for the balance of the season. The possibility of the book-louse as one of the elements in this reduction was inquired into, and it was found that these insects readily fed upon *Sitotroga* eggs, and if starved would eat even the chorion. They, of course, got into the oviposition cans along with the moths. In these cans the eggs were scattered through a proportionately large amount of starch, but large numbers of them were destroyed. With eggs and crushed wheat both available, both were attacked, with no apparent preference. A colony can live and thrive for a very long time on a small piece of wheat kernel.

In view of the finding that *L. divinatorius* will eat *Sitotroga* eggs, and in consideration of the huge numbers of this insect present, we feel sure that the numbers of *Sitotroga,* to some extent at least, were controlled by these insects. We know also that a good proportion of the eggs in the oviposition cans were attacked, making them unfit for parasitism.

With regard to the life-history of this insect, our observations indicate that the period from egg to adult occupies about one month, at a temperature of 80°F., and a relative humidity of 65 per cent. There are three moults. The eggs and nymphs are white, or almost so, with the exception of the mouth parts. The adult is about one mm. long and varied from light brown to greyish-brown in colour. After a pre-oviposition period of two to three weeks, eggs are laid at the rate of about one every twelve hours, until perhaps seventy-five per cent of the total are laid. A long period then follows when only an occasional egg is deposited. We have adults under observation which lived for over three months. Rosewall (1) has given figures showing the average deposition of eggs during June, July and August to be fifty-seven. (Temperature 60°F. - 95°F.) He observed one female which lived from July 27th to October 27th, and laid ninety-eight eggs. The females are parthenogenetic and males are comparatively rare. We examined a large number of specimens, but were not able to find a male form, nor was any copulation observed in the room which was so heavily infested.

Moisture appears to be of considerable importance to the life of this insect. General observation leads to this inference. Also it was found that the addition of moisture, absorbed by paper, to a rearing dish, results in thin and lethargic book-lice, becoming filled out and active within two or three hours, and often in stimulation to further egg laying.

Noland (2) reports gregarine protozoa as frequently filling two-thirds of the mid-gut. She also reports a large nematode in the body cavity as a parasite, which does not have any effect on the activity of the host. She has observed a parasite protozoan in the testis.

A psocid other than *L. divinatorius* was also found at the laboratory. It is probably *Clothilla pulsatorius,* or closely related. It is much more active than its smaller relative, and will devour *Sitotroga* eggs eagerly.

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THE PRESENT STATUS OF THE EUROPEAN PINE SHOOT MOTH* IN SOUTHERN ONTARIO

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Following an interception of larvae of the European pine shoot moth, in mugho pines of Dutch origin, at Windsor, Ontario, in the spring of the year 1925, and the subsequent discovery, in the autumn of that same year, that the pest was present and well distributed throughout the nursery and park plantations of the Niagara Falls and Toronto districts, officers of the Entomological Branch have done everything within their power to eradicate or hold in check this dangerous enemy of young pine trees.

The vigorous attempts at complete eradication, carried on for the past seven years, mostly during the spring months, when the injury is conspicuous, have not as yet met with entire success; but the persistent pruning of affected shoots and the occasional complete destruction of the larger, very heavily infested trees, in nurseries and parks, has undoubtedly saved many young plantations from serious injury and more or less kept the insect under control on such properties.

From the spring of the year 1926, when systematic control work was first commenced, until the early summer of 1931, the attempts to eradicate this pest were largely confined to work on ornamental stock and plantings in nurseries, parks, cemeteries and private gardens; but, following the discovery, in 1931, of alarmingly heavy infestations among the sandhills and summer home colonies, along the north shore of lake Erie in Welland county, operations were extended to include careful scouting of the pine windbreaks and reafforested areas in Haldimand, Brant and Norfolk, with the special object of protecting the immense Provincial forest nurseries and plantations in the latter county.

This year, 1932, in co-operation with the Provincial Forestry Department, the campaign was still further extended to include the systematic pruning of infested buds from the heavily infested reafforestation plots in the vicinity of Port Colborne in Welland county, and the combined scouting and cleanup of the scattered plantations and windbreaks in Haldimand county. At the same time, further vigorous efforts were made, by the most careful and systematic means, to clear the infestations from the nurseries and other previously known infested areas.

At the beginning of the eradication campaign, this spring, the European pine shoot moth situation in southern Ontario appeared to be as follows:— Certain commercial nurseries, within the counties of Northumberland, Durham, Ontario, York, Peel, Halton, Wentworth, Welland, Wellington, Waterloo, Brant, Oxford, Middlesex, Lambton, Kent and Essex, although showing marked improvement, following the long persistent efforts at eradication, were still carrying some scattered infestation here and there throughout their blocks of ornamental pine.

**Rhyacionia buoliana* Schiff.

It is believed that the infestations on many of the smaller nurseries will more or less readily yield to further control measures, in the near future; but some of the larger establishments, within the counties of Welland, Wentworth and York which normally carry many thousands of pine trees on their premises, present a very serious problem and one which nothing but the most painstaking and persistent of efforts can ever hope to overcome.

Apart from nursery infestations, the European pine shoot moth appears to have gained a foothold in parks, cemeteries, private gardens and reafforestation plots in the counties of York, Peel, Halton, Wentworth, Lincoln, Welland, Haldimand and Brant; with centres of the most serious infestations in the vicinities of Toronto, Hamilton, Niagara Falls and Port Colborne.

Such infestations as those in and around the cities of Toronto and Hamilton are probably directly attributable to the distribution of affected nursery stock; but those at Niagara Falls and Port Colborne should be considered from a different angle, although it is conceded that the planting of infested nursery pines may have had some slight bearing on the situation in the former locality.

At Niagara Falls, the situation is most serious along the river bank, with the heaviest infestations in the immediate vicinity of the Horseshoe falls. Year after year, most determined attempts have been made to eradicate the pine shoot moth in the ornamental plantings in Queen Victoria Park; a work which has involved an immense amount of pruning of the smaller trees, and the cutting down and destruction, by the park authorities, of at least eight large 30 to 35 years old Scotch pines, which were found, on examination, to be carrying, in their upper branches, as many as a thousand or more infested buds per tree.

Notwithstanding the fact that, during the course of control work over a number of years, many thousands of infested pine buds have been destroyed in the park and on adjacent private estates, only partial control has been achieved; for, each season, surprising numbers of newly infested buds have made their appearance on trees of all ages throughout the Niagara border area. It is difficult, if not impossible, to believe, that all this fresh infestation, every year, is due to a natural increase from the comparatively few infested buds which are overlooked during the course of annual control work; therefore, it is necessary to seek some other explanation for the persistently heavy infestations at Niagara Falls. In this connection there would appear, at the present time, to be only one tenable theory to advance and that is, that, during the season of adult emergence and flight, there is a migration or accidental movement of the moths, across the river, from the heavily infested plantations on Goat island or other adjacent parts of New York state. This westward movement of moths may be purely accidental and may take place at any time during the flight period, when winds and weather conditions are favourable; but, on the other hand, there may be some definite attractive force in the powerful illuminating searchlights situated on the Canadian side of the Horseshoe falls and, in this connection, it is rather a significant fact that however carefully the pine trees, both above and below these lights, are cleaned up, each succeeding season they are again found to be quite heavily infested.

For the origin of the recently discovered and very serious infestation along the shore of lake Erie in Welland county, the writer has two theories to advance. Nearly all of the pines in this southern section of the country were obtained from uninfested Government nurseries and have been planted as part of a scheme to reafforest the waste sandhill areas of the district, and to prevent movement or drifting of sand among the numerous summer residences which are situated along the shore line. Very few ornamental pines, from commercial nurseries, have been planted within this area and such as have been brought in, from time to time, do not appear to have carried infested buds; therefore the probability of this infestation emanating from the introduction of affected nursery stock becomes somewhat remote and unworthy of being seriously entertained. This being the case it is necessary to look for other sources of infestation and, in this connection, it would appear that two distinct probabilities should be taken into consideration.

In the early part of the past summer, whilst conducting control work in the Humberstone township of Welland county and searching the surrounding country for pine plantations, a considerable growth of 25 to 30 years old Scotch pines was discovered in a rough sandhill area along the lake shore immediately east of Port Colborne. These Scotch pines, most of which were apparently imported directly from France, some 20 or more years ago, for reafforesting the shifting sandhills of this particular area, are now nearly smothered by dense growths of mixed deciduous trees and many of them are in a dead or dying condition; however, many hundreds are still making some sort of growth and here, on such living pines, an immense amount of both old and new injury by the European pine shoot moth was discovered. There would appear to be but little doubt that these old Scotch pines, which have, undoubtedly, been heavily infested for a considerable number of years, are the main source of infestation for this particular district and are directly responsible for the infestation in all the more or less recently planted pines in the vicinity of Port Colborne.

For the infestations further east along the lake shore, other factors must be taken into consideration for, although there may have been some slight spread eastward from the centre of infestation, at Port Colborne, everything seems to point to a general westward movement of moths during the midsummer flight period; therefore, we are inclined to advance the theory that the infestations east of Humberstone township have been occasioned by a natural flight spread, across the Niagara river and the narrow end of the lake, from the heavily infested plantations of Erie county, in the state of New York. This theory of flight spread from adjacent infested territory in the state of New York is given added weight by the fact that isolated plantations of young trees along the Niagara river boulevard, between Niagara Falls and Fort Erie, obviously free from infestation when set out, and situated seven miles or more, in a straight line, from the nearest point of infestation on the Canadian side, became infested within a year after planting.

This general westward movement of moths, although more or less contrary to the prevailing ground winds, would, nevertheless, appear to be quite clearly defined, especially in respect to the scattered infestations in Haldimand county and in that portion of the county of Welland which lies west of the ship canal. As an illustration of this apparent westward flight spread, it is necessary to diminishing intensity, all the way through to the mouth of the Grand river. From the Grand river westward to the Norfolk county border, pine trees of any kind are few and far between; but, nevertheless, light, scattered infestations of a recent nature have been found extending as far west as the east side of a block of mixed woodland, situated within close proximity to the Haldimand-Norfolk county lines.

In consideration of the foregoing observations, and reviewing the situation as a whole, it would appear that the extensive Provincial forestry nurseries and other plantations in Norfolk county are most seriously threatened by a natural flight spread from the east and, this being the case, most intensive efforts were made, this past season, to clean up the scattered infestations in Haldimand county and in all those portions of Welland county which lie west of the ship canal. In addition, and in order to increase the margin of safety and reduce the general menace from this direction, joint crews of Dominion and Provincial employees, under the direction of the writer, have cut out and destroyed immense numbers of infested buds from the heavily infested plantations of young trees in the vicinity of Lorraine and Port Colborne.

Although the most serious menace to the Norfolk county pine forests is apparently from the natural flight spread of the moths; nevertheless, the danger of introduction by means of affected nursery stock must not be overlooked and in this connection it will perhaps be of interest to record here that the Department of Agriculture is continuing its efforts to eliminate this most dangerous forest pest from ornamental plantations of pines in all the commercial nurseries of Southern Ontario.

Up to the present time, factors in relation to biological control do not appear to have had any very marked bearing on the European pine shoot moth situation within the infested territory under review; but, in this connection, the following observations may be of some interest:

During the course of control work, a small percentage of larvae have been found dead within the buds, apparently having been attacked by some form of disease; while, in some situations, many empty pupal chambers have been discovered without any clue as to the agency responsible for the removal of the pupae.

Partial, but not by any means conclusive, experiments, conducted by the writer, would tend to indicate that the larvae and pupae of the European pine shoot moth are somewhat distasteful to birds; therefore any extensive natural control by such means is scarcely to be looked for.

On the other hand, insect parasites have been found to be reasonably active, in some localities, and the following Hymenopterous species have been recovered, at various times, from collections of infested material:—*Pimpla detrita* Hlgr., *Pimpla inquisitor* Scop., *Hemiteles* sp., *Ephialtes extensor* L., *Pristomerus orbitalis* Hlgr., *Lissonota culiciformis* Gr., *Perilampus tristis* Mayr., *Habrocytus* sp., *Microbracon stabilis* Wan., and *Eurytoma appendigaster* Bch., *Secodella subopaea* Gahan. In addition to the foregoing native parasites, which do not appear to have any great effect upon the European pine shoot moth population, two species of introduced parasite, *Orgilus obscurator* Nees., and *Cremastus interrupter* Grav., have been quite frequently recovered in the field, a circumstance which would serve to indicate that some measure of partial control may, eventually, be looked for in this direction.

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