Ontario Department of Agriculture

Sixty-Fourth Annual Report

OF THE

Entomological Society

of Ontario

1933

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HON. DUNCAN MARSHALL, Minister of Agriculture

ONTARIO

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1934

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Entomological Society of Ontario

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ENTOMOLOGICAL SOCIETY OF ONTARIO

FINANCIAL STATEMENT

For the Year Ending October 31st, 1933

Receipts		*Expenditures*	
Cash on hand, 1932	$ 286.64	Printing	$1,216.00
Subscriptions	475.43	Annual Meeting	74.45
Dues	177.58	Expense	26.33
Advertisements	39.50	Cheque returned	4.97
Back Numbers	167.61	Exchange	1.17
Government Grant	350.00	Balance on hand	219.35
Exchange	45.51		
	$1,542.27		$1,542.27

Respectfully submitted,

Reg. H. Ozburn,
Secretary-Treasurer.

Auditors—R. W. Thompson, W. E. Heming.

Entomological Society of Ontario

REPORT OF THE COUNCIL

The Council of the Entomological Society of Ontario begs to present its report for the year 1932-33.

The Sixty-Ninth Annual Meeting of the Society was held at Ottawa on December 1st and 2nd, 1932.

The morning and afternoon meetings were held in the Confederation Building, and the Smoker in Standish Hall, Hull.

The Thursday evening meeting was held in the auditorium of the National Museum. Dr. W. H. Brittain, President of the Society, acted as Chairman and Dr. R. Matheson of Cornell University gave an interesting lecture on "Insects in Relation to Animal and Human Diseases."

The meetings were well attended by members from the various provinces and a number of visitors.

During the course of the meeetings the following papers were presented:—

"Presidential Address"—Dr. W. H. Brittain, Macdonald College, Quebec.

"Notes on the Control of the Pear Psylla and San Jose Scale"—W. A. Ross, T. Armstrong and D. F. Patterson, Entomological Laboratory, Vineland Station, Ontario.

"Studies on the Effects of Burying and of Cultivation on Oriental Peach Moth Larvæ"—T. Armstrong, Entomological Laboratory, Vineland Station, Ontario.

"Observations on the Relation of Temperatuare and Moisture to the Oriental Peach Moth"—G. G. Dustan, Fruit Branch, Toronto, and T. Armstrong, Entomological Laboratory, Vineland Station, Ontario.

"Some New Facts Concerning the Gladiolus Thrips (*Taeniothrips gladioli M. and S.*)"—Alan G. Dustan and W. G. Matthewman, Entomological Branch, Ottawa.

"Blackfly Control with Larvicides"—C. R. Twinn, Entomological Branch, Ottawa.

"Some Notes on the Biology and Life History of Psocids"—L. R. Finlayson, Dominion Parasite Laboratory, Belleville, Ontario.

"Sodium Fluoride as a Control for Cattle Lice"—R. W. Thompson, Ontario Agricultural College, Guelph, Ontario.

"The Present Status of Knowledge Concerning the Classification of the Elateridæ"—W. J. Brown, Entomological Branch, Ottawa. (By title).

"The Japanese Beetle Question"—L. S. McLaine, Entomological Branch, Ottawa. (By title).

"The Grasshopper Situation in the West and Forecasting Outbreaks"—Norman Criddle, Entomological Laboratory, Treesbank, Manitoba.

"The Present Status of the Pale Western Cutworm in the Prairie Provinces"—H. G. Crawford, Entomological Branch, Ottawa.

"Notes on Surface Treatments as a Promising Factor in White Grub Control"—G. H. Hammond, Entomological Laboratory, Hemmingford, Quebec.

"On the Function of Air Sacs in Insects"—G. J. Spencer, University of British Columbia, Vancouver, British Columbia. (By title).

"Insects Infesting Grain in Farmers' Granaries in Southwestern Ontario"—G. M. Stirrett and D. A. Arnott, Entomological Laboratory, Chatham, Ontario.

"Some Remarks on Fumigants"—C. R. Twinn, Entomological Branch, Ottawa.

"Recent Developments in the Corn Borer Parasite Situation"—G. Wishart and I. E. Thomas, Dominion Parasite Laboratory, Belleville, Ontario.

"The European Corn Borer Situation in Ontario in 1932"—L. Cæsar, Ontario Agricultural College, Guelph, Ontario.

"Practical Results of Biological Control as Applied to Insects"—A. B. Baird, Dominion Parasite Laboratory, Belleville, Ontario.

"A Successful Parasite Introduction into British Columbia"—R. Glendenning, Entomological Branch, Agassiz, British Columbia.

"Design for a New Type of Light Trap to Operate at Controlled Intervals"—H. L. Seamans and H. E. Gray, Entomological Laboratory, Lethbridge, Alberta.

"The External Parasites of Two Birds Introduced into British Columbia"—G. J. Spencer, University of British Columbia, Vancouver, British Columbia. (By title).

"A Co-operative Quantitative Investigation of the Relation between Summerfallow Methods and the Wireworms in Saskatchewan; a Progress Report"—K. M. King and R. Glen, Entomological Laboratory, Saskatoon, Saskatchewan.

"The Grasshopper Campaign in Manitoba in 1932"—A. V. Mitchener, Manitoba Agricultural College, Winnipeg, Manitoba. (By title).

"Possibilities of Co-operation between the Entomologist and Economist"—Dr. J. F. Booth, Economics Branch, Department of Agriculture, Ottawa.

"The Present Status of the European Pine Shoot Moth in Southern Ontario"—R. W. Sheppard, Plant Inspection Office, Niagara Falls, Ontario.

"The European Pine Shoot Moth"—J. J. de Gryse, Entomological Branch, Ottawa.

"Control of the Locust Borer by Forest Management"—A. H. MacAndrews, New York State College of Forestry, Syracuse University, Syracuse, N.Y.

"Forest Insects of the Season in the Maritimes and Gaspe Peninsula"—R. E. Balch and L. J. Simpson, Entomological Laboratory, Fredericton, New Brunswick.

"Notes on Some of the More Injurious Insects of the Season 1932 in Canada": (By title).

Nova Scotia	Mr. F. C. Gilliatt
New Brunswick	Mr. R. P. Gorham
Quebec	Mr. G. Maheux and Mr. C. E. Petch
Ontario	Prof. L. Cæsar 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

The Canadian Entomologist, the official organ of the Society, completed its sixty-fourth volume in December last. The volume contained 287 pages, illustrated by nine full plates and eight original figures. The contributors to these pages numbered forty-four and included writers in Ontario, Alberta, British Columbia, New Brunswick, Manitoba, Quebec, and also fifteen of the United States.

REPORT OF THE LIBRARIAN

The usual additions have been made to the Society's library and the work of re-arranging and indexing the whole library is being continued.

REPORT OF THE MONTREAL BRANCH

The 60th Annual Meeting of this branch was held on May 14th, 1933, in the Lyman Entomological Room, Redpath Museum, McGill University, Montreal.

The usual eight meetings were held during the season, and the attendance was good. The November meeting was taken care of by Professor Brittain, of Macdonald College, who spoke of the "Pollination of Apple Orchards by Bees," and at our February meeting, Professor Wynne-Edwards described a trip he had taken to Mount Albert, Gaspe Co. This year we donated two prizes for the best collection of insects at the Boys' and Girls' Hobby Exhibition in the Central Y. M. C. A.

The treasurer's report showed a balance on hand of $205.76.

The following papers were read and talks given during the year:—

Presidential Address	A. F. Winn
"Entomology in Izaak Walton's Compleat Angler"	G. A. Moore
"The Coming Eclipse of the Sun"	G. H. Hall
"Hemiptera collected by Mr. Winn at Tadoussac"	G. A. Moore
"Collecting at Lanoraie"	A. F. Winn
"Hemiptera taken at Lanoraie"	G. A. Moore
"Recent Eclipse of the Sun"	G. H. Hall
"Pollination of Apple Orchards by Bees"	Prof. Brittain
"The Honey Bee"	G. D. Hall
"Sir Ronald Ross"	G. H. Fisk
"1932 Collecting at Peake's Island"	G. A. Moore
"A Trip to Mount Albert"	Prof. Wynne-Edwards
"Resting Habits of Catocolas"	P. J. Croft
"Genus Ceresa"	G. A. Moore
"Butterflies of the Genus Cœnonympha"	A. F. Winn
"Glosina"	Dr. H. B. Fantham
"Membracidæ"	G. A. Moore

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, C. Chagnon, A. C. Sheppard and G. H. Fisk.

J. W. BUCKLE, *Secretary-Treasurer.*

REPORT ON THE ACTIVITIES OF THE ENTOMOLOGICAL SOCIETY OF BRITISH COLUMBIA FOR 1933

The thirty-third annual meeting of the Entomological Society of British Columbia was held in the Vancouver Daily Province Board Room, Vancouver, B.C., on Saturday, February 24th, 1934. Twenty-two members were present.

Under the general business of the Society, the library was discussed and it was decided to have it concentrated in Victoria instead of having it divided, part in Victoria and part in Agassiz. All numbers of the Proceedings for distribution, however, will be in the hands of the Secretary at the Vernon Laboratory.

Mr. Munro then discussed the Provincial Government grant to the Society. This grant has been cut during the past four years from $250 to a bare $100 and it is becoming increasingly difficult to meet the expense of publishing the Proceedings.

A financial plan for the Society was discussed and a committee appointed to enquire into such a plan with a view to becoming financially independent in time. The idea in mind was the establishment of a sinking fund, and eventually, when this fund became adequate, to publish two numbers per year or perhaps a quarterly.

The following papers were presented at this meeting:—

"A Review of Applied Entomology in British Columbia" ..... R. Glendenning
"The Family Life of *Nicrophorus conversator* Walker" ..... H. Leech
"Annotated List of the Ticks of British Columbia" ..... *Eric Hearle
"Food Plants of B.C. Lepidoptera" ..... J. R. J. Llewellyn-Jones
"Observations on Nomenclature and Taxonomy of Coleoptera" ..... R. Hopping
"The Blister Mite and Its Blister Making" ..... A. D. Heriot
"The Review of Plant Quarantine in British Columbia" ..... H. F. Olds
"Economic Insects of Interest or Recent Occurrence" ..... W. Downes
"Vectors of Relapsing Fever in Relation to an Outbreak of the Disease in British Columbia" ..... Eric Hearle
"Preliminary List of the Trypetidæ of British Columbia" ..... G. J. Spencer
"Notes on Ticks and Insect Parasites of Game Animals in British Columbia ..... E. R. Buckell
"Meteorological Observations in Relation to the Spruce Budworm ..... W. G. Mathers
"New Records of Hemiptera for British Columbia" ..... W. Downes
"Ectoparasites of Mammals in British Columbia" ..... G. J. Spencer
"Preliminary Report of the Coast Lizard-Tick Relationship in British Columbia" ..... J. D. Gregson
"Preliminary List of Tipulidæ of British Columbia" ..... G. J. Spencer

There are now approximately fifty members of the Entomological Society of British Columbia the principal development during the past two years being that the society has become international in character with the election of Messrs. Baker, Wilcox, and Crumb of the U. S. D. A. Experiment Station at Puyallup, Washington. New members elected at the past meeting were Mr. C. H. Martin of the U. S. D. A. Experiment Station, Sumner, Washington, and Mr. H. Andison of Kelowna, B.C.

Election of officers resulted as follows:—Honorary President, L. E. Marmont; President, W. Downes; Vice-President, Coast, G. J. Spencer; Vice-President, Interior,

* Obit.

E. R. Buckell; Advisory Board, J. W. Eastham, G. H. Larnder, W. H. Lyne, J. R. J. Llewellyn-Jones, L. E. Marmont; Secretary-Treasurer, G. R. Hopping; Auditor, J. W. Eastham.

An informal dinner was held in the evening with twenty members and wives present. Speakers of the evening were Mr. J. B. Munro, Mr. E. R. Buckell, Professor G. J. Spencer and Mr. W. Downes.

GEO. R. HOPPING, *Secretary-Treasurer.*

EUROPEAN CORN BORER SITUATION IN ONTARIO IN 1933

By L. CAESAR
Ontario Agricultural College

In our inspection for corn borer this fall we were able to cover most of the counties under the Corn Borer Act, west of Toronto, but none anywhere else. The following table gives the figures obtained and also, for the purpose of comparison, those of the previous years back to and including 1926, which was the year of the terrible damage to corn in Essex and Kent.

TABLE SHOWING THE PERCENTAGE OF INFESTED CORN PLANTS BY COUNTIES FROM 1926 TO 1933

County or Municipality	1926	1927	1928	1929	1930	1931	1932	1933
Pelee Island			15.0	23.6	4.8	6.0	7.1	12.0
Essex	*83.0	64.7	41.7	35.9	16.7	27.6	27.7	29.5
Kent	*78.7	48.8	35.0	21.4	22.2	26.9	28.5	35.0
Lambton	*34.0	56.9	21.4	14.2	7.4		34.5	23.3
Elgin	47.7	37.1	24.0	20.9	9.0	17.1	22.5	16.6
Middlesex	*28.5	36.2	18.3	9.9	9.0	14.5	21.6	19.8
Norfolk	16.1	10.1	19.7	6.1	5.1	5.2	10.7	9.4
Oxford	31.2	14.2	14.7	17.5		13.2	15.7	17.0
Brant	*10.3	15.6	14.9	10.3		7.3	15.0	14.5
Lincoln	* 5.3	42.7	29.7	10.8	8.9	11.3	12.9	20.0
Wentworth	* 1.8	22.0	24.6	9.0	13.3	8.2	16.6	18.5
Welland	*23.7	41.0	25.5	5.0	13.6	10.2		7.5
†Peel		*3.8	10.4	18.5	17.3	21.5	29.3	39.0
†Halton		*7.7	*6.8	8.7	11.8	12.7	11.6	16.6

* Federal figures. All the others are Provincial.

† Counts taken in Peel and Halton since 1931 were in the southern parts alone where sweet corn is grown. The northern parts were much more lightly infested.

The figures indicate that there has been an increase of the borer in Pelee Island, Essex, Kent, Oxford, Lincoln, Wentworth, Halton and Peel; and a decrease in Lambton, Middlesex, Elgin, Norfolk and Brant.

I have little data on the situation in most counties east of Toronto, but Mr. Baird and his assistant, in the course of their work with parasites, have been able to inspect Prince Edward, Hastings, Lennox and Addington, and I think part of Northumberland. Mr. Baird reports that there has been much less damage from the borer in Prince Edward and in the front sections of the other counties than in 1932. The northern part of the latter counties, however, he said, were somewhat heavier infested than last year.

In the Ottawa district Mr. A. Dustan reports that the borer was scarce or present in numbers below normal.

In Glengarry Mr. Hammond states that it was generally distributed through the county and that about 1% of the plants in some sweet corn plots were infested. He says that apparently the borer was not known to be present in the county last year.

From the above data and reports it is not easy to determine whether in the province as a whole there were any more borers this year than last. I think that if we could know all the facts we would probably come to the conclusion that there had been little if any increase over 1932. I say this because the figures do not tell the whole story. For instance in the southern part of Peel and Halton counties, the part where sweet corn was grown and in which the inspection was made the last three years, there was much less corn planted than usual, largely, I think, because of the unprofitable price of table corn in 1932. Hence in these two counties the moths had to lay their eggs on a smaller acreage and this in itself seems to me to have been sufficient to account for the increased percentage of stalks infested. The large increase indicated for Lincoln may, I think, be accounted for partly by a lessened acreage and partly by a poorer clean-up in the spring than in 1932; (The poor clean-up in this county was partly due to a misunderstanding). In Essex the small increase from 27.7% to 29.5% may be attributed to the fact that the wet weather last spring caused many fields to be planted so late that there were no borers in them. These fields were very generally worked up early in the fall and sown to wheat because there was no chance of any of the corn maturing, hence in this county too the moths laid all their eggs on a smaller acreage than in 1932.

The only increase which causes me anxiety is that in Kent county from 28.5% to 35%, an increase of 18%. The clean-up here, especially in the heaviest infested areas seemed to us to be good. It is doubtful if the acreage was much, if any, less than last year and there does not seem to have been sufficient late fields to have had much effect. Moreover, the drought which prevailed during most of the season would, judging from past experience, be unfavorable to an increase, so as I said, I am at a loss to understand why any increase took place. Possibly Mr. Stirrett, from his ecological studies, may be able to give us some light on this problem.

Coming back to the table of infestation, I think it will be interesting to you to note that an examination of the figures from 1926 to 1933 shows that the percentage of infested stalks went down rapidly from 1926, or in some cases 1927, until 1930 when it reached the lowest figure. Since then in most of these counties it has been slowly rising, though, as I have said, it is doubtful whether there has been any increase this last year. The infestation, however, in almost all these counties is still very much lower than in 1926 and 1927 and very few fields, even in Kent and Essex, have been severely enough infested to cause any severe loss.

The fluctuation in percentage of infestation naturally makes us wonder what is the cause or causes which bring it about. Some think that it coincides with good and bad years for corn, the borers increasing in the years of good crops and decreasing in the years of poor crops. This seems to me to be merely another way of saying that weather is the determining factor, certain kinds of weather being very favorable both to the borers and to the corn, and other kinds being unfavorable. In my previous reports I have discussed the importance of weather to some extent. All I shall say at this time is that it is very difficult, without full details of temperature, moisture and wind velocity, to explain why on the one hand there should have been this year a decrease of the borer in Lambton county and in Prince Edward and on the other an increase in Kent. The clean-up in Lambton and Prince Edward was certainly no better than in Kent and all three counties suffered a severe drought. The corn borer unquestionably gives the ecologists an excellent opportunity to distinguish themselves.

A Perplexing Situation

At the present time we are going through an interesting and perplexing phase in the fight against the borer. When the Corn Borer Act was passed the farmers in most counties were pretty generally convinced from what they read about the huge losses in Essex and Kent and from the rapidity with which the insect spread over the

Province, that without the Act the corn industry was doomed. Now after seven years of the Act and no appreciable damage to the corn they are beginning to think that the borer is not nearly so dangerous as they were led to believe and that in at least the majority of counties corn growing would be safe without any Act. Such an attitude of mind is natural and I am not at all surprised at it; in fact, I felt it was sure to come sooner or later. I do not mean that all farmers look on the Act that way, for many do not, though many others do.

Another factor, and perhaps almost as important, has to be considered; namely, that all farmers are hard hit by the depression and most of them find they have to work hard and economize in every way to pay their taxes and keep their farms running. Under these conditions any extra work or expense such as cleaning up a dirty corn field, is felt to be a hardship.

Then too there is the fact that our County Councils are forced to economize in every way possible and one of these ways seems to many of them to be by trying to avoid appointing a corn borer inspector.

From these and other reasons there has sprung up in some counties a strong agitation for the repeal of the Act, or for its suspension.

The Department of Agriculture considered the matter and decided that it was worth while trying the experiment of allowing any county east of Toronto this year to dispense with the Act if it wished. The counties of Ontario, Northumberland and Durham, Lennox and Addington and Prince Edward, chose to do so and therefore there were no inspectors in these counties this year. Hastings county chose to remain under the Act and had an inspector as usual. York county, on hearing that there might be an opportunity to drop out, petitioned, through their County Clerk, to have the Act continued.

It is not likely that any of the counties now free from the Act will petition for its re-inforcement for several years. By choosing to withdraw from under it they have taken the responsibility for the consequences upon their own shoulders. It will be interesting to watch what happens. If after say five years it is found that corn can be grown profitably without the Act, everyone, including myself, will be glad. If the borer increases and causes serious loss the farmers will recognize the importance of the Act more fully than from any other course that could have been taken, and so enforcement will then be simpler and more effective.

In conclusion I wish to state that I am as firmly convinced as ever that the only practical method of fighting the borer is by destroying all corn remnants each year by ensiling, or burning or plowing them under. Any new devices that will make these clean-up measures simpler and more effective will advance the work. We hope as soon as the depression is over to take up this aspect of the problem again. In addition to control by compulsory clean-up measures I am still in favor of further work in trying to discover and establish parasites in the hope that they may destroy a sufficient percentage of the borers each year to make it safe for us to lighten greatly the regulations which require the gathering and burning of corn remnants dragged up to the surface in spring in the course of preparing the corn field for grain or any other crop. I hope you will not misinterpret this statement and get the impression that I think a time is coming when the farmer can afford to totally disregard the corn borer. He cannot do this even in Europe where parasites and other natural control factors play a very important part. There is no doubt at all in my mind or, I think, in the mind of any entomologist who has studied the insect carefully, that if Essex and Kent were to go back once more to their former practice of leaving the great mass of the corn stalks on the surface of the ground and merely discing them up well before planting the next crop the borer would quickly increase and once more ruin the corn. In the same way corn growers all over the province and

especially wherever sweet corn is growing will always have to practise a fair degree of thoroughness in disposing of the previous year's corn remnants if they are to escape serious losses from time to time.

SOME CHARACTERISTICS OF THE FLIGHT AND OVIPOSITION HABITS OF THE EUROPEAN CORN BORER, *PYRAUSTA NUBILALIS* HUBNER

By Geo. M. Stirrett, Geoffrey Beall and Edward Lindsay

Dominion Entomological Laboratory, Chatham, Ontario

A detailed quantitative study of the flight and associated activities of the European corn borer, *Pyrausta nubilalis* Hubner has been made at Chatham, Ontario, for the past seven years. In 1929, a paper upon this work was published by the senior author under the title of "Some Preliminary Observations on the Flight of the European Corn Borer."* The present paper enlarges upon the observations then made and gives additional data collected in the years since then recorded.

The methods of study and the technique employed are fully given in the paper cited and will not be elaborated at present, except to mention some of the refinements adopted during the progress of the work. These have to do mainly with more rigid standardization, particularly in regard to the time of observations. The observations were begun strictly on time at the hourly intervals. The observations in 1933 were made according to constant intervals with regard to sunset, while the earlier years were done at regular hourly intervals measured in eastern standard time.

In order that no confusion may arise in considering our observations, the following table of the time at which sunset occurred at Chatham, Ontario, for the dates under consideration is given. We are indebted to C. C. L. Gregory, Wilson Observatory, University of London, England, for the calculations.

June	28—8:10	July	11—8:6	July	24—7:57
	29—8:10		12—8:6		25—7:56
	30—8:10		13—8:5		26—7:55
July	1—8:9		14—8:5		27—7:54
	2—8:9		15—8:4		28—7:53
	3—8:9		16—8:3		29—7:52
	4—8:9		17—8:3		30—7:51
	5—8:9		18—8:2		31—7:50
	6—8:8		19—8:1	Aug.	1—7:49
	7—8:8		20—8:1		2—7:48
	8—8:8		21—8:0		3—7:47
	9—8:7		22—7:59		4—7:45
	10—8:7		23—7:58		5—7:44

These average values for various reasons are not strictly true from year to year, but they are not, however, in error more than a minute if applied to any year. Sunset is taken to be the moment at which the upper rim of the sun apparently sinks below the horizon.

During the progress of the work, it has also been found better to examine three rows of corn at a time instead of walking up and down each row as reported in the previous paper.

The plots of corn grown each year have been as uniform from season to season as it was possible to make them with regard to the types of growing season encountered. The plots have been planted as nearly at the same phenological time each year as it was possible to judge. The corn type and variety have remained the same during each year, the variety being Wisconsin number 7, a white dent corn.

* Sixtieth Annual Report of the Entomological Society of Ontario, 1929, pp. 46-51.

The height of corn in the plots has varied from year to year, but so also have the dates of flight and therefore the height of corn (maturity) from year to year would have no significance in regard to the relative attractiveness of the corn to the moths on the same date. The corn height in the plots each year would, however, have a marked significance in comparing the flight as found in our plots with that found in adjacent plots in the same season. In general, when plots of corn have been planted by other growers in the vicinity of our plots, they have been planted at the same time of the year as our own and hence, all plots would be approximately at the same stage of maturity at the time of the beginning of moth flight. One might compare the height of the corn on any fixed date from year to year. However, since any such date falls at a different point in the progress of flight from year to year, it would appear more satisfactory to refer the height of corn from year to year to some relatively fixed point in the progress of flight. Accordingly, it has been referred to the apparent peak of flight. The height of the corn in the plots at the time of the peak of moth flight is given below. The height of corn is the distance from the ground surface to the upper part of the bend in the topmost leaf of a plant.

Year	Date of peak of moth flight	Average height of corn in inches
1927	July 13	18
1928	July 16	23
1929	July 7	12
1930	July 8	27
1931	July 9	31
1932	July 8	27
1933	June 29	22

Variation in the size of plots was tried out in the earlier years of the work. The size of the plot over which flight records were taken in 1927 was 9,600 square feet (40 x 240 feet). In 1928, the area was 4,800 square feet (40 x 120 feet), while in 1929 and in the ensuing years the plot size was 16,000 square feet (80 x 200 feet). An error in statement was made in the first paper in regard to the size of the plot of 1929 (page 47). This plot was 16,000 square feet in area. The size for the ensuing years has also been 16,000 square feet.

The magnitude of the flight occurring in the plots of 1927 and 1928 cannot be compared with those of the ensuing years because of the difference in size and also for the reason stated below. The data as to the number of moths observed in 1928 are the actual numbers multiplied by two as in the original paper and for the reason that this plot was only half the size of that of 1927. In 1929 it was found necessary to move the location of the plots a distance of about three miles. The plots of 1927 and 1928 were at the same locations while all the plots since and including 1929 were grown in a new laboratory field. This change in size of plot and change of location should be remembered when studying the histograms. Because the year 1927 and 1928 are not comparable to the following year, they have been made the subject of a separate histogram.

When moths were captured in the plots, and it was always the aim to do so if possible, they were examined as to sex and then killed.

During the years 1931 and 1932, a light trap was operated in a farmyard about one mile distance from our corn plots. This lamp consisted of a 100 watt white frosted electric bulb set over a funnel-shaped receptacle. It was provided with a cover to keep rain out of the killing and receiving box. Insects were killed by the use of calcium cyanide dust. The light trap catches were examined daily. On certain nights several thousand insects of various kinds were collected in this trap.

Some analysis of the physical factors governing flight were given in the paper cited. These have been omitted at present as they are being made the subject of a detailed statistical paper for later publication.

The Annual Cycle of Flight

The seasonal cycle—During the years under study, the flight period has varied very little in regard to the time of commencement and termination in the field. The following tabulation shows the numbers of moths in flight each night for seven years as observed in our plots.

TABLE I.—SHOWING THE NUMBER OF MOTHS IN NIGHTLY FLIGHT
CHATHAM, ONTARIO

Date	1927	1928	1929	1930	1931	1932	1933
June 22							—
23							0
24							10
25							3
26							15
27				0			30
28				0		3	6
29				1	0	8	36
30				14	1	1	33
July 1				0	1	0	14
2				0	1	0	0
3				0	0	0	14
4			1	8	6	0	22
5			4	10	4	11	28
6			0	3	3	16	29
7		2	14	5	2	1	22
8		0	8	55	5	21	9
9	(Incomplete)	12	6	24	9	16	7
10		0	0	25	0	20	4
11	25	10	1	3	2	12	3
12	73	10	12	4	7	19	12
13	116	0	3	1	12	8	6
14	97	18	1	0	4	9	8
15	53	8	4	1	6	2	4
16	92	64	5	6	3	9	2
17	40	24	14	7	0	7	1
18	53	36	0	0	3	5	3
19	0	24	0	0	3	6	2
20	16	24	0	1	0	2	1
21	90	28	3	0	0	0	0
22	23	34	6	0	0	3	1
23	30	8	6	0	0	0	0
24	22	16	2	1	0	2	0
25	23	6	3	0	0	0	0
26	19	4	3	0	0	0	
27	21	14	4	0	0	0	
28	10	0	1	—	0	0	
29	0	0	3	—	0	0	
30	16	4	2		0		
31	5	6	1				
Aug. 1	0	0	0				
2	0	4	0				
3	0	6	0				
4	3	—	0				
5	0	0	0				
6	5	0	0				
7	3	2	0				
8	0	0	0				
9	0	4	—				
10	0	0	—				
11	0	—					
12	—	—					
13	—						
Totals	835+	368	107	169	72	181	325

The length of the flight season may be calculated in two ways, (1) as to the period between time of commencement and time when the last moth was observed and (2) as to the total number of nights in which flight actually took place in the field. These comparisons are made in the following table:

TABLE II.—LENGTH OF FLIGHT PERIOD, LABORATORY PLOTS, CHATHAM, ONTARIO

Year	Length of flight period in days	Length of flight period—actual nights of flight	No. of days in which no flight took place
1927	—	22—	—
1928	33	24	9
1929	27	23	4
1930	25	17	8
1931	19	17	2
1932	26	21	5
1933	28	27	1

The characteristics of the flight seasons can probably be visualized more readily through the plotting of the above data as histograms.

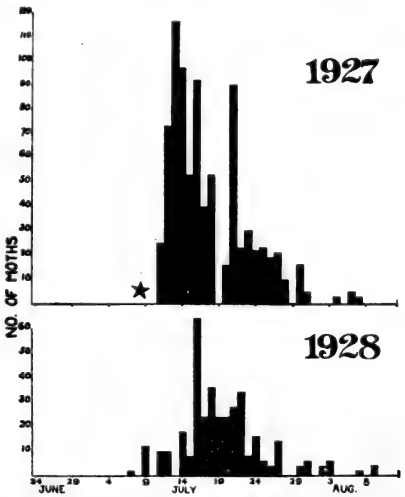

Fig. 1.—Histogram for flight seasons of 1927 and 1928 at Chatham, Ontario. The star indicates that the data in the early season of 1927 are incomplete.

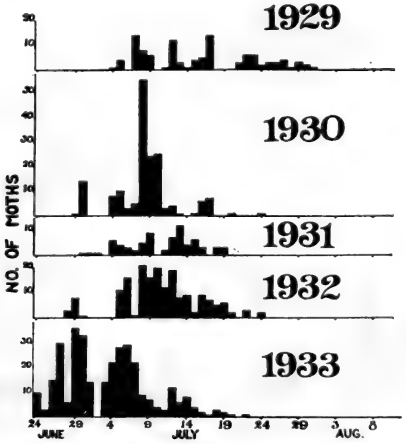

Fig. 2.—Histogram for flight seasons 1929-1933 at Chatham, Ontario.

From a study of the histograms given in figures 1 and 2, it will be noted that the flight period has had the tendency to commence earlier during the last few years. Whether or not such tendency will be continued it is impossible to say. If the tendency to earliness is continued it would be a boon to growers in regard to the date of planting corn to escape infestation because as it is now the corn has to be planted so late that in some years it does not experience a growing season long enough to enable it to mature before frost.

The question of the skewness of the flight curve is possibly of some interest since if the flight is very skew (as in 1933 when the peak was very early and the period of decline early) the infestation will fall to a greater extent on early fields of corn. If the flight is more symetrical, the early and late fields are more nearly liable to have the same number of eggs deposited on them.

The number of moths flying each season in our plots is given in table I, and also is indicated in the histograms figures 1 and 2. As has been stated above, the plots of 1927 and 1928 were not grown on the same location as the remainder of the plots, and also there was a variation in the size of the plots in these two years. We believe, therefore, that the data, for magnitude of flight only for these two years, cannot be compared directly with that of later years. The methods of study from and including 1929 onwards we believe give as good a comparison of flight magnitude from year to year as can be obtained.

The size of the catch of *Pyrausta nubilalis* Hubner taken in the moth flight studies in the laboratory plot and the size of the catch in the light trap have most of the controlling factors common and one factor not common. Mutually, they are dependent upon meteorological conditions and the number of moths in flight in the district. Respectively, they are dependent upon the attractability of the corn in the plot and the attractability of the light. The collection of data from two such angles is an extremely happy situation and calls for a comparative study. The meaning and value of both methods of collection may be better understood as a result of such work.

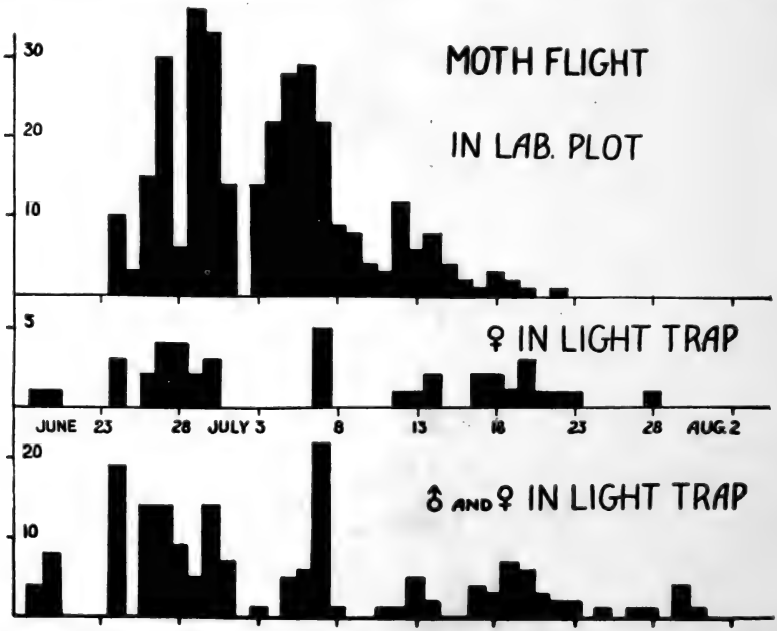

Fig. 3.—Histogram showing catches of *Pyrausta nubilalis* Hubner in the laboratory field and at the light trap, Chatham, Ontario, 1932.

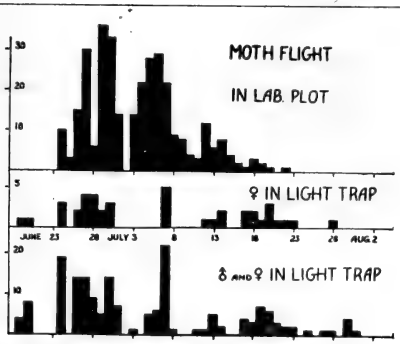

Fig. 4.—Histogram showing catches of *Pyrausta nubilalis* in laboratory field and at light trap, Chatham, Ontario, 1933.

In both years moths were captured in the light trap for a longer period than in the field plots. The flight in the field agrees, however, fairly closely with that recorded by the light trap. The deficiency of the catch in the field at the end of the season probably occurred because the attractability of the corn had diminished while the deficiency at the beginning may possibly have occurred because the attractability of the corn was still low. The deficiencies are more clearly marked in the season of 1932.

The percentage of the sexes of moths taken in flight in the field has varied from year to year as will be seen by the following table:

TABLE III.—SEX. RATIO OF FIELD CATCHES, CHATHAM, ONTARIO

Year	Per cent males
1929	4.1
1930	7.4
1931	5.2
1932	15.0
1933	33.0

The relative proportions of male and female moths in the laboratory field and in the light trap are summarized as follows for the two years for which we have data:

1932	Per cent males	Standard deviation of estimate of per cent.
Field catch	15 per cent.	2.6 per cent.*
Light trap	75 per cent.	
1933		
Field catch	33 per cent.	2.7 per cent.*
Light trap	76 per cent.	

* The formula used is standard deviation of a per cent.$= \frac{100}{N}\left\{\frac{(p \cdot q)}{N}\right\}^{\frac{1}{2}}$

Where $p =$ number of males
$q =$ number of females
$N = p + q$

Testing the significance of the difference of field catch, one finds it has a standard deviation of 3.8 per cent.* This means that so great a difference would only occur by chance once in a quarter million cases if the situation had been the same in 1933 and 1932. Therefore, one judges the difference to be significant and the proportion of males twice as high in 1933 as in 1932. Since the light trap yielded the same proportion of males in 1933 as in 1932, there is a discrepancy

* By the calculation— $\sigma_{(33\%-15\%)} = \left\{(2.6)^2 + (2.7)^2\right\}^{\frac{1}{2}}$

between these results and laboratory plot results. This difference may occur because the reactions of the moths had changed. The reaction of the borer to corn or light may be different in the two years. The unusual time of flight as noted below in 1933 suggests that the whole behaviour of the moths may have been upset.

The Time of Occurence of Nightly Flight

Previous to 1933, the greater amount of the flight took place between the first half hour after sunset and four hours and a half after sunset (8:30 p.m. - 12:30 a.m. Eastern standard time).

The record of hourly flight for the season of 1932 will serve to illustrate the flight in all the years previous as there was not much variation in time of flight.

TABLE IV.—FLIGHT OF PYRAUSTA NUBILALIS HUBNER BY HOURLY INTERVALS IN HOURS AFTER SUNSET, CHATHAM, ONTARIO, 1932

Date	:30	:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30
June 28	0	1	2	0						
29	0	1	7	0						
30	0	1	0							
July 1	0	0	0							
2	0	0	0	0						
3	0	0	0							
4	0	0	0	0						
5	0	1	4	3	3	0				
6	0	3	8	5	0	1	0	0	0	0
7	0	0	1	0	0	1	0	0	0	
8	0	1	12	7	1	1	0	0	0	
9	0	4	9	2	1	0	2	1	2	0
10	0	0	14	6	0	0	2	0	0	0
11	0	0	8	4	0	0	0	0	0	0
12	0	1	8	4	5	1	2	4	0	0
13	–	3	5	0	1	2	0	0	0	0
14	0	0	8	1	0	1	1	0	–	
15	0	0	1	1	2	2	1	2	0	
16	2	0	3	3	1	2	0	0	–	
17	0	0	5	2	0	0	0	0	0	
18	0	0	3	2	0	0	1	0	0	
19	0	2	4	0	0	0	0	0	0	
20	0	2	0	2	0	0	0	0	0	
21	0	–	0	0	1	1	0	0	0	
22	0	0	3	0	0	0	0	0	0	
23	0	0	0	0	–	–	–	–	–	
24	1	0	1							
25	0	0	0							
26	0	0	0							
27	0	0	0							
28	0	0	0							
29	0	0	0							

Note that readings have been tabled at the nearest half hour past sunset.

In 1933, the flight of the moths was peculiar because of the large number of males in flight in the field and also because the flight commenced earlier in the evening than in any previous year of which we have records. This is shown in the table of hourly flight for this year.

TABLE V.—FLIGHT OF PYRAUSTA NUBILALIS HUBNER BY HOURLY INTERVALS IN HOURS AFTER SUNSET, CHATHAM, ONTARIO, 1933

Date	:30	:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30
June 24	–	4	3	3	0	–	0	0	0
25	0	0	2	1	6	1	1	0	–
26	0	3	4	3	2	2	1	0	0
27	1	6	8	8	5	2	0	0	0
28	0	3	3	0	0	2	1	0	0
29	0	5	12	5	2	6	6	3	2
30	0	5	7	6	5	5	5	4	0
July 1	2	1	4	4	3	0	0	0	0
2	0	0	0	0	0	0	0	–	–
3	0	2	8	2	2	0	0	–	–
4	12	4	2	3	1	0	0	–	–
5	4	5	7	8	4	0	2	2	2
6	3	3	8	6	3	4	2	2	2
7	5	3	4	1	3	5	1	0	1
8	1	0	2	2	2	2	0	1	1
9	0	3	4	0	1	0	0	0	0
10	3	1	0	2	0	0	0	0	–
11	2	0	1	0	0	0	0	0	0
12	3	5	2	2	0	0	0	–	–
13	4	2	0	4	1	0	1	2	0
14	5	0	2	1	2	–	3	1	1
15	3	1	0	1	2	0	0	2	0
16	1	0	1	1	0	0	0	0	0
17	0	0	1	0	1	1	0	0	–
18	1	1	1	2	0	0	0	0	–
19	1	0	1	0	1	0	0	–	–
20	0	1	0	0	0	0	0	0	–
21	0	0	0	0	0	0	0	–	–
22	0	1	0	0	0	0	0	0	–
23	0	0	0	0	–	–	0	0	–
24	0	0	0	0	0	0	0	–	–
25	0	0	0	0	0	0	0	–	–

The hourly interval—30 indicates one half hour before sunset. This would be at approximately 7:30 p.m.

The unusual early evening flight of 1933 consisted to a larger extent of males than did that at any other hour.

There seems from the work of 1932 and 1933 to be no indication of a distinct and separate morning flight. The flight observed after midnight is simply a continuation of the evening flight. The morning flight, of course, is very much smaller in magnitude than the evening portion of the flight.

To illustrate the entire flight period through a single night, the following nights have been selected from among our records.

TABLE VI.—FLIGHT OF PYRAUSTA NUBILALIS HUBNER BY HOURLY INTERVALS IN HOURS AFTER SUNSET

(Evening and Morning Flight)

1932	–:30	–:30	1:30	2:30	3:30	4:30	5:30	6:30	7:30	8:30	9:30	10:30	11:30	12:30
July 7	0	0	1	0	0	1	0	0	0	0	–	–	–	–
July 9	0	4	9	2	1	1	0	0	0	–	–	–	–	–
July 10	0	0	14	6	0	0	2	1	2	0	–	–	–	–
July 16	0	1	4	2	0	2	0	0	–	–	–	–	–	–
1933														
July 6	4	5	7	8	4	0	2	2	2	1	1	2	1	0

The dash in the above table indicates no records were taken at these hours.

Like the early evening flight in 1933, the early morning flight at sunrise is also peculiar to that year.

Observation on oviposition—The length of the oviposition period and its trends are closely associated with those of the flight season. The following histogram illustrates the number of egg masses laid on our establishment plots which in each case were adjacent to the plots over which flight studies were carried on. The corn variety, height, etc., are similar to the flight plots.

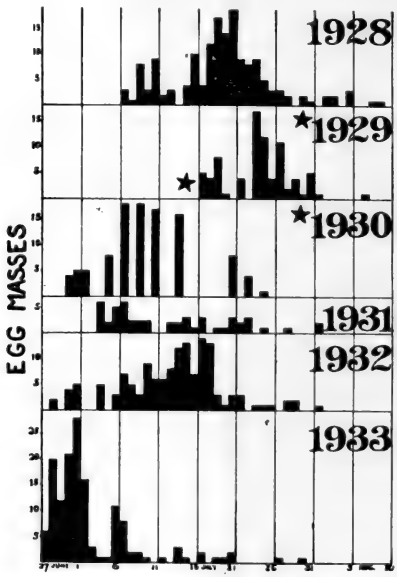

Fig. 5.—Histogram showing egg laying records in egg masses, Chatham, Ontario. Plots were examined every day except in the years marked with a star. In these years, counts were taken every second or third day. In 1929, egg-laying had commenced before our records were started.

It will be noticed in comparing figures 1 and 2 with the above histogram that at times there appears to be a very close correlation between the fluctuations in raw numbers of eggs deposited, while at other times no significant correlation is apparent. On July 16, 1928, for instance, there was a heavy flight, but on July 17 only a very few egg masses were secured.

The peak of flight and of oviposition occur about the same time, but the trend of oviposition falls off more rapidly than that of flight. This is particularly true in 1933. This would probably indicate that the season was earlier more unfavourable to egg-laying than it was to flight, although both terminated very rapidly during this year. The peak of egg-laying was reached more rapidly than was that of flight during this same year.

From a study of the number of moths in flight in our flight plots and from our egg counts in our establishment plots within the same field, we can calculate the number of eggs per plant per one hundred females for each season since our records have been taken. The calculation is based, of course, upon the supposition that a like number of moths flying in an area at any point in the field would lay a similar number of eggs. Our fields were always fairly uniform as to maturity and height. In such a calculation, errors are, of course, found. One error that would occur and which would probably make our calculations too low, is the fact that in the flight plot proper, moths were killed whenever caught, while in the establishment plots they were undisturbed at all times.

TABLE VII.—CALCULATED NUMBER OF EGGS LAID PER 100 FEMALES PER PLANT LABORATORY PLOTS, CHATHAM, ONTARIO

Year	Actual total number of moths observed in plot	Per cent males observed	Total number of females observed	Actual number of eggs laid per plant in plot	Calculated number of eggs per plant per 100 females
1928	368	–	–	15.4	–
1929	107	4.1	102.8	19.6	19.0
1930	169	7.4	156.5	15.1	9.7
1931	72	5.2	68.3	3.8	5.5
1932	181	15.0	153.9	14.2	9.2
1933	325	33.0	217.8	15.9	7.3

The year 1931 appears to have been the most unfavourable year for flight both in regards to actual duration and the numbers of moths flying (See table II). It is also one of the poorest years in regard to the number of eggs laid per female, although 1933 is probably the worst in this respect as we had 217.8 females in actual flight extending through 27 days and only have 7.3 eggs per 100 females per plant laid.

The egg-laying habits change with the seasons to a slight extent only. The bulk of the eggs is always laid on the undersurface of the leaves as the following table shows:

TABLE VIII.—POSITION IN WHICH EGG MASSES ARE LAID (WISCONSIN No. 7 CORN), CHATHAM, ONTARIO

Year	On undersurface of leaf Per cent.	On upper surface of leaf Per cent.	On Stems Per cent.
1928	97.3	2.7	
1929	89.4	10.6	
1930	98.2	1.8	
1931	94.0	6.0	
1932	86.0	11.0	3.0
1933	94.2	5.8	

Eggs laid on the upper surface are more liable to be killed from heat or direct rays of sunlight. The position in which eggs are laid is also important when considering the application of ovicides in control.

APPLE LEAF ROLLERS IN ONTARIO

By J. Allan Hall

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Introduction

The following paper containing data on the distribution, status and biology of apple infesting leaf rollers is largely compiled from observations and studies in Norfolk county, Ont., but contains some notes relevant to conditions in other counties. The material is additional to two previous papers* by the writer on the same subject.

Summary

Ten species of Tortricidæ and one species of Gelechiidæ injurious to the apple are discussed as to their relative distribution and economic importance. Observations show that the degree of infestation is largely governed by such factors as climatic conditions, tree growth, variety of apple, stage of development and time of year when hibernation begins, and the interdependence of certain species.

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* Leaf Rollers Attacking the Apple in Norfolk County—Rpt. Ent. Soc. Ont. 1929, p. 137.
Notes On The Palmer Worm (*Dichomeris ligulella* Hub.) and The Red Banded Leaf Roller (*Eulia velutinana* Walker)—Rpt. Ent. Soc. Ont. 1930, p. 38.

Data are given on: number of generations; spring activities; deposition and hatching of eggs; larval feeding periods; duration of larval instars; pupal periods; emergence and flight of adults; fecundity and hibernation.

A key for the identification of mature larvæ, and descriptions of their injury to foliage and fruit are included.

Species of Leaf Roller; Their Distribution and Status

During the past five years, eleven species of Lepidoptera with leaf-rolling habits have been found infesting the apple. The names, distribution and status of these are as follows:

Tortricidae

1. *Archips argyrospila* Walker (The Fruit-tree Leaf Roller)—This species occurs in orchards throughout Norfolk County and also in the counties of Brant, Durham, Huron, Lambton, Lincoln, Northumberland and Oxford. It is probably present in all Ontario fruit-growing sections, but has appeared in outbreak form in only a comparatively small number of orchards. It is by far the most prevalent leaf roller.

2. *Archips semiferana* Walker (The Box-elder Leaf Roller)—This species has been found in the vicinity of Simcoe, Vittoria and Walsh in Norfolk county and in one orchard near Hamilton. Adults were reared from larvæ collected near Trenton, and Mr. M. Webster, Ontario Fruit Branch, reported the species as being present in orchards near Stirling in Hastings county. During the period 1929-1933 it has been observed in outbreak form in only four orchards.

3. *Archips rosaceana* Harris (The Oblique-banded Leaf Roller)—This leaf roller which thrives on many other plants besides the apple, is quite generally distributed over Southern Ontario. In many apple orchards it is responsible for a small amount of fruit injury practically every year.

4. *Pandemis limitata* Rob. (The Three-lined Leaf Roller)—This species has been found in nearly all Norfolk orchards in which collections have been made. It has also been taken in Northumberland and Oxford counties. Where present, it is in about the same category as *rosaceana*. It is most abundant in orchards infested with budmoth and tentiform leaf miners, in the old nests of which the summer caterpillars find shelter. In some orchards 10 to 31 per cent. of the caterpillars collected have been of this species.

5. *Archips fractivittana* Clemens—This species has been taken in small numbers in two orchards near Simcoe and one at Windham Centre. We have no record of it from other districts. It is of very minor importance.

6. *Archips purpurana* Clemens, 7. *Eulia quadrifasciana* Fern., and 8. *Amorbia humerosana* Clemens have been taken only in the experimental orchard at Simcoe and here only in small numbers, but it is likely that they occur over a wider area. The last mentioned was only seen in two out of five seasons.

9. *Eulia velutinana* Walker (The Red-banded Leaf Roller) was discussed elsewhere.*

10. *Archips persicana* Fitch has not been identified from Norfolk county. One adult of the species was captured in an orchard near Trenton, Ont., on June 9, 1932.

Gelechiidae

11. *Dichomeris ligulella* Hub. (The Palmer Worm) was discussed elsewhere.*

* Rpt. Ent. Soc. Ont. 1930, p. 38.

FACTORS INFLUENCING INFESTATIONS

Evidence, gathered during the course of the investigations, show that infestations of *argyrospila* and *semiferana* have been most severe in orchards where the wood growth on the trees is dense and which are located at some distance from the Great Lakes. The latter by lowering evening temperatures, brings about a reduction in egg deposition.

The influence of weather conditions is well shown in the experimental orchard by a marked reduction of population in 1931-32, resulting from the hot, dry seasons of 1930 and 1931; and by a slight increase in 1933, due to more eggs having been laid in the less extreme season of 1932. This is borne out by the bait pail catches which are given in the table below.

TABLE No. 1

POPULATION FLUCTUATIONS AS SHOWN BY BAIT PAIL CATCHES
1929 to 1933

	Year and Number Taken				
Species	1929	1930	1931	1932	1933
A. argyrospila	280	622	320	254	327
A. semiferana	2014	1100	165	57	216
A. rosaceana	219	161	130	84	107
P. limitata	287	534	257	198	324
A. fractivittana	?	63	57	70	65
E. velutinana	?	18	18	14	4
D. ligulella	?	50	6	0	0
A. purpurana	0	3	0	0	1
A. humerosana	1	2	0	0	0

Variety studies show that *A. semiferana* confines itself largely to Spy and Yellow Transparent. *A. argyrospila* is less selective, and in different orchards, containing the same varieties, the following have been found heavily infested by it: Greening, Baxter, Stark, Spy, Snow and Wagener. No varieties have been found exempt.

Topography, soil type, method of culture and proximity to native woods have not been found to affect the degree of infestation.

Weeds in an orchard may be a factor by affording shelter to pupæ but not by serving as food plants. While we have successfully reared *A. argyrospila* on quack grass (*Agropyrons repens* L.) and on some clovers, and while some larvæ of this same species, in seeking pupation quarters, may feed slightly on the ground vegetation, they have never in our experience "fed freely upon almost any kind of succulent or moderately succulent weed beneath the trees" (Caesar).* In this connection it should be mentioned that the larvæ of *Archips pallorana* and *Sparganothus sulfureana,* which feed respectively on quack grass and sweet clover, resemble *A. argyrospila* and *A. semiferana* and might easily be confused with them.

The stage in which leaf rollers hibernate is directly connected with the percentage of winter mortality, those wintering as pupæ or adults seldom occurring in outbreak form. The time the insects go into winter quarters is also a factor, e.g. *A. fractivittana,* which goes into hibernation quarters in July, has a heavier mortality than species which commence hibernation in September or later.

LIFE HISTORIES OF LEAF ROLLERS

In each of the past five years leaf rollers have been reared through all stages in the insectary. Some were confined on apple seedlings and others on apple leaves in jars. The development in confinement was compared, and found to coincide closely with that observed in the orchard.

* Caesar L. "Leaf-Rollers Attacking Apple Trees," Rept. Ent. Soc. Ont. 1915, p. 164.

Number of Generations—The following species produce one generation per annum: *A. argyrospila, A. semiferana, P. limitata, A. fractivittana, A. purpurana, D. ligulella, A. humerosana, A. persicana* and *E. quadrifasciana.*

A. rosaceana produces a full first and a partial second generation, and *E. velutinana* a complete first, a large second and a partial third, per annum.

Spring Activities: The eggs of *argyrospila* and *semiferana* hatch, and the larvæ or adults of other species leave their hibernaculæ in May, beginning when the buds of Greening apples are in the late prepink, and continuing until fifty per cent. of the blossoms have opened.

In the following pages the life cycles are discussed and tables showing the comparative seasons and rate of development are given.

Records of the deposition, hatching and incubation periods of leaf roller eggs are presented in table No. 2 and in table No. 3, data on the season of larval activity are given. The latter shows that larvæ hatching and feeding in the same season vary considerably in their rate of development.

TABLE No. 2

DATES OF DEPOSITION, HATCHING AND INCUBATION PERIOD OF LEAF ROLLER EGGS, 1929-1933

Species	Date Laid		Date Hatched		Incubation Period		
	Earliest	Latest	Earliest	Latest	Longest	Shortest	Average
A. argyrospila	June 26	July 25	May 1	May 23			309 days
A. semiferana	July 1	July 27	May 1	May 26			305 days
A. rosaceana							
1st generation	June 14	July 15	June 24	Aug. 6	11 days	7 days	9 days
2nd generation	Aug. 5	Sept. 20	Aug. 15	Sept. 30	12 days	10 days	11 days
A. fractivittana	June 9	June 23	June 18	July 4	11 days	9 days	10 days
A. purpurana	July 10	Aug. 12	July 23	Aug. 26	14 days	13 days	13.5 days
P. limitata	July 1	Sept. 1	July 10	Sept. 11	10 days	9 days	9.5 days
E. velutinana							
1st generation	May 7	May 31	May 24	June 5	17 days	15 days	16 days
2nd generation	July 6	Aug. 3	July 16	Aug. 12	11 days	7 days	9 days
3rd generation	Aug. 12	Sept. 2	Aug. 20	Sept. 14	12 days	7 days	10.5 days
D. ligulella (1932)	May 19	June 11	May 28	June 20	9 days	9 days	9 days

TABLE No. 3

LARVAL FEEDING PERIODS OF LEAF ROLLERS
1929-1933

Species	Season	Feeding Period in Days		
		Max.	Min.	Ave.
A. argyrospila	May - June	45	26	33
A. semiferana	May - June	52	29	36
A. rosaceana				
Wintering				
1st generation	July - Aug., May - June (including hibernation)			343
2nd generation	Aug. - Sept., May - June (including hibernation)			293
1st generation; transforming.				
	July - Aug.	49	18	36
A. fractivittana	July; May - June (with hibernation average 339)			31
P. limitata	July - Sept., May - June	98	80	89
A. purpurana	Aug. - Sept., May - June (including hibernation)			305
E. velutinana	May - Sept.	70	24	35
D. ligulella	June	30	25	28

Duration of Larval Instars—During the growth period of the larva the skin is cast at more or less regular intervals. The normal number of moults is five for those species which pass the winter in the egg, pupa or adult stage and six for those hibernating as larvæ. In rare cases an extra moult occurs.

When ready to moult the skin splits along the top of the thorax and is worked off by arching and body movement. The head is freed before the abdomen.

The following tables give the duration of instars for the various species.

TABLE No. 4

DURATION OF LARVAL INSTARS

Particulars	Number of Instar 1st	2nd	3rd	4th	5th	6th	All
1. *Archips argyrospila* Walker (1929-1933)							
Average days	7.4	5.4	5.3	6.3	7.2	....	31.8
Maximum days	13	12	14	14	16	....	45
Minimum days	4	2	2	3	3	....	21
No. of larvæ	269	258	253	241	214	....	213
Total days	1996	1395	1341	1523	1551	....	6774
2. *Archips semiferana* Walker (1929-1932)							
Average days	8.4	6.9	5.4	6.2	8.7	....	35.6
Maximum days	15	16	11	16	16	....	52
Minimum days	5	3	2	2	4	....	28
No. of larvæ	139	128	116	103	65	....	65
Total days	1168	888	633	644	565	....	2316
3. *Archips rosaceana* Harris (1930-1931)							
(a) First Generation Which Transformed in Current Year:							
Average days	4.8	4.5	4.8	6.4	7.9	8.8	35.7
Maximum days	7	8	11	14	22	17	49
Minimum days	2	2	2	2	1	1	18
No. of larvæ	23	23	23	20	19	18	19
Total days	110	104	111	129	150	158	679
(b) First Generation Which Hibernated:							
Average days	6.7	64.6	249	7.8	8.7	10.6	343
Maximum days	10	319	328	21	19	20	366
Minimum days	3	3	6	5	4	4	319
No. of larvæ	51	50	48	45	42	35	44
Total days	345	3232	11993	353	366	372	15093
(c) Second Generation (1930-31, 1932-33) (All hibernated):							
Average days	8.4	77.8	198.4	6.9	6.5	8.8	306
Maximum days	13	291	295	13	9	13	343
Minimum days	5	6	4	3	5	2	284
No. of larvæ	30	30	30	29	28	27	27
Total days	252	2335	5952	200	183	239	8262
4. *Archips fractivittana* Clemens.							
Average days	6.3	8.0	315	6.1	4.8	9.3	342
Maximum days	8	13	318	8	9	14	354
Minimum days	5	5	312	5	3	4	333
No. of larvæ	85	85	6	6	6	6	6
Total days	541	682	1890	37	29	56	2052
5. *Eulia velutinana* Walker							
(a) First Generation 1930 and 1931.							
Average days	8.2	6.2	4.8	5	4.8	....	29
Maximum days	11	10	7	7	8	....	39
Minimum days	6	4	4	3	3	....	25
No. of larvæ	69	68	66	66	66	....	66
Total days	570	421	319	328	317	....	1912

(b) Second Generation (Transforming to Adults)

Average days		24
Maximum days		33
Minimum days	Hatching to Pupation	18
No. of larvæ		34
Total days		812

(c) Second Generation (Non-transforming)

Average days		65
Maximum days	Hatching to Pupation	70
Minimum days	Pupated in October and	60
No. of larvæ	hibernated as pupæ	26
Total days		1690

(d) Third Generation (1930)

Average days	7.	7.4	8.2	8.1	15.5	....	44
Maximum days	8	12	11	15	21	....	46
Minimum days	6	5	6	5	10	....	40
No. of larvæ	23	23	23	23	11	....	11
Total days	159	171	188	186	171	....	483

6. *Archips purpurana* Clemens (1929-1931

Average days	7.6	12.2	282.2	10.2	8	13	305
Maximum days	9	17	288	14	13	15	334
Minimum days	5	7	275	7	8	11	294
No. of larvæ	16	16	15	17	17	2	17
Total days	122	195	4233	174	134	26	5181

7. *Pandemis limtata* Rob. (1929-1930)

Average days 327; maximum days 343; minimum days 315; No. of larvæ 7; total days 2293. (From hatching to pupation, six instars).

The Pupal Period—The pupal periods of various species varied from a maximum of 23 to a minimum of 8 days. The average time being from 11 to 19 days.

The times of larval transformation to pupæ and the duration of the pupal periods are shown in tables Nos. 5 and 6, below.

TABLE No. 5

TIME OF PUPATION

Species	Earliest and Latest Dates of Pupation	
A. argyrospila	May 29	July 15
A. semiferana	June 11	July 3
A. fractivittana	May 17	June 10
A. rosaceana (wintering)	May 31	July 17
1st generation	August	September
A. purpurana	June 16	July 2
P. limitata	June 10	Aug. 15
E. velutinana (wintering)	October	
1st generation	June 25	July 5
2nd generation	Aug. 7-24	Oct. 10-30
3rd generation	Oct. 10	Oct. 30
D. ligulella	June 16	July 17

TABLE No. 6

DURATION OF PUPAL PERIOD

Species	No.	Duration of Pupal Period in Days Total	Maximum	Minimum	Average
A. argyrospila	152	1686	16	8	11.1
A. semiferana	77	1048	17	10	13.6
A. rosaceana					
Transforming 1st generation	14	158	14	8	11.2
Hibernating 1st generation	28	312	14	9	11.1
2nd generation	17	184	13	9	10.8
All sources	72	806	15	8	11.2
P. limitata	12	175	16	13	14.6
A. fractivittana	12	171	18	11	14.2
E. velutinana					
1st generation	63	772	15	9	12.2
Transforming 2nd generation	51	563	13	9	11.0
2nd generation	26	October to May			
3rd generation	11	October to May			
D. ligullela	..	...	..	..	14.0
A. purpurana	19	369	23	15	19.4

Emergence and Flight of Adults—The emergence of adults of all species occurred during all parts of the day with the maximum emergence in the forenoon.

Flight, mating, oviposition and other activities were largely confined to the late evening hours and only took place at temperatures of sixty degrees F. or higher.

The table below shows the earliest and latest dates of emergence and flight of adults. The emergence was recorded from reared and collected specimens and the flights on days in which moths were taken in bait pails.

TABLE No. 7

EMERGENCE AND FLIGHT OF ADULTS

Species	Year	Period of Emergence		Dates of first and last flight (bait pail rec.)	
A. argyrospila	1929	June 11	July 27	July 5	July 31
	1930	June 16	July 25	June 23	July 25
	1931	June 20	July 9	June 29	July 13
	1932	June 24	July 20	June 30	July 24
	1933	June 24	July 15	June 23	July 18
A. semiferana	1929	June 26	July 15	June 26	Aug. 2
	1930	June 26	July 14	June 30	July 29
	1931	June 29	July 9	July 1	July 15
	1932	July 4	July 18	July 8	July 27
	1933	June 24	July 6	June 25	July 20
A. rosaceana					
1. Wintering	1929	June 17	July 29	June 22	Aug. 1
	1930	June 14	July 21	June 16	July 30
	1931	June 19	July 18	June 19	July 15
	1932	June 20	July 28	June 21	Aug. 1
	1933	June 7	June 30	June 17	July 28
2. 1st generation	1929	Aug. 19	Sept. ?	Aug. 27	Sept. 12
	1930	Aug. 9	Sept. 21	Aug. 18	Sept. 8
	1931	Aug. 5	Sept. 10	Aug. 5	Sept. 14
	1932	Aug. 19	Sept. 15	Aug. 20	Sept. 20
	1933	Aug. 9	Sept....	Aug. 10	Sept. 18
P. limitata	1929	July 2	Sept. 6	July 13	Sept. 9
	1930	June 26	July 22	June 30	Aug. 18
	1931	July 1	Aug. 17	July 4	Aug. 17
	1932	July 8	Aug. 19	July 8	Aug. 25
	1933	June 28	July 11	July 1	Aug. 1

A. fractivittana	1929	June 11	June 19	no record	
	1930	June 4	June 11	June 4 to	June 23
	1931	June 3	June 18	June 13 to	June 24
	1932	June 14	June 23	June 14 to	June 29
	1933	June 3	June 13	June 8	June 20
A. purpurana	1930	July 7	July 22	July 11	Aug. 8
	1931	July 6	?		
	1932	July 28	Aug. 5		
	1933	July 6		July 6	
E. velutinana					
Wintering generation	1930	May 7	May 8	.....	
	1931	May 6	May 19	May 6	May 29
	1932	May 14	May 25	May 16	May 25
	1933	no data		none taken	
1st generation	1930	July 2	July 27	July 14	Aug. 6
	1931	July 6	July 15	July 10	Aug. 3
	1932	July 12	Aug. 1	July 17	Aug. 1
	1933	July		July 13	July 31
2nd generation	1930	Aug. 18	Sept. 4	Sept. 2	
	1931	Aug. 21		Aug. 29	
	1932	no data		Aug. 12	Aug. 13
	1933	no data		none taken	
D. ligulella	1930	June 30	July 31	July 7	Aug. 11
	1931	wintering adults		May 19	June 11
	1931	new generation		none in baits	
	1932	July 26	.....	none in baits	
	1933	June 28	July 6	none taken	
A. humerosana	1930			June 4	June 6

Fecundity of Females—Females of seven species were caged singly and in groups of two, three or four on apple seedling and in tree cages. One or more males were confined with each female. In many cases the moths did not behave normally and the females laid no eggs. A post mortem of several such females revealed abdomens filled with what appeared to be fully developed ova. The records of those which laid eggs are tabulated below.

TABLE No. 8

FECUNDITY OF FEMALES OF LEAF ROLLERS

Species	No. Moths	Eggs	Number Eggs per Female Max.	Min.	Ave.
A. argyrospila	64	5952	168	15	93.0
A. semiferana	21	805	113	6	38.3
A. rosaceana					
Spring brood	13	3811	660	3	293.1
First generation	1	330	330	330	330.
P. limitata	2	404	232	172	202.
A. fractivittana	2	338	240	98	169.
E. velutinana					
Spring brood	5	210	89	4	42.
First generation	4	368	125	61	92.
Second generation	8	260	77	4	33.
A. purpurana	2	479	395	84	239.5

Hibernation—The time of year that leaf rollers go into winter quarters and the stage and location in which they hibernate are given in table No. 9, below.

TABLE No. 9

HIBERNATION OF LEAF ROLLERS

Species	Time	Stage of Development and Location
A. argyrospila	July	Egg, on the upper aspect of one and two year old growth.

A. semiferana	July	Egg, in axils of branches and crevices in bark of older wood.
A. rosaceana	Sept.	Second and third instar larvæ, in hibernaculæ on twigs and under bud scales and rough bark.
P. limitata	Sept.	Third instar (black headed) larvæ, in hibernaculæ on twigs and in old bud-moth nests.
A. fractivittana	July	Third instar larvæ, in hibernaculæ in dead leaves, under bud scales, etc.
A. purpurana	Sept.	Third instar larvæ, in fallen leaves.
E. velutinana	Oct.	Pupæ, rolled in dead leaves on ground or attached to twigs by webs of larvæ.
A. humerosana	Oct.	Pupae, rolled in dead leaves.
D. ligulella	July-Aug.	Adult, under bark or other protection.
S. ocellana	Sept.-Oct.	Small larvæ, in hibernaculæ under bud scales or other protection on trees.

Identification of Leaf Roller Larvae

There is considerable similarity in the superficial characters of the larvæ of several species, particularly in the early instars, and one determines them by familiarity rather than by distinctive differences. They may however be divided into two general groups, as follows: (1) Those with black or brown head capsules, and (2) those with greenish, amber or yellowish head capsules. The first group includes *argyrospila, semiferana, rosaceana, ocellana, fractivittana, purpurana* and *humerosana.* The second group comprises *limitata, velutinana and ligulella.* The following key gives the identifying characters of the mature larvæ.

KEY TO IDENTIFICATION OF MATURE LEAF ROLLER LARVAE

A. Head—shiny black.
B. Body—cinnamon-brown. Fully grown in June-July.
Spilonota ocellana D. & S.

2A. Head—shiny black (male) or chestnut (female).
B. Body—pale apple-leaf green. Length 13-18 mm.
C. Tubercles—concolorous. Full grown in June.
D. Anal fork—5-7 pale yellow teeth.
Archips argyrospila Walker.

3A. Head—grey-black sides and pale front.
B. Body—leaf green. Length 16-19 mm.
C. Tubercles—concolorous. Fully grown in June.
D. Anal fork—four pale teeth.
Archips semiferana Walker.

4A. Head—dark brown or black.
B. Body—length 15-22 mm. Yellowish-green (dusty brown cast above, paler beneath).
C. Tubercles—contrasting pale. Fully grown:
wintering generation . . . . . June-July
first generation . . . . . August-September
Archips rosaceana Harris.

5A. Head—dull brown or blackish.
B. Body—yellowish-green. Length 17 mm.
C. Tubercles—concolorous. Fully grown in May.
Archips fractivittana Clemens.

BB. Body—whitish-green. Length 18 mm.
C. Tubercles—paler than body color.
Fully grown June 15-July 15.
Archips purpurana Clemens.

6A. Head—pale green or amber coloured.
B. Abdomen—not definitely striped. Light olive-green in colour. Length 15-22 mm.
C. Tubercles—lighter but nearly concolorous. Fully grown in June-July.
Pandemis limitata Rob.

7A. Head—pale amber or honey-yellow.
B. Body—light greenish-yellow. Length 12 mm.
C. Tubercles—concolorous or paler; conical and prominent.
D. Anal fork—brush-like, five-toothed. Fully grown:

first generation	June 19 - July 2
second generation (transforming) . .	August
(hibernating) . .	October
third generation	October

Eulia velutinana Walker.

8A. Head—yellow-brown.
B. Abdomen—definitely striped. Two addorsal narrow and two lateral wider whitish, longitudinal lines; olivaceous or brownish-green. Length 14 mm.
C. Tubercles—sooty-black on dorsal and thoracic segments. Fully grown in June - July.
Dichomeris ligulella Hbn.

Leaf Roller Larval Injury to Foliage and Fruit of the Apple

The spring feeding habits of larvæ of the different species are so similar that few distinctions can be made. In general the early injury consists in the entering and webbing of the buds and unfolding leaves and feeding within. Later the caterpillars roll the leaves down. (*A. purpurana* rolls them up) and feed within or on the surrounding leaves.

The injury to the fruit consists in feeding upon the floral structures, setting fruit and small apples. At the time of harvesting this injury shows as brown scars and open cavities with a hard, corky surface usually accompanied by more or less distortion of the fruit.

The injury done by the summer broods of larvæ does not differ markedly with the species. It consists in the skeletonizing of the leaves and the eating of small cavities in the fruit.

The following tabulation shows the minor differences in the feeding habits of the various species observed.

Larval Injury to Foliage and Fruit

Archips argyrospila and *Archips semiferana* Walker:—

Work on leaves: The newly hatched larvæ enter the unfolding leaves, web down the edges and feed within. Later they roll the leaves down and feed within or on the surrounding leaves and fruit.

Work on fruit: The larvæ consume portions of the blossoms, setting fruit and small apples which results in calloused holes and depressions on the mature fruit.

Archips rosaceana Harris:—

Work on leaves: Bores into the opening buds in spring; later rolls or ties several leaves together and feeds upon the surrounding foliage. New generations appear in mid and late summer and feed by skeletonizing the leaves from the underside.

Work on fruit: Similar to that of the foregoing species; injury by the new generations consists in eating small slightly mined holes in the fruit.

Pandemis limitata Rob.:—

Work on leaves: Enter buds in spring, later rolls leaves upwards and feeds

chiefly on the margins. New generation enters old nests of budmoth and tentiform leaf miners and skeletonizes leaves.

Work on fruit: That of spring brood similar to *argyrospila.* New generation ties leaves to fruit and makes small circular, usually red or purple rimmed holes which occur singly or in twos or threes.

Archips fractivittana Clemens:—

Work on leaves and fruit: Injury of spring brood similar to that of *argyrospila.* The new generation rolls or ties the leaves and injures by skeletonizing.

Dichomeris ligulella Hbn.:—

Work on leaves: Skeletonize during June and early July, concealing themselves in rolled leaves.

Work on fruit: Eat small holes in young fruit in June and early July.

Archips purpurana Clemens:—

Work on leaves: In spring the larvæ crawl back to the tree and are most commonly found on root suckers and in the lower central part of the tree. They roll the leaves "up" and feed on the margins. The new generation rolls or ties the leaves and injures by skeletonizing.

Work on fruit: The larvæ have not been observed to injure the fruit in early summer. The new generation ties leaves to the fruit and injures the latter by eating small circular holes in the skin and mining the pulp beneath. The injury is difficult to distinguish from that of budmoth and the oblique-banded leaf roller.

Eulia velutinana Walker:—

Work on leaves: First, second and third generations of larvæ skeletonize the leaves.

Work on fruit: Late second and the third generation larvæ attack maturing fruits and eat away the skin and underlying pulp over a considerable portion of the apple; the attack is most frequently begun around the stem or calyx cup but is also common at other points.

Spilonota ocellana D. & S.:—

Work on leaves: Bores into the opening buds in spring. Later ties the expanding leaves together in bunches; cuts stems of young shoots and blossoms causing them to die and turn brown. New generation appears July-August and skeletonizes the under side of the leaves.

Work on fruit: Often bores holes in setting apples resulting in russetted scars. New generation fastens leaves to apple surface and, feeding between, produces numerous small excavations.

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QUARANTINE AND CONTROL OPERATIONS FOR THE JAPANESE BEETLE IN THE UNITED STATES

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Many of you already are acquainted with the life history and destructive habits of the Japanese beetle. Possibly few of you, however, have had an opportunity to tour the densely infested sections during July and August when the adult is in active flight and approaches swarm conditions. Rather than go into considerable detail in explaining what the Japanese beetle is and does, four reels of motion pictures, later to be shown, will probably portray the insect's life cycle and feeding habits, and demonstrate the measures practiced for its control, in a much more interesting and instructive manner than could be given to you in this paper. It is the object of this paper to cite some of our most recent experiences with this insect invader and to describe the success we have had in controlling isolated infestations, similar to those that might develop through its accidental spread to Dominion territory.

Proximity to the Canadian border of a number of incipient Japanese beetle infestations in western New York State is the contact point which may be cited as warranting some measure of consideration of this pest by the members of the Entomological Society of Ontario. Although the center of infestation of the insect is some 275 miles south of the Canadian border, there are a number of isolated infestations within comparatively short distances of this province. Trapping activities during 1932 disclosed small infestations in Niagara Falls, Buffalo, Rochester, Syracuse, Utica, Ithaca and 15 other towns and cities of lesser importance in northern New York. Three first-record infestations were found in Maine, 6 in New Hampshire, and 4 in Vermont. The largest of the New England infestations was one of 343 beetles in Concord, N. H. In addition, 8 beetles were collected in Detroit, Michigan, and a few each in Cleveland, Columbus, and 3 other Ohio cities. Disclosure of these infestations in the New England States and northern New York led to extension of the area within which is restricted the movement of likely carriers of the pest. This summer's trapping outside the regulated territory resulted in the determination of established infestations in Portland and Waterville, Maine. No infestations of consequence were observed in non-regulated territory in New Hampshire and Vermont. Fewer beetles were found this year at the important isolated infestations in northern New York. Only 2 beetles were collected in Niagara Falls as compared with 13 last year. There were also corresponding reductions in Buffalo and Rochester. Some of the Ohio infestations did not persist over last winter. Others, as in the case of Canton and Columbus, carried over in reduced numbers. No additional beetles were recovered within the infested area to which lead arsenate had been applied in Detroit, although 4 beetles were found at other points in the city. These reductions possibly are linked to deficiencies in rainfall during July and August of 1932, when the eggs were hatching to produce the larvæ to overwinter and form this year's supply of adults. There occurred no widespread dissemination of the insect this year, and only nominal revision of the quarantine regulations is contemplated.

Territory under regulation for the insect includes the District of Columbia, and the States of Massachusetts, Rhode Island, Connecticut, New Jersey, and Delaware in their entirety. It also extends to portions of the States of New Hampshire, Vermont, New York, Pennsylvania, Maryland, and Virginia. The northern boundary of the regulated zone in the New England States approaches within 70 miles of

Quebec, and in New York is but 60 miles from Ontario. Within this regulated section, infested articles may move without restriction. The regulated zone totals 97,690 square miles, or an area approximately twice the size of southeastern Ontario south of Lake Nipissing. Thus, in a period of seventeen years, the insect has invaded territory in the United States equivalent to two-thirds of the land area in the four islands of the Japanese group regarded as the native habitat of the pest.

The southwestern section of Ontario in which we are now located is of precisely the same degree of latitude as is the Island of Hokushu, the northernmost island of Japan in which the Japanese beetle is quite generally dispersed. It is evident, therefore, that the pest is capable of perpetuating itself in latitudes even farther north than the northernmost points in the States to which it has now penetrated.

Sections continuously infested with the Japanese beetle are confined to the southern two-thirds of New Jersey, a portion of southeastern Pennsylvania, and small localized zones in Delaware and New York. Territory which may be regarded as subject to continuous damage by the pest includes approximately 6,200 square miles. This densely infested zone is comparable to the districts of Hastings-Peterborough and Frontenac-Addington in Ontario province.

Finding of 13 Japanese beetles in the park regions on the American side of Niagara Falls led to a consideration of the possibility of the insect having spread to the Canadian side of the river. On October 19, 1932, I accompanied Mr. Lee A. Strong, then chief of the Bureau of Plant Quarantine of the United States Department of Agriculture, on a tour of the Niagara Peninsula. At that time Mr. McLaine took us on a tour which covered Niagara Falls, Queenston, Port Dalhousie, St. Catharines, Font hill, Ridgeville, Vineland, Jordon, Grimsby and Winona. In the section through which we travelled, I observed a great many grape vineyards. Since grapes are among the highly preferred food plants of the Japanese beetle, it is evident that the insect could extensively damage your crops if they were to become established in this province. Such infestation would force vineyardists to apply sprays specifically for Japanese beetle control, thus increasing their cost of production. Grape foliage is heavily fed upon by the Japanese beetle. The insect does not feed upon the fruit. This summer a canvass was made of farmers in the heavily infested section of New Jersey. In conjunction with the canvass, 14 vineyardists were interviewed in southern New Jersey. These growers, most of whose vineyards were 6 acres or less, reported a total annual crop loss of $2,150, or an average loss per owner of over $150. Only 5 growers attempted spray control, with total expenditures of $140. Despite sprays applied, each of the 5 growers experienced loss from beetle depredations. Almost complete protection of the foliage of bearing vines may be obtained by 2 thorough applications of an arsenical spray. The second application is necessary to protect any new growth that appears after the first spray. Young and non-bearing vines may be sprayed with lead-oleate coated lead arsenate, with repeated sprays as often as necessary to protect new growth. It has been quite definitely established that leaf skeletonization of the grape affects the sugar content of the fruit. Riddling of the foliage stops photosynthesis, upon which the sugar content of the grape is dependent. Defoliation also exposes the ripening grapes to sunscald, and frequently results in withering and rotting of the fruit.

Important sources of accidental infestation which probably might carry the beetle to Canada are freight cars, irrespective of contents, which have been loaded in the densely infested sections or may become infested while enroute through swarms of beetles flying across the highways at the peak of the adult flight in such sections. This year, for the first time since 1923, there was no pronounced flight of the insect in the environs of Philadelphia. It was, therefore, unnecessary to place even a limited embargo on the movement of fruits and vegetables from that market. Automobiles from or passing through the densely infested section during July and August

might also harbor a few adult beetles which have flown in and not been able to escape. Since the 13 beetles caught during 1932 in Niagara Falls were trapped in close proximity to railroad stations and freight yards, the probability is that they travelled to that point via rail shipments of non-agricultural commodities, upon which they accidentally alighted during a heavy flight of the insect.

A vigorous eradication campaign, involving lead arsenate application to infested premises, supplemented with foliage sprays and trap operation, consistently practised for 3 years, has met with a real measure of success in checking a moderately heavy infestation in Erie, Pennsylvania. During 1931, 170 beetles were collected in four adjacent city blocks in the residential section near the city park. In the fall of 1931, 32 acres in and surrounding the infested sections were treated with arsenate of lead at the rate of 500 pounds per acre. This dosage did not give satisfactory control, for during 1932, 270 beetles were trapped in this treated area. In addition, 12 beetles were caught outside the poisoned section. The 1932 trap work was supplemented by repeated application of an attractive poisonous spray to all foliage in the infested sections. Following disappearance of the adult beetle in 1932, additional applications of lead arsenate were made to the original centers of infestation, to other adjacent small infestations, and to two infestations of a few beetles each at some distance from the previously treated sections. The 1932 treatments involved the application of 11.2 tons of soil insecticide to 40.6 acres. Yards which appeared to be centers of infestation were treated at the rate of 750 pounds per acre in addition to the previous application of 500 pounds per acre. The remainder of the treated sections was dosed at the rate of 500 pounds of poison per acre. Three premises and adjacent properties near the original infestation on which were trapped single beetles in 1932, received treatment at a 1,000 pound per acre rate. This latter rate also was used in treating an isolated infestation of 5 beetles. Early in July last, spray applications of coated arsenate of lead were made to the foliage in 34 residential blocks, including all in which beetles were trapped in 1932. Small cages from which was vaporized attractive liquid bait were hung in the principal sprayed host plants to attract the beetles and induce feeding on the poisoned foliage. This summer 1,282 traps were concentrated in Erie, with the result that 167 beetles were caught. Only 10 of these were trapped in sections which had received previous lead arsenate soil treatment. Only a single beetle was caught in the yard where last year 151 beetles were trapped. In the most heavily infested block, the catch was reduced from 200 to 6 beetles. Traps in the latter area were baited with both bran and liquid bait to assure the catch of all beetles present. As new infestations have been disclosed in Erie this year, soil treatments with lead arsenate have been made at the rate of 1,000 pounds per acre. This year's soil treatment covered an area of 55 acres.

Canvassing of farmers, estate owners, city residents, and superintendents of golf courses, parks and cemeteries, was undertaken this year during the months of July and August, to determine expenditures for control of the Japanese beetle and actual losses from crop destruction by the insect. The survey was designed to procure statements from individuals showing definite and accurate losses and control costs. Twenty-nine golf courses reported average annual expenditures at $618 per course for Japanese beetle grub control. Average annual expenditures of $225 per unit were reported by superintendents of 11 cemeteries, parks, and community spraying organizations. Expenditures by individual property owners interviewed in a city block canvass of 11 blocks in 4 cities averaged $2.50 per year. Annual expenditures per block were $62.80. Nineteen growers whose field corn plantings totalled 511 acres had their crops injured to the extent of from 3½ to 80 per cent. Their cash losses totalled $2,540, or an average of approximately $5.00 per acre. Commercial orchardists whose holdings include 37,000 bearing apple trees reported an average fruit injury of 43% on 6,300 apple trees of the varieties susceptible to beetle injury. Crop loss through this injury amounted to $12,200. The normal yield of 10,600

peach trees of susceptible varieties was reduced 27%, resulting in loss of sale of 9,100 bushels valued at $12,500. Total crop damage sustained by 28 farmers owning 3,480 acres amounted to $6,130, or an average per farm of $219. These figures represent random selection of crop injury to be found through the entire zone of continuous damage.

Many South Jersey farmers this year delayed the planting date of their field corn so that the ears would silk after the peak of the adult beetle flight. This resulted in a minimum of Japanese beetle feeding on the silk. Destruction of the silk in some instances in 1932 caused from 5 to 80 per cent. loss of the corn crop.

One unusual occurrence observed this year for the first time was a large flotation of Japanese beetles in the Delaware River and Bay and in the ocean at Staten Island and along the western third of Long Island's ocean coast line. Millions of beetles were observed floating on the surface of the river, bay and ocean. Live beetles drifting across the bay from New Jersey to lower Delaware resulted in establishment of comparatively heavy infestations on the Delaware coast. At a number of Staten Island and Long Island beaches the flotation of dead beetles proved quite objectionable to bathers. At some points about 25% of the beetles were able to crawl after being washed ashore. Approximately 100 miles of ocean and bay front were involved in this beetle flotation.

In enforcing the quarantine restrictions on the movement of nursery and ornamental stock and other likely carriers of the beetle in the grub or adult stages, a system of inspection and certification has been devised to protect non-quarantined territory from receiving infested material. As a basis for regulating commercial nurseries and greenhouses, periodic surveys are made of the premises during the period of adult flight to determine the absence or presence of infestation in or near the nursery premises. If freedom from infestation is found the establishment is obliged to conform to a minimum of restrictions, and their stock is entitled to certification without further treatment or handling. Upon the determination of an infestation in a nursery or greenhouse, thorough measures to rid stock of possible beetle infestation are required before certification is granted for movement to non-regulated sections. In the case of an infestation in the vicinity or inside of a greenhouse, the regulations require removal of all uncertified stock, treatment of the soil inside the house, screening of the doors and ventilators, treatment of the potting soil, and the maintenance of a beetle-free condition of all stock taken into or produced in the certified greenhouse. Field-grown nursery stock from an infested zone, to be eligible for certification with an accompanying soil-ball, must be grown in soil poisoned with lead arsenate at the rate of 1,500 pounds per acre, or must be treated with carbon disulphide or hot water at the time of digging. Large quantities of nursery stock are shipped free from soil and are eligible for certification on that basis. Soil plots, coldframes, and hotbeds to be used in producing certified plants require treatment with lead arsenate, carbon disulphide, or napthalene. Potting soil is subjected to carbon disulphide fumigation or treatment with napthalene, steam, or lead arsenate. Carloads of sand, peat, compost, and manure, for shipment during the period of adult beetle flight are fumigated with carbon disulphide after the same has been loaded in closed box cars. Similar material may be shipped during the balance of the year if the upper 12 inches of surface soil have been removed under supervision before the material is dug. Quarantined fruits and vegetables are certified on the basis of production in non-infested sections of the regulated zone, or after actual, visual inspection if they have been subject to infestation in the field or orchard where grown or in a market district. Approved grading and packing operations are sufficient to remove any beetle infestations which may be present in peaches. Mechanical beetle separators are employed in removing beetles from string and lima beans. Actual handling of each ear is required in making inspection of

corn. Berries which have been exposed to infestation must be fumigated with carbon disulphide, while carloads of bananas loaded in the presence of flying beetles must be fumigated with hydrocyanic acid gas before certification is granted.

Spread of the insects in the United States is determined entirely by use of Japanese beetle traps devised after a number of years' research work by Departmental employees. A liquid bait is dispensed from small bottles with wicks set inside a metal cylinder. The entire trap is hung from a metal rod at a height of about 4 feet. This year 52,000 traps were distributed in 451 towns and cities outside the known infested area. These caught a total of 724 beetles in 87 localities. Infestations had been found during 1932 in 28 of the latter cities.

Shortly after my visit to the Niagara Peninsula in October of 1932, I suggested the desirability of placing some traps throughout a limited area of the peninsula to determine whether any beetles had found their way across the border. Financial considerations, I am informed, prevented such an attempt this summer. In view of the situation as disclosed at points in the States within comparatively short distances of Canadian territory, it still appears desirable that some precautionary measures be taken by the Dominion Entomological Branch to forestall any establishment of the insects in your country.

THE ECONOMIC INSECT FAUNA OF NIAGARA PEACH ORCHARDS

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In this paper we have attempted to bring together in very brief form information regarding the occurrence of insects and mites, which are or may become of greater or less economic importance, in peach orchards in the Niagara tender fruit belt. The annotated list of species is based almost wholly on observations made by the writers, and is, of course, by no means complete. Parasites are not included, and reference is made only to the more important predators, which the junior writer has collected during the course of an ecological study of the peach tree fauna—a study which is being continued.

Acarina (6 species)

European Red Mite (*Paratetranychus pilosus* C. & F.):—This species, which infests all our fruit trees, is much less injurious to the peach than it is to European plums and prunes. It is present in all peach orchards; local outbreaks of it, largely restricted to a few varieties, such as New Prolific, South Haven and Rochester, have occurred occasionally, and have dwarfed the fruit to a greater or less extent, but so far there has been no general and widespread outbreak on peach trees.

Common Red Spider (*Tetranychus telarius* L.):—The peach is one of the many hosts of this well-nigh omnivorous spider cite, but, judging by our experience, it is by no means a preferred host. Red spider is sometimes quite abundant on young trees, particularly where they are interplanted with raspberries and tomatoes, but even under such conditions it is rarely, if ever, of much economic importance.

Clover Mite (*Bryobia praetiosa* Koch):—This species has been taken in small numbers on peach trees in spring, but, so far as we are aware, it never causes appreciable injury.

Silver Leaf Mite (*Phyllocoptes cornutus* Bks.):—Since 1916, at which time this free-living eriophyid was first found by the senior writer, the characteristic silver

leaf injury caused by it has been very commonly observed here and there in Niagara peach orchards. In 1930 silver leaf was very prevalent throughout the fruit belt.

No attempt has been made to determine the actual damage caused by a heavy infestation of *Phyllocoptes*, primarily because such injury is not easily measured.

Anystis agilis Bks.:—This predator occurs in small numbers in many orchards, and sometimes becomes abundant on trees infested with the European red mite, on which it prays. It has also been observed attacking to some extent the eggs of the Oriental fruit moth and feeding on *Seiulus*. It is probably a general feeder.

Seiulus sp.:—This predaceous mite is quite commonly found on peach trees, feeding on European red mite, red spider and silver leaf mite, and it is often common where none of these hosts are present in noticeable numbers.

Collembola

Bourletiella arvalis Fitch:—This springtail is often quite abundant on young peach trees, but nothing is known concerning its habits.

Orthoptera

Striped Tree Cricket (*Oecanthus nigricornis* Wlk.):—The eggs of this species, laid in the characteristic rows of deep punctures, are occasionally found in peach twigs.

Neuroptera (3 species)

Chrysopa rufilabris Burm.; *Chrysopa plorabunda* Fitch; *Meleoma signoretti* Fitch:—Investigations conducted by the junior writer have shown that chrysopids are an important factor in the natural control of the oriental fruit moth. The species responsible are *C. rufilabris* and to a lesser extent *C. plorabunda* and *M. signoretti.*

Thysanoptera (3 species)

Aphanothrips obscurus Mull.:—This thrips is fairly common on peach and sometimes causes a slight amount of visible injury to the foliage.

Haplothrips subtillissimus Hal.:—At times this predaceous thrips is common on trees infested with European red mite. Both the nymphs and adults feed on eggs of the mite and of the oriental fruit moth.

Aeolothrips melaleucus Hal.:—A few nymphs of this species have been found attacking red spider. Under experimental conditions nymphs also fed on oriental fruit moth eggs.

Hemiptera (7 species)

Oak and Hickory Plant Bugs (*Lygus quercalbae* Knight; *Lygus omnivagus* Knight; *Lygus caryae* Knight):—The experience of the past decade or so has demonstrated very clearly and at considerable cost to Niagara fruit growers, that peach trees should not be grown in the immediate vicinity of oak and hickory trees. The adults of three species of *Lygus* which breed and feed on these forest trees have the nefarious habit of migrating in June from their hosts to nearby peach trees, where they puncture and feed on the fruit, causing gum to exude and giving rise to ugly scars, which render the peaches unsaleable. Bug-scarred fruit has been found as far as 200 yards from oaks and hickory, but invariably the injury has been most severe in the immediate neighbourhood of the host trees.

Tarnished Plant Bug (*Lygus pratensis* L.):—There is no evidence that the tarnished plant bug, by feeding on fruit and giving rise to so-called "cat-facing",* is responsible for appreciable injury to peaches in the Niagara district, but there is an abundance of evidence that this species is by far the most injurious pest of peach nursery stock. Only too frequently, in late June and early July, the bugs appear in destructive numbers in blocks of peach nursery stock, and puncture and destroy the terminal buds, giving rise to so-called "stop-back" injury, which results in the production of inferior, stunted and bushy trees.

Acholla multispinosa DeG.:—This reduviid is generally common in most peach orchards and is often sufficiently abundant to attract the attention of fruit growers. We have no definite information regarding its food habits.

Ambush Bug (*Phymata erosa* L.):—This bug is common on peach trees.

Triphleps insidiosa Say:—This species is occasionally found on trees infested with red spider on which it preys.

Homoptera (11 species)

Macropsis trimaculata Fitch:—In an investigation on the possibility of insect transmission of peach yellows, Kunkel* tested many species of insects, but the only one which transmitted the disease was the leaf hopper *M. trimaculata.* This species breeds on peach in the Niagara district, but it is generally scarce, and somewhat irregularly distributed. This past year it was more readily found at Grimsby than in the eastern part of the peninsula.

Grape Leaf Hopper (*Erythroneura comes* Say):—The peach is one of the many spring food plants of the grape leaf hopper.

Erythroneura obliqua Say:—This is the most common leaf hopper which breeds on peach. While sometimes abundant enough to cause noticeable injury, it is never sufficiently troublesome to justify the adoption of remedial measures.

Potato Leaf Hopper (*Empoasca fabae* Harris):—This species breeds to a limited extent on peach, largely on young trees.

Rose Leaf Hoppers (*Empoa rosae* L.):—Adult rose leaf hoppers are occasionally found on peach trees.

Ormenis pruinosa Say:—This fulgorid has been found occasionally breeding on peach trees, particularly on young shoots.

Greenhouse Whitefly (*Trialeurodes vaporariorum* West.):—At times the whitefly is common on, but is never injurious to peach trees.

Black Peach Aphid (*Anuraphis persicae-niger* Smith):—This species is rarely seen on peach trees in the Niagara district.

Green Peach Aphid (*Myzus persicae* Sulz.):—Very frequently on bright, warm days, in late September and early October, the air seems to be almost full of the return migrants of the green peach aphis, but in spite of this superabundance of sexuparæ, we have yet to witness a general epidemic of the aphid in spring. Local outbreaks have occurred at times here and there in peach orchards, but have seldom if ever caused appreciable commercial loss. The comparative insignificance of

* Porter, B.A.; Chandler, S.C.; and Sazama, R.F.—"Some Causes of Cat-facing in Peaches," Illinois Natural History Survey, Bulletin Vol. XVII, Article VI, 1928.

* Kunkel, L. O., "Insect Transmission of Peach Yellows." Contributions from Boyce Thompson Institute, Vol. 5, No. 1, pp. 19-28, 1933.

M. persicae as a pest of the peach may be attributed, we believe, first to the excessively high mortality of the plant lice in fall, due to a fungus *Entomophthora* sp., insects enemies, spiders and probably other factors, and secondly to the fact that the aphids do not remain long on the peach in spring—they migrate early to secondary hosts.

San Jose Scale (*Aspidiotus perniciosus* Comst.):—The peach is one of the preferred hosts of the destructive San José scale, but, due to the general practice of spraying annually with a scalecide, the insect is scarce or absent in most commercial peach orchards.

Cottony Peach Scale (*Pulvinaria amygdali* Ckll.):—So far as we know this species has flared up only once, in 1925-26, and at one place, Port Dalhousie, where a severe infestation was largely confined to one peach orchard. At that time the scale was found quite generally distributed in small numbers throughout the peach belt.

European Fruit Lecanium (*Eulecanium corni* Bouché) (?):—A species of *Eulecanium*, most probably *E. corni*, is quite commonly seen on peach trees, but in our experience it has never assumed serious proportions.

Coleoptera (9 species)

Rose Chafer (*Macrodactylus subspinosus* Fab.):—The peach is included in the very catholic diet of this beetle, which, when abundant, may eat out holes in the fruit and defoliate the trees. Fortunately, chafer injury is restricted to a few light sandy sections, where there are neglected fields, which serve as breeding grounds for *M. subspinosus*.

Bumble Flower Beetle (*Euphoria inda* L.):—Occasionally this brown fruit chafer has been sufficiently numerous to attract the attention of fruit growers, but so far, it has never caused appreciable injury to peaches.

Potato Flea Beetle (*Epitrix cucumeris* Harris):—This species occasionally causes slight injury to young peach trees, especially when they are interplanted with tomatoes.

Hyperplatys maculata Hald., *Cyrotophorus verrucosus* Oliv., *Neoclytus acuminatus* Fab.:—These three cerambycids have been bred from the trunks of dying peach trees.

Plum Curculio (*Conotrachelus nenuphar* Hbst.):—The plum curculio is one of the few major pests of the peach. Its work results in the premature dropping of fruit, in the occurrence of wormy peaches at harvest time, and in the production of malformed fruit. The curculio is most troublesome in orchards adjoining woods or other places which afford the insect suitable hibernating quarters.

Gray Snout Beetle (*Anametis granulata* Say):—In the spring of 1930 and again in 1931, this snout beetle was found near Beamsville, eating holes in and destroying the buds of recently set peach trees. We have reason to believe that this particular injury has been somewhat more prevalent than our records indicate, and that at times the unfortunate nurseryman has been blamed for the work of *A. granulata*.

Fruit Tree Bark Beetle (*Scolytus rugulosus* Ratz.):—Peach and cherry trees appear to be more subject than other fruit trees to the attack of this bark beetle. The insect breeds only in dead or dying wood, but it will attack healthy trees, and may weaken them to such an extent that in due course they will become suitable for breeding purposes, and may be killed outright. Neglected piles of dead branches and trees from fruit plantations are commonly responsible for the genesis of serious bark beetle outbreaks.

PEACH BARK BEETLE (*Phthorophloeus liminaris* Harris):—This species is apparently comparatively rare in the Niagara district.

LEPIDOPTERA (9 species)

PEACH BORER (*Conopia exitiosa* Say):—The peach borer occurs in all parts of the Niagara district, but it is destructive only occasionally in comparatively few orchards. Most Niagara peach growers have not found it necessary to combat the borer.

LESSER PEACH BORER (*Conopia pictipes* G. & R.):—In all mature orchards this borer may be found working in cankers; and the more cankers there are, the more borers are present. *C. pictipes* gains entrance only through wounds, and is therefore wholly secondary. The most than can be said about it as a peach pest is that it is unquestionably a factor in aggravating and increasing the size of cankers.

PEACH TWIG BORER (*Anarsia lineatella* Zell.):—This insect, which has habits quite similar to those of the oriental fruit moth, is generally distributed in the Niagara fruit belt, but it is never of any commercial importance.

ORIENTAL FRUIT MOTH (*Laspeyresia molesta* Busck):—The oriental fruit moth is by far the most important pest of the peach. It has caused serious losses to peach growers, not only by making fruit unfit for human consumption, but also by affecting the demand for and consequently the price of peaches. Furthermore, it would appear that it has been an important factor in upsetting the normal peach planting program in the Niagara peninsula. On some farms, it has resulted in a reduction in acreage, and throughout the peach belt it has encouraged the overplanting of mid-season varieties. It has been a most disturbing factor since 1926, and it will continue no doubt to exact a greater or less toll every year until satisfactory artificial, remedial measures are developed and adopted, but we have some reason to believe that it already has done its worst, and that in some sections of the peninsula it will shortly reach, if it has not already reached, a state approximating one of biological equilibrium. Be that as it may, it is distinctly encouraging to know that during the past few years, biotic and physical factors have effected, in most orchards, particularly in the early part of the season, a very considerable degree of control.

OBLIQUE-BANDED LEAF ROLLER (*Cacoecia rosaceana* Harris):—The larvæ of this species have been observed boring into young fruit and devouring the kernel. They are, however, never abundant.

COTTON MOTH (*Alabama argillacea* Hbn.):—The cotton moth is of particular interest because of its habit of migrating from the South, and also because the adult insect has mouth parts adapted for piercing fruit—the tip of the maxillæ is armed with stout spines. The moth has been taken quite commonly during the month of September in the Niagara peninsula, but only twice in our experience, viz. in 1927 and 1930, has it been sufficiently numerous to attract the attention of orchardists. In 1927, it was present in immense numbers, and by puncturing and feeding on ripe peaches rather freely, gave rise to widespread alarm among fruitgrowers, and to wild and ridiculous reports in newspapers. The 1930 invasion was not nearly as sensational as that of 1927.

GREEN FRUIT WORMS (*Graptolitha sp.*):—We have one record of a species of *Graptolitha* attacking and eating out large holes in peaches (Vineland, 1920).

COPPER UNDERWING MOTH (*Amphipyra pyramidoides* Gn.):—The caterpillars, which bear a general resemblance to green fruit worms, have occasionally been observed feeding on peach foliage.

Ennomos subsignarius Hbn.:—The larvæ of this and of some other geometrids are at times observed on peach trees.

HYMENOPTERA

ANT (*Lasius niger* L.) :—This ant, attracted by the secretions of the leaf glands, is often very abundant on young peach trees.

THE RELATION OF ENTOMOLOGY TO THE DUTCH ELM DISEASE

By L. S. McLAINE

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The discussion of a plant disease on an entomological programme would seem to be out of place were it not for the fact that as a result of investigations in the United States in connection with the recent outbreak of the Dutch elm disease, insects appear to play an important part in the dissemination of the disease and complicate the methods of control. In the early part of June (1933) samples of twigs of an elm at Maplewood, New Jersey, showing severe wilting of the leaves, were submitted to Washington for examination. Cultures were made and the tree found to be affected by the Dutch elm disease. Later in the month the tree was taken down and found to be seriously infested with one of the European species of elm bark beetles. A little later in the season a shipment of elm logs imported from Europe, was intercepted at the port of Baltimore, which on examination was found to be affected by the disease and infested with two species of European elm bark beetles. Previous to the interception of the imported elm logs steps had already been taken to carry on extensive scouting to determine the extent of the outbreak.

The Dutch elm disease was discovered in Holland in 1919, and since that time has spread to Germany, Belgium, France, Austria, the Balkans, Northern Italy, Spain, the Scandinavian countries and England. Its seriousness can hardly be over emphasized in view of the destruction it has already caused to the elms in the countries invaded. In fact, one noted German authority fears that the valuable elm stands of Central Europe are doomed. The first recorded outbreak of the disease on this continent was the discovery of three infected trees in Cleveland and Cincinnati, Ohio, in 1930; the following year four trees were found infected and by 1932, it was hoped that the disease was eradicated as no sign of infection was discovered that year. However, in 1933, another infected tree was found, making a total of eight for the Ohio area.

As a result of scouting following the discovery in New Jersey, the infected area is found to cover an area with a diameter of about thirty miles. Up to October 20, a total of 603 infected trees were found in New Jersey, 46 in southern New York and one in Connecticut just over the New York State line. A single infected tree was also found in the vicinity of the docks at Baltimore. There is apparently no connection between the three outbreaks—i.e.—Ohio, New Jersey—New York and Baltimore.

From investigations carried on both in Europe and the United States, it would appear that all varieties of elm are susceptible to the disease and the white or American elm (*Ulmus americana*) is particularly so. The Chinese or Siberian elm (*Ulmus pumila*) is highly resistant to the disease and certain European workers are of the opinion that is is immune. The wood of an infected tree, however, shows the characteristic brown streaks, but there is no wilting of the leaves. The resistance of

the latter species to the disease leads Dr. R. Kent Beattie of the Bureau of Plant Industry, Washington, D.C., to believe that the disease is not of European origin but may have been introduced from Asia on imported plants.

It is not within the scope of this paper to discuss the disease itself as it is fully dealt with in the literature. It may be mentioned, however, that affected trees show first a wilting or yellowing of the leaves on the twigs which is frequently mistaken as due to drought and a cross-section of affected twigs shows the typical brown streaks. In the United States no definite determination is made by a mere macroscopic or even microscopic examination of the suspected material. Two series of cultures are made of each tree and the fungus definitely identified. It is not yet known in the United States how long the fungus takes to kill a tree, but young trees fifteen to twenty years old, lose their healthy appearance within three days and the leaves fall in a week, whereas older trees sixty to eighty years of age die much more slowly.

The authorities in the United States feel that they can safely state that the disease was not introduced on nursery stock; although no explanation is forthcoming as to the cause of the Ohio outbreak, it appears that the importation of beetle infested and infected logs are responsible for the outbreak in the New Jersey, New York and Baltimore areas. Infected logs have also been intercepted at the ports of New York and Norfolk.

The importation of elm logs or burls for veneering purposes is a comparatively recent industry. Some few years ago a furniture manufacturer visited Europe and noticed that European manufacturers were using "Carpathian" elm in making up expensive furniture. The first European logs were imported in 1926 and since that time the industry has grown, as furniture made from these logs brings a higher price than that made of bird's-eye maple.

Investigations carried on by European workers have proved that the Dutch elm disease is transmitted from dying infected trees to healthy trees by either of two species of bark beetles belonging to the genus *Scolytus*. The logs intercepted at the ports previously mentioned were infested by both these species. The large European elm bark beetle (*Scolytus scolytus* Fab.) is not known to be present or established in the United States, but the second species, the small European Elm bark beetle (*Scolytus multistriatus* Marsh.) has been established since 1909, when it was first found in elm trees on the campus of Harvard University at Cambridge, Mass. This species is now known to occur in southern New England, southern New York and northern New Jersey. It was at first thought to be a primary pest of elms, but is now recognized as attacking only weakened trees or weakened portions of trees. Investigations carried on this past season by Dr. M. W. Blackman, Division of Forest Insects, Bureau of Entomology, Washington, D.C., indicate that spores of the fungus responsible for the disease are carried on the bodies of the beetles and in the fæces. The adult beetles after emerging from a diseased tree, "May fly to a healthy tree, where they feed for sometime on the young twigs before they are ready to deposit their eggs. It is this feeding of the young adults that makes them very dangerous as disease carriers." This feeding produces wounds into which the spores may enter and thus the healthy tree becomes inoculated with the disease. Other insects may act as vectors in disseminating the disease but there has not been sufficient time to conduct investigations in this connection. Owing to the sticky nature of the fungus spores it does not seem probable that wind plays an important part in spreading the disease.

Since the discovery of the Dutch elm disease in New Jersey the United States Department of Agriculture and the affected States are taking active steps in an endeavour to exterminate it if possible. The importation of elm trees and allied genera has been prohibited for some years and all elm logs must now be barked before entering the country and immersed in hot water at a temperature of 180°F.

for two hours within twenty days after arrival. In so far as the outbreak is concerned, extensive scouting has been carried on in order to determine the extent of the infected area and all infected trees are cut down and destroyed. Scouting is also being carried on along the railways which have transported the logs from the seaboard to the veneering plants situated inland, and also in the vicinity of the veneer plants themselves. The problem of destroying trees or portions of trees infested with the small bark beeetle (*Scolytus multistriatus*) and the advisability of restoring the vigour of weakened trees to retard bark beetle attack is also under consideration.

Fortunately, the disease has not yet made its appearance in Canada, and according to Dr. J. M. Swaine, Associate Dominion Entomologist, *Scolytus multistriatus* is not known to occur within the boundaries of the Dominion. The Federal Department has, nevertheless, taken active steps to prevent the introduction of the disease. In 1928, the importation of elms was prohibited from Europe, and during that same and succeeding year, an endeavour was made to reinspect all elms imported into Canada since the inauguration of the permit system of 1923. Inspectors are constantly on the alert for suspicious signs of the disease either in the nurseries or in planted or native elms, and suspected material is forwarded to the plant pathological laboratories for culturing. In addition, at the larger Customs ports, the import records have been examined for nine years back but no records of imported elm logs from Europe have been traced.

It is needless to mention to residents of eastern Canada or the United States the value of the elm as a shade tree. It is regarded as one of the five most important shade trees on the continent and in New England it is estimated that eighty-five percent. of the shade trees are elms and the same figure would apply to the Maritime provinces. The appearance of the Dutch elm disease in the New Jersey area and the danger that is threatening the elms is not only a National problem in so far as the United States is concerned but one in which Canada can not help but be vitally interested. We, therefore, extend our sympathy to our neighbours to the south and sincerely trust they will succeed in their endeavour to exterminate the disease.

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A PRELIMINARY REPORT ON THE CONTROL OF TARNISHED PLANT BUG, *LYGUS PRATENSIS* L. IN CELERY

R. W. Thompson, Ontario Agricultural College

Introductory

The work with tarnished plant bug in the Burlington celery gardens was started as the result of a request for help from the growers in that area during July of 1929. At that time a severe outbreak of the insect had occurred and was threatening serious damage. Fully 50 per cent. of the early crop of celery was infested and damaged. Losses in this particular crop of celery, which is harvested in August, means greater reduction in returns that would be the case with later celery. The reason for this is that the early celery requires extra labor and also brings a higher price. Early celery has thus far been the only celery to suffer serious damage in this district. The injury to celery by tarnished plant bug seems to be caused mostly by the feeding and

oviposition punctures made by the adults, and to a lesser extent from feeding by the nymphs, some of which almost reach maturity before the early celery is harvested. Where the surface of the celery has been punctured a brownish area occurs which gives rise to the term "marked" celery among the growers. When the feeding occurs on the young stalks of the celery heart the brownish areas are much larger and later coalesce, with the result that the whole heart may become a soft-rotted area and the plant a total loss. The reason why only early celery is damaged has not been

Injury to heart stalks of early celery caused by tarnished plant bug.

satisfactorily determined. It may be that the population concentrates on the celery from crops in the neighborhood which are harvested previously, such as early cauliflowers and cucumbers.

The conditions which appear to favor the insect in the Burlington district are mainly connected with the excellent winter quarters which are furnished by weeded areas, bush-lots and in some cases by piles of rubbish which accumulate around the greenhouses and packing sheds. I think myself, that in addition to furnishing winter quarters these weeded areas provide food plants for the bugs in the spring, before the cultivated crops are available.

Celery growing in the Burlington district is of sufficient importance that control of the tarnished plant bug in that area is always a very important problem.

Local Control Measures

One of the first things which the writer did in July, 1929, was to make a survey of the control methods which the growers were using. Nicotine was the main insecticide which most of them were using. This may have been a direct result of the success which one grower claimed that he obtained with it against all stages of the bug in 1928. By dusting with a power duster, using a 3 per cent. commercially

prepared nicotine dust, a 100 per cent. kill of the nymphs and a 40 per cent. kill of the adults was reported to have been obtained. An alternative to the dust applications was the use of Black Leaf 40 as a spray, at the rate of 1 pint to 100 gallons of water, or Bordeaux mixture 3:6:40. The latter was in common use for the prevention of celery blight. In 1929, however, the 3 per cent. dust failed to give results and therefore a special 4 per cent. dust was developed. Results from this dust were also not satisfactory and a factory cotton curtain, 30 ft. x 10 ft. was attached to the back of the duster, above the spouts, so as to keep the dust and fumes in contact with the insects for a longer period.

Control Experiments by the Writer

Control experiments were for the most part conducted in one celery garden which adjoined a vacated truck farm that had been allowed to grow up to weeds. The celery in this garden was the most seriously infested and damaged, in the district, probably because of this fact.

Experiments were conducted to ascertain the value of nicotine as a control for all stages of the bugs. Applications of both 3 and 4 per cent. commercially prepared dusts were made with both power and hand dusters, at various times through the day and at various temperatures. Different amounts of dust were used to simulate different rates of application per acre. When the power duster was used a curtain was attached in some applications and was left off in others.

The cost of nicotine dust, it was found, could be approximately cut in half if it were rolled at home. Four per cent. dust was made by the writer in an old drum which had a tight-fitting lid. The advantage of this homemade dust, in addition to the reduction in price, is that it can be used as soon as it is made, and thus does not become weakened by having been kept. Tests were made with this type of dust with both power and hand dusters, at various times, temperatures and wind conditions through the day. The best results were obtained from a heavy application with a hand duster on boarded celery, from which the board on one side was removed in order to get good penetration with the dust. The temperature at the time of the application was 87°F. and the day was absolutely calm. Moreover, the bleaching boards were replaced as soon as the application had been made. Only 40 per cent. of the nymphs and about ten per cent. of the adults succumbed in this treatment, but these results were much better than any that had been obtained with any of the other nicotine dust treatments.

A second group of experiments was conducted to test the efficiency of liquid applications of nicotine. Power and hand sprayers were used for applying the treatments. The strength of nicotine used was Black Leaf 40 at the rate of half a pint to 40 gallons of water. When soap was used as a spreader it was added at the rate of 2 pounds to 40 gallons of spray. Even with the good penetration obtained with the power sprayer the results at a temperature of 67°F. were negative since only a very small number of the nymphs succumbed.

These experiments proved that nicotine will not control tarnished plant bug in any stage, either as a dust or in the liquid form. Moreover, the cost of this material, provided it had been successful, would prohibit its use, even on a high value crop such as celery.

Evergreen was applied with a power sprayer and a single gun at the greatest strength recommended by the manufacturers, namely 1 pint to 12 gallons of water. The results obtained were very poor. The rate was increased to double the greatest strength recommended and a large number of nymphs of all stages and a few adults were knocked from the plants and laid in a stupefied condition between the rows of

celery. Practically every insect, however, returned to the plants within one and a half hours. For the same reasons as given under nicotine this material is impractical.

Derris powder mixed with fresh hydrated lime was used at the rate of 1 pound of derris to 20 pounds of lime as a dust. A hand duster was used and the material applied on a perfectly calm day. Penetration was poor and examinations carried on over a period of 2 weeks failed to show any difference in the amount of damage on the treated rows as compared with those in the check. Derris was also applied as a spray at the rate of 1 pound of derris to 20 gallons of water, to which a quarter of a pound of laundry soap had been added. The active principle of the derris was extracted by treating the pound of powder with 1 pint of methyl alcohol. Derris did not prove of any value against any stage of the tarnished plant bug, either as a dust or as a spray.

Naphthalene flakes appeared to have some value as a repellent when tested against adults of the tarnished plant bug in a Riley cage. For this reason part of a celery row was treated with naphthalene flakes by scattering a strip of the flakes three inches wide on the soil at each side of the row. In the open no difference was noted between the row treated with naphthalene flakes and the untreated rows. Volatilization was not rapid and the flakes remained on the soil for a long time.

Experiments in 1930 and 1931

During the seasons of 1930 and 1931 tarnished plant bug was at no time present in sufficient numbers to cause damage in the celery gardens and for that reason experiments which had been planned were not conducted.

Experiments in 1932

In a report published by L. L. Hill, of Ithaca, N.Y., in Jour. Ec. Ent. June, 1932, page 671, results were given which indicated that dusts of superfine sulphur and sprays of sulphur and hydrated lime were of value in the prevention of tarnished plant bug injury to celery. Accordingly, a number of experiments were conducted in which the value of various sulphur compounds were to be tested. These experiments were, however, inconclusive because the celery was harvested before the tarnished plant bug injury became conspicuous in any part of the patch. One experiment was started after this, however, and the grower was prevailed upon to leave a small amount of the treated area and a check so that estimates might be made and conclusions drawn. In this experiment, Koloform, a proprietory fungicide having an analysis of 56 per cent. sulphur and 44 per cent. inert matter, was applied with a power sprayer to celery that was in the bleaching boards. The results obtained from the one application showed that the treated celery had been protected from tarnished plant bug injury sufficiently to reduce the damage in this plot to about one-third that in the untreated check.

Experiments in 1933

In view of the encouraging results which had been obtained with the Koloform during the previous year, this material was applied as a dust at the rate of 200 pounds per acre when the tarnished plant bugs threatened to do damage again this summer (1933). The application was made July 12 with a power duster, in the morning while the plants were still wet. As a check, a single row of celery was left throughout the full length of the patch and examinations made on this check row. Since scattered specimens began to appear in the treated area about one week after the application and as the check row was appreciably marked it was decided to repeat the application. An equal amount of Koloform was applied under conditions

practically the same as in the first treatment. Several examinations of the treated celery were made while it was in the bleaching boards but though scattered individuals of all stages were present in the patch no damage from marking occurred. In the check row, however, a much larger population of bugs of all stages was present and by the time the treated celery was dug, without the loss of a single root, the check was too badly damaged to be worth lifting.

Irrigation was continued in this patch after the treatments had been applied, but a conspicuous residue of sulphur occurred in the hearts of the celery at the time that it was lifted. This residue was easily removed by the rinsing to which the celery is subjected before it is bundled. The celery taken from this patch was sufficiently better than that from neighboring patches that it commanded a premium price from the truckers and on the open market.

From the results obtained it would appear that the application of sulphur as a dust, if it penetrates well into the hearts of the celery, will prevent damage from tarnished plant bug. The total amount used per acre over the whole season is less than half the amount used by Hill in New York. In his experiments six weekly applications totalling 900 to 1,200 pounds of sulphur were given, as compared with the total of 400 pounds in the writer's experiments. These applications continue from August until October. In the Burlington area there has not been any need of protecting more than the early celery which is harvested in August. Some further work done by Hill indicates that the addition of such large quantities of sulphur as were used in his experiments may have an undesirable effect on the soil by changing the pH value. The same risks may exist even with the amounts used by the writer and for that reason it is intended to test the efficiency of smaller rates per acre next year, if tarnished plant bug activities make experiments possible.

PLOUGHING AND DISCING EXPERIMENTS FOR THE CONTROL OF WHITE GRUBS IN EASTERN CANADA

By G. H. Hammond

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During recent years white grubs have been very injurious to field and garden crops throughout Eastern Canada, causing losses aggregating thousands of dollars, although much of the actual injury is neither recorded nor recognized, and is frequently ascribed to "winter killing," "sun-scorching" or some unfavourable soil condition.

Previous control investigations by the author were principally connected with the use of soil insecticides and materials of value in preventing June beetle oviposition in sod. The knowledge of the possibilities of cultural means for white grub control had received little attention and accordingly an exploration of the value of farm tools in directly reducing the numbers of white grubs present during an outbreak was undertaken in 1933, mainly with regard to the effect of ploughing and discing.

It was especially desired to determine the cultural practices necessary to directly reduce white grub concentrations to a point where they would not menace a given crop and thereby release infested land to productive use at the earliest possible date.

In all cases cultural experiments were conducted in timothy sod which had borne a crop of hay for two years or which was seeded down during the spring of 1931. During the spring and early summer up to mid-July, experiments were directed against the smaller, second instar white grubs, but during the latter part of the season the large, third instar grubs were the common stage under study. Of the two stages the smaller, second instar form was regarded as being the more difficult stage to destroy by cultural means.

Ploughing and discing have long been assumed to be effective against white grubs, partly on account of the crushing effect of the implements and partly on account of the mortality caused through the breaking of hibernating and molting cells, as well as the incidental increased exposure of grubs to parasites, predators and weather.

The following cultural practices have been studied and discussed as to their value in control: (a) ploughing with horses at graduated depths followed by discing; (b) tractor ploughing of sod, followed by repeated discings; (c) ploughing with horses in sod followed by repeated discings; (d) discing alone where grubs have destroyed the sod; and (e) three ploughings at an average depth compared with three discings after one ploughing.

A uniform method of sampling soil for white grubs was adopted throughout. Each sample consisted of one-quarter of a square yard of soil to a depth of 10 inches. The soil was examined on a sorting table and was afterwards returned to the hole from which the sample was taken.

Ploughing with Horses at Graduated Depths Followed by Discing—The following tabulation will illustrate the effect of ploughing at four graduated depths on white grubs and the mortality following three subsequent discings. The experiment consisted of four rows, each 325 feet long and 12.5 feet wide, in each of which 18 samples were taken after each process.

TABLE No. 1

WHITE GRUB MORTALITY FOLLOWING PLOUGHING WITH HORSES AT GRADUATED DEPTHS WITH THREE DISCINGS

Aver. depth of ploughing (inches)	Total original population	Average grubs per sq. yard	Dead grubs after 1st ploughing	Dead grubs recorded after 3 discings	% reduction
2.44	190	42	28	152	80
3.47	200	44.4	23	129	64.5
4.77	156	34.4	11	110	70.5
6.11	93	20.4	5	46	60.2

A study of the dead specimens indicated a reduction of 80 per cent. where ploughing was carried out at a depth of 2.44 inches, a reduction of 64.5 per cent. in the second group where ploughing was carried out at 3.47 inches, a reduction of 70.5 per cent. at an average depth of 4.77 inches, and 60.2 per cent. where the ploughing was at a depth of 6.11 inches. Ploughing at a still deeper level would have illustrated the advantage of shallow ploughing still more markedly.

Extensive observations supplement the above findings to the effect that deep ploughing as at 6 inches in late autumn and early spring will probably bury grubs too deeply to be afterwards reached by the discs, especially during the early part of the season. Recent observations have further shown that the majority of the grubs, instead of coming up to feed near the surface after ploughing, as would ordinarily be the case, remain at some depth and in the fibrous root area of the sod, close to the former surface.

Therefore it may generally be said that shallow ploughing is preferable to ploughing so deeply that the disc harrow will not cut the inverted sod. Where the sod has already been destroyed through white grub feeding it will often be advantageous to use the disc harrow, instead of the plow, weighting the harrow and setting the discs to cut deeply.

Tractor Ploughing of Sod, Followed by Repeated Discing—In the following table, number 2, a detailed summary is given regarding the effect of repeated discings with a tractor-drawn outfit after the initial ploughing. This experiment consisted of 16 parallel strips of a length of 225 feet and 12.5 feet wide in each of which 6 samples were taken after each process. The period of examination extended over about three weeks during the month of June.

TABLE No. 2

WHITE GRUB MORTALITY FOLLOWING PLOUGHING AND DISCING WITH A TRACTOR OUTFIT

		Number of white grubs alive after various treatments				
Row No.	Original population	1st ploughing and discing	2nd discing	3rd discing	4th discing	5th discing
1	106	56	48	23	12	14
2	99	50	48	6	4	5
3	150	50	55	11	6	8
4	78	34	17	7	3	2
5	59	34	8	6	2	0
6	82	54	47	32	10	11
7	124	37	26	19	6	10
8	141	26	20	11	8	7
9	97	31	20	7	4	2
10	81	19	20	7	2	1
11	47	16	1	6	2	3
12	51	13	4	6	0	1
13	52	10	9	0	1	3
14	88	27	20	7	2	1
15	90	20	6	3	1	0
16	68	18	25	16	10	9
Totals	1,413	495	374	167	73	77
Average per sq. yd.	58	20.6	15.5	6.9	3.0	3.2
Per cent. reduction		65.	73.6	88.2	94.9	94.6

It will be observed that the total number of white grubs in samples compared with the original populations dwindled from 1,413 to 73 with the fourth discing. This represents a reduction of 94.7 per cent with the fourth discing, or expressed in terms of grubs per square yard an original population of 58 grubs per square yard was reduced to the small total of 3.

The slight increase in the number of white grubs after the fifth discing was due to the fact that many of the samples were unfortunately taken too near the margin of the experimental strips and in a rocky area where the soil was not worked so thoroughly.

It will be observed later that the tractor outfit was distinctly more effective in reducing white grub populations than the horse-drawn equipment, under conditions which actually were more unfavourable. This was due partly to the greater crushing effect of the wheels of the tractor itself and also to the deeper penetration and crushing effect of the discs.

Ploughing in Sod with Horses, Followed by Repeated Discings—In the following table, number 3, a summary of results with horse-drawn equipment is given for comparison with the tractor-drawn outfit presented in table two. This experiment was carried out mainly during the latter part of July in the same field as the preceding study and with similar plots and sampling.

TABLE No. 3

WHITE GRUB MORTALITY FOLLOWING PLOUGHING AND DISCING WITH HORSE-DRAWN EQUIPMENT

Row No.	Original number grubs	Number of white grubs alive after various treatments			
		1st ploughing and discing	2nd discing	3rd discing	4th discing
2	140	72	43	30	22
3	87	53	16	28	22
4	116	44	16	15	4
5	64	17	16	18	3
6	107	33	15	17	6
7	103	82	48	35	16
8	77	84	37	30	16
11	55	14	4	4	0
12	32	18	4	2	0
13	55	35	13	14	10
14	66	38	19	9	11
15	65	18	1	2	0
16	61	25	17	9	7
Totals	1,028	533	249	213	117
Average per sq. yd.	52.7	27.3	12.7	10.6	6.0
Per cent. reduction		51.8	75.8	79.3	88.7

Here it can be observed that the total number of white grubs dwindled from an original estimated population of 1,028 to 117 by the fourth discing and the average population was reduced from 52.7 per square yard to 6 per square yard, or by 88.7 per cent. This should be compared with the results obtained from the tractor ploughing where a reduction of 94.9 per cent was secured under comparable treatment.

The final population of six white grubs per square yard indicates a safe condition for the planting of most farm crops, exclusive of corn, potatoes and strawberries. A further discing, however, we feel would render the soil suitable for the planting of all crops, eliminating likelihood of economic loss in spite of the failure to show this in the formal experiment shown in table 2.

Discing in Muck Soil—In order to determine the effect of discing alone in muck soil where the sod had been killed out through previous white grub feeding, an area of one-half acre was disced twice. The soil was moist and friable at the time and the previous sod was entirely detached and loose. The following results were obtained:

Total grubs from 20 sample areas	132
" " alive after discing	86
" " killed by discs	46
Per cent reduction	37.7%

This reduction of 37.7 per cent following discing is about equal to a reduction of 32.9 per cent following one ploughing in muck soil at about 4.5 inches under somewhat similar conditions in which the results were checked by 72 samples taken both before and after ploughing.

From this preliminary evidence therefore, two discings were equally as effective as one ploughing, and at the same time were much quicker and less laborious. However, the discing should not be regarded as being a substitute for ploughing. It was effective, however, under the above conditions in a muck soil and where the sod had been destroyed.

Three ploughings and One Discing Contrasted with One Ploughing Followed by Three Discings all with Horse-Drawn Implements and at Average Depths—To compare directly the relative values of repeated ploughings and discings similar strips of land to that in the experiments reported in tables 1 and 2 were cultivated with the respective tools. The ploughing was at a depth of 4.5 inches and a discing followed by the first ploughing chiefly to prepare to soil for the second ploughing. The three ploughings occurred at approximately four-day intervals. The land under treatment being in sod, the repeated discings were preceded by a single ploughing.

The following table indicates the reduction of white grubs following the three ploughings and the single discing.

TABLE No. 4

WHITE GRUB MORTALITY AFTER PLOUGHING AND DISCING FOLLOWED BY TWO SUBSEQUENT PLOUGHINGS

Row No.	Original population	Number of white grubs alive after treatments		
		1st ploughing and discing	2nd ploughing	3rd ploughing
1	143	82	34	25
3	243	94	59	51
5	213	94	49	34
7	161	91	41	31
Totals	760	361	183	141
Average population per sq. yd.	42.2	20.0	10.1	7.2
Per cent. reduction		47.5	76.0	81.5

In the above treatments a reduction of 47.5 per cent was secured with the first ploughing and discing. With the second ploughing the reduction reached 76.0 per cent while the third ploughing produced a reduction of 81.5 per cent from the number which could reasonably be expected to be present.

The three discings following an original ploughing were carried on immediately adjacent to the ploughing series and under identical conditions. The ploughing alone gave here a reduction of 40.4 per cent in the living grub population and the first discing increased this to 58.3 per cent. Two subsequent discings further reduced the population of 69.7 per cent and 79.7 per cent respectively, the latter figure being substantially equal to that in the treatments with the plough in the preceding experiment.

From the foregoing it can be concluded that the above repeated ploughings and discings were about equally effective in reducing white grub numbers.

Although the above studies are but a progress report upon this aspect of white grub control the very promising results justify the incorporation of both the plough and the disc in the cultural control practices for these pests. Their use is not urged as the chief means of control but should be recognized as rather expensive emergency measures to be utilized to free badly infested land from injurious numbers of grubs which have become established in spite of crop rotation, distribution and selection.

As a general practise, however, after the parts of a farm liable to white grub losses have been recognized, the chief reliance for control should be placed upon so arranging the crop rotation as to prevent the land ever becoming severely infested with these insects.

For a satisfactory application of the results of these studies it is unfortunate that it was not possible to determine the value of the plough and the disc with graduated numbers of grubs per square yard; as without doubt this is a very important consideration. The numbers experimented with, however, are as high as are to be met with in any outbreak encountered and hence the information secured to date can reasonably serve as the basis for authoritative recommendation.

In appraising the number of cultural treatments required in any field notice should be taken of the numbers of grubs present. These can be expected to vary of course with the soil, crop and cultural treatment in the last year of June Beetle flight. Nevertheless in general we should say that in the case of pasture or meadow where grubs are liable to be most numerous five discings after the shallow ploughing would be required to render the field safe for all crops. In grain stubble or land in hoed crop the discings could usually be reduced to three or four with safety.

In all operations the depth of white grubs in the soil is important. Ploughing and discing should be done between early May and late September, otherwise a considerable number of grubs may be below the effective working level for plough and disc. In any case it is well to plough fields which have large numbers of white grubs early in autumn or relatively late in spring, giving extra discings if the five recommended do not bring the grub number to at least five grubs per square yard.

THE GRASSHOPPER CAMPAIGN IN MANITOBA IN 1933

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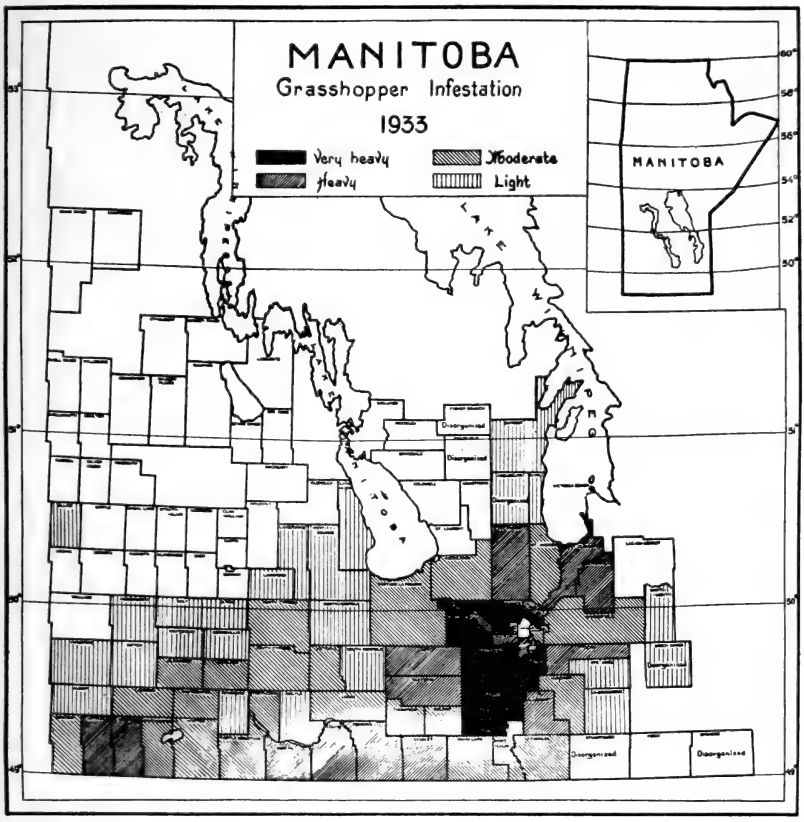
In the sixty-third annual report of the Entomological Society of Ontario for the year 1932 there appeared an account of the grasshopper campaign in Manitoba in 1932. The map of Manitoba appearing in that paper showed the relative distribution of grasshoppers for that season as indicated by the actual extent of poisoning undertaken by the farmers in the areas involved. Our purpose in presenting this paper is to record the movement of the outbreak of grasshoppers in this province from 1932 to 1933 and to indicate the progress of the course of the campaign. The spread of grasshoppers into adjoining municipalities may have been due to environmental factors at present little understood or it may have been due to chance. The importance of understanding any principles determining the spread of an outbreak is evident. In order to ascertain these principles we must have first the most accurate data available showing the relative infestations in given municipalities yearly throughout the course of an outbreak. It is very difficult to obtain this information. Under conditions prevailing in Manitoba where poisoned bait is free and available to all farmers who will spread it, perhaps as accurate a method as any is to measure abundance of grasshoppers by the relative amount of bait used in each municipality during the year. The map of Manitoba shown in this paper has been prepared on this basis. When comparing this map with that which appeared in last year's report of the Entomological Society of Ontario we should bear in mind that a restriction was placed on the amount of bait any farmer might obtain in 1933. Each farmer was permitted to obtain daily a maximum of two bran sacks full of prepared bait for each quarter section of land owned or for each male person in the household capale of



Map. 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 pounds 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 during 1933.

spreading bait on the land. Previous to 1933 there was no such restriction. Although this may have reduced somewhat the amount of bait used in certain cases, it was applicable throughout the province and comparisons will be affected only as between 1932 and 1933 and not for various municipalities in 1932 or 1933.

The species of grasshoppers involved in the 1933 outbreak were the same as those occurring in injurious numbers in 1932. The organization set up to supply and distribute poisoned bait was the same in 1933 as in 1932.

The following is the formula for the bait used in 1933:

Bran or malt sprouts	50	lbs.
Sawdust (bulk equal to bran) approx.	2½	bushels
Liquid sodium arsenite	1	quart*
Water	10 to 12	gallons

* The one quart of liquid sodium arsenite contained 2 lbs of As_2O_3

In 1933 no salt was used in the bait. This omission did not seem to impair the attractiveness of the bait and a substantial saving was effected by not using it. In 1933 the liquid sodium arsenite contained 8 pounds of As_2O_3 per gallon of prepared material. No difficulty was experienced whatever in the preparation or use of the poison at this strength. The handling costs on the liquid sodium arsenite because of its greater concentration were practically half of those of the previous year. Malt sprouts were used in place of bran to the full extent of the malt sprouts available which was approximately 400 tons.

Preliminary experiments undertaken in the Department of Entomology in 1933 and recorded elsewhere (1) indicate that grasshoppers do not eat the sawdust in the bait nor suck the moisture from it. Its greatest apparent usefulness is to improve the physical properties of the bait and make a given amount of bran cover a greater area. Lead fluosilicate, and sodium fluosilicate to a somewhat lesser extent, gave excellent kills in poisoning experiments. Further it was found that various carriers for the poison such as green wheat plants, malt sprouts, beet pulp, oat straw, wheat straw, bran, sawdust and brewer's grains had different powers of absorbing moisture and that once a bait had become dry, it absorbed very little atmospheric moisture thereafter.

In 1933 the first bait was used on May 19. Poisoning was general from June 2 to June 24 and then slackened until it had practically ceased by July 24. It cannot be stated too emphatically that hoppers should be poisoned as soon as they begin to eat after hatching. Early poisoning is more effective and less expensive and is accomplished before plant damage has been done.

During the campaign this year 41,000½ cwt. of bran, 8,005 cwt. of malt sprouts, 30,362 gals. of sodium arsenite containing 8 lbs. As_2O_3 per gal., and 201 carloads of sawdust each containing from 20 to 22 tons were used. Of these amounts 2,287 cwt. of bran were supplies held over from 1932. These materials supplied approximately 12,500 tons of prepared wet bait for the 18,165 individual farmers who poisoned grasshoppers in Manitoba in 1933. The net cost to the provincial government was $62,952.62, while the municipal costs approximated $36,500.00. The crop acre costs were approximately 1¾ cents to the government and 1 cent to the municipality.

In 1933 seventy municipalities mixed grasshopper bait while nine additional municipalities purchased prepared bait to meet their needs from adjoining municipalities where bait mixing was undertaken. In these seventy municipalities there were 112 mixing stations in operation. In additon prepared bait was available at 107 other distributing points or supply depots. Forty-nine municipalities operated a single mixing station, ten operated two, while the other eleven operated from three to six mixing stations each, with a total of forty-three mixing stations. Forty-six municipalities operated only power mixers, three operated a combination of power and hand machine, six used only hand machines and fifteen municipalities used the shovel method of mixing. Of the 112 stations in operation 71 used power driven machines, 18 used hand-turned machines and 23 mixed their bait with shovels.

Grasshoppers select places for ovipositing that are suitable to the species. More attention should be directed towards the cultural practices which will tend to reduce egg laying and to those which will destroy the eggs of grasshoppers. These methods of control not only prevent destruction of crops but also have the added attraction of being inexpensive. The fact that they lack the spectacular element makes their widespread acceptance somewhat difficult.

Much crop loss was prevented by the use of the poisoned bait. The writer estimates that 8 million bushels of wheat, 5 million bushels of oats and 3½ million

bushels of barley were saved through poisoning grasshoppers. In addition other crops such as flax, fall rye, spring rye, forage crops, garden crops, etc., were saved in whole or in part in the infested areas. It is impossible to place a value upon the benefits derived from killing an enormous number of grasshoppers before they reached the adult stage and laid their eggs.

The writer wishes to express his indebtedness to Mr. H. E. Wood, Assistant Director, Extension Service, Department of Agriculture, Winnipeg, for the information given in this paper relating to materials used and their costs.

REFERENCE

(1) Mitchener, A. V., 1933. Grasshoppers and Their Control. In Press Report, World's Grain Exhibition and Conference, Regina, Pt. II.

NOTE ON A NEW LIGHT TRAP

By J. J. de Gryse

Lepidoptera caught in light traps are very often so badly frayed and rubbed as to make them practically valueless as museum specimens. The trap described herein partly overcomes this objectionable feature. It consists of two principal parts, a large funnel made of galvanized iron and a receptacle of copper. The use of copper is recommended in the construction of the receptacle because it is more easily worked and more durable than other sheet metal. The apparatus may be constructed in any desired dimensions. The principal measurements of the trap as illustrated in the accompanying diagram are as follows: Mouth of funnel 24″, neck of funnel 4½″, top of receptacle 10″, bottom of receptacle 7 or 8″, height of funnel 24″, height of receptacle 14″.

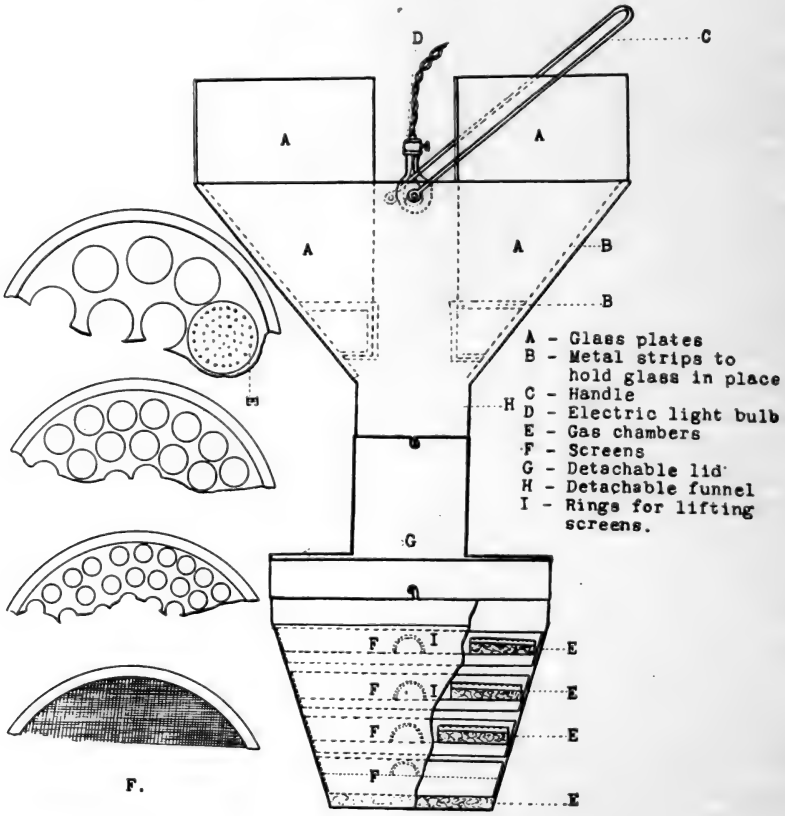
The funnel is detachable, it is made to fit tightly into the neck of the receptacle and is attached to it by means of three pins which slide into slots cut in the neck of the latter. Two vertical glass plates are mounted on opposite sides of the trough and have been found useful in stopping and throwing down insects circling swiftly around the light. An ordinary electric bulb, a daylight bulb or a good lantern is suspended between the glass plates near the level of the funnel's rim. The quality and intensity of the light source no doubt has a certain influence upon the number and kind of insects attracted and any choice in this matter must be left to the individual collector.

The receptacle is bucket shaped. It has a detachable lid with three slots which fit over an equal number of pins mounted on the sides of the bucket. The collar which slides over the neck of the funnel is built into the top of this cover. A set of movable trays, fitting closely one into the other and pierced with circular openings of a gradually decreasing diameter are mounted inside of the bucket. The openings of the topmost tray are ⅝ of an inch in diameter; those of the second tray ¼ of an inch and those of the third tray ⅛ of an inch. The fourth or lower tray is made of a fine mesh copper screen. These screens are quite effective in separating the insects according to size and prevent excessive packing and subsequent mutilation of the specimens inside of the container.

The whole apparatus is in reality very simple. Several details could be altered, possibly to some advantage, but not without considerably increasing the cost of construction which has been kept as low as compatible with efficient operation. The trap, as described, can be made for approximately fifteen dollars.

Carbon tetrachloride is used as a killing agent. Underneath the lowest tray there is a layer of cotton wool which covers the bottom of the trap. The tetrachloride is poured on it until the cotton is saturated with the fluid. In addition to this, to secure uniform distribution of the gas, each tray carries a small tin container filled with absorbent cotton and covered with a perforated lid. Tetrachloride is also poured into these. The tins may be placed either in the centre or to one side of the trays. The latter arrangement will offer less obstruction to the insects falling into the trap. A small ring soldered to the centre of each tray will be useful in lifting out the screens. Carbon tetrachloride stupefies the insects almost instantaneously, but the specimens killed by it need to be thoroughly relaxed before they can be pinned. This excessive stiffening is the principal objection to tetrachloride as a killing agent. It is necessary to renew the gas supply every night; ¾ of a gallon of tetrachloride, if judiciously used, will suffice for one season.

The accompanying drawing, prepared by Mr. H. A. Gilbert, supplements the details of construction lacking in the present description.



After experimenting with various types of light traps for several years it was found that the one described above gave the most satisfactory results. Under ordinary circumstances, the trap may be put out early in the evening and will need no further attention until the next morning. On a few nights, when there is an extraordinarily heavy flight, it may be necessary to empty the trays about midnight. The device is by no means perfect and further experiments will probably lead to many improvements.

It may be added here that, no matter how effective a trap may be in itself, the location and the conditions of exposure will influence to a very large extent the success obtained from its operation. An open verandah with the walls of the building acting as a reflector and the roof of the porch as a protection against the weather, is an ideal emplacement for a trap. The character of the vegetation of the surrounding country will, of course, be an important factor in determining the nature of the catch.

THE EUROPEAN SPRUCE SAWFLY OUTBREAK IN THE GASPE PENINSULA

By R. E. Balch, L. J. Simpson and M. L. Prebble

In the Canadian Entomologist for July, 1932, a brief account was given of the outbreak of the European spruce sawfly, (*Diprion polytomum* Hartig), which had been discovered in the Gaspe peninsula, Quebec, in the autumn of 1930. Since then the insect has been studied closely at a camp on the headwaters of the Cascapedia river and the progress of the outbreak has been followed by surveys and cruises in co-operation with pulp and paper companies and the Quebec Forest Service. This paper summarizes the situation at the end of the 1933 season.

In 1931, the noticeably infested area was estimated by an air survey at something over 2,000 square miles. Over a good deal of this area the black and white spruce had lost the greater part of the old foliage. At the same time an outbreak of the Eastern spruce barkbeetle (*Dendroctonus piceaperda* Hopk.) had commenced and some 6 per cent of the trees had been killed by this beetle.

The 1932 season was short and mostly cold, and less than 30 per cent of the larvae in the ground emerged as adults. The attack was less severe and the growth of new foliage compensated largely for the old foliage destroyed during the season. No important extension of the infested area occurred although new areas were discovered which had not been observed the previous year. At the same time, while the trees had succeeded in holding their own to a large extent, the ring growth had become quite small. Also, although there was no increase in the insect numbers, there were still as many cocoons in the ground containing larvae as there were cocoons from which adults had emerged. The situation looked somewhat less serious, but it was pointed out that if conditions in 1933 should for some reason bring about a greater percentage of emergence than had occurred in the previous two years, there were enough larvae in the ground to cause further serious damage, perhaps complete defoliation of some trees.

That is what has happened. The season of 1933 was unusually dry and during the period of greatest adult emergence the temperature was high. Apparently as a result of this the percentage of emergence was at least twice as great as in 1932. Larvae which had spun up in 1930 or previous and remained dormant for three winters and two summers pupated and emerged in considerable numbers.

The result has been a serious increase in the damage and an enlargement of the area of heavy infestation. This now extends throughout the interior of the peninsula, reaching the north shore at some points but not going as close to the shore on the south and eastern sides. It goes as far west as the Matapedia valley and includes parts of the forest west of that, notably on the Patapedia river, near Metis lakes and at the western end of Temiscouata county. This area is some 200 miles in length and over 4,000 square miles of forest is seriously attacked.

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* Contribution from the Division of Forest Insects, Entomological Branch, Ottawa.

The mortality to date consists almost entirely of trees attacked by the bark-beetle. The evidence does not suggest that the barkbeetle outbreak was dependent on the sawfly attack. It may not even have been encouraged by it. Although it confuses somewhat the estimation of mortality due primarily to the sawfly, it may be said that the trees which have died from sawfly attack only are at present comparatively few. There are, however, a number scattered throughout the forest which have already died without the assistance of barkbeetles. Mortality from this year's defoliation has not yet of course taken place and cannot be estimated until next year, but some of the trees are completely defoliated and will doubtless be unable to recover.

The seriousness of the situation lies in the fact that the whole forest is weakened and the reserves of foliage are very low. Another attack such as took place this year will certainly kill a great deal of spruce. In addition to that, the barkbeetle outbreak is not yet over though apparently past its peak. Our cruise figures for the Upper Cascapedia area, which is representative of much of the Gaspe, show a mortality already of 40 per cent of the white spruce and 24 per cent of the black spruce, by volume.

Our population studies offer no hope of an end to the sawfly outbreak. The number of overwintering larvae has increased considerably over the whole infested area this year. To give some idea of the population this fall: 204 samples of 4 square feet each, taken beneath defoliated trees in widely separated areas, gave an average per square foot of approximately 17 cocoons containing larvae, while there were 8 cocoons from which adults had emerged, and 15 destroyed by shrews and other agencies. The number of larvae was at least twice as large as in the spring before emergence.

Of the biotic factors of control the most important is the destruction of the overwintering larvae by shrews, and, to a lesser degree, by mice. Birds and predaceous insects are of minor importance and parasitic insect enemies are practically absent. Of the many thousands collected and reared during the past three years only eight individuals have proved to be parasitized.

Of the climatic factors, temperature is important. It would appear to influence the percentage and time of emergence of the adults considerably, although our experiments have not yet gone far enough to provide definite evidence of this. Summer temperatures are also important in the control of the speed of development of the larvae and consequently of their ability to reach the hibernating stage before the snow and frost make this impossible. There were nearly 4 inches of snow at our camp on October 20 and there will be snow on the ground probably until next June. The season, therefore, is short and there is only just comfortable time for one generation in normal years. Over most of its range in Europe, two generations occur.

In the absence of parasites, however, there is no one factor of control capable of reducing the outbreak, except starvation from destruction of the trees. Favourable combination of a number of control factors may reduce it but with the present population it seems probable that the attack will be again heavy next year.

The question of spread into other parts of the northeastern spruce forests is extremely important. We have no very definite evidence of the insect's powers of dispersal. Practically all the new areas of infestation discovered show evidence from cocoon samples of having been infested to some degree for two or three years. It would seem to have been a case of locally increased numbers rather than spread, although in some places part of the increase may have been due to invasion from more heavily infested areas.

Another point of importance is that we have found the sawfly present in small numbers in southern New Brunswick, near Fredericton, and in a few places in north-

ern New Brunswick. It is probably present in most of the spruce forests of this province. We have found, however, no signs of increase as yet outside of the above-mentioned areas in Quebec. At Fredericton, the species is able to complete two generations in a season, as in Europe, and the second generation feeds quite freely on new foliage. We do not know yet why it has become more numerous in the apparently less favourable climate of the Gaspe. It may have something to do with the area of continuous mature forest present. On the other hand, the outbreak may eventually extend southward.

With regard to spread, interesting observations have been made on Mount Albert and other mountains in the heart of the Gaspe. During the flight period of the adults, large numbers of them were found on the tops of the mountains above tree line, often on barren areas or on areas still covered with snow. They were doubtless carried there involuntarily by rising air currents. This suggests that under certain circumstances they would probably be carried to new areas by wind. Such spread as has been noticed, however. has been in opposition to the prevailing winds.

There seems to be little doubt that this is the European species although there are slight differences which might be considered racial. A closer study will be made as soon as more European material is received, but Mr. S. Walley, Division of Systematic Entomology, Ottawa, meanwhile, reports that the Gaspe adults are slightly larger than those so far examined from Europe. Another difference is that the cocoons are apparently formed on the tree in Europe as a general rule, while in Canada they are spun in the ground, very rarely in the tree. Also, Dr. W. R. Thompson, Farnham Royal Laboratory, reports that in Europe males are plentiful, often as numerous as the females, whereas in Canada we have only obtained four males from amongst many thousands of females. These have been tentatively determined as *polytomum* by Mr. Walley.

Until recently we had considered the males to be absent. Since Dr. Thompson reported that preliminary experiments had produced only males from mated females, it would still seem wise to test the effect of mating European males and Gaspe females. Controlled quantitative experiments are needed to decide whether it would be safe to liberate European males for the purpose of reducing the reproductive potential.

Although the sawfly is easily controlled by dusting, present economic conditions do not permit of artificial control measures. The almost complete absence of attack by native parasites offered a strong argument for the introduction of European parasites. Through the co-operation of Dr. Thompson. in charge of the Farnham House Parasite Laboratory of the Imperial Institute of Entomology. a number of shipments have already been received and are being reared at the Dominion Parasite Laboratory at Belleville, Ont. Some liberations were made in the Gaspe during the 1933 season.

Attacking as it does the most valuable tree in Eastern Canada, this outbreak is evidently a serious menace to the pulp and paper industry. It merits close and continuous study, with one of the chief purposes in view to discover some efficient means of natural control.

Dominion Entomological Laboratory, Fredericton, N.B., November 16, 1933.

A REVIEW OF ENTOMOLOGY AS PRESENTED BY THE DAILY AND WEEKLY PRESS OF CANADA

By H. A. Gilbert

Entomological Branch, Ottawa

The services of a press clipping bureau were first secured by the Entomological Branch in 1931 with the purpose of watching to what extent the publicity material released in connection with the control of the pale western cutworm was actually made available to the public, and also, to follow the progress of the outbreak as recorded in local or general news stories. The material proved to be so interesting and valuable that the service has been continued. It is in the hope that a sketchy analysis may be of interest to some of our members, that the following notes were prepared.

The clippings, with dates and source of publication appended, are received weekly in bunches from the clipping service. They are filed under various classified headings to ensure their ready accessibility. These clippings are culled from 100 daily newspapers, 700 city and rural weeklies, 30 agricultural journals and 150 periodicals so that a fairly comprehensive cross section of all entomological news is secured. In 1932, some 4,000 clippings were received, the number is indicative of a definite increase in entomological news. This has been due possibly to the fact that the public is becoming more interested in entomological matters, following a procession of very serious insect situations in Canada during the last few years, such as those associated with the corn borer and oriental fruit worm in Ontario, grasshoppers and cutworms in the West and the apple maggot in the various apple growing districts in the East.

Various types of entomological articles appear in the current press. There is the sensational news such as would be found in Ripley's "Believe it or not" section. For instance, the drawing of a cecropia moth appeared in this section in September last, with this foot-note:—"*Samia cecropia* moth, that never eats during its life, (it has neither mouth nor stomach) but each of its children eats more than 96,000 times its own weight in food." In a similar class are those human interest articles on the wonders of nature as are found under such a title as "Uncle Jack's Corner," which appear daily or by the week in Metropolitan papers. These add to the interest of the public and supply both useful and general information.

Other papers catering to the agricultural reader run an entomological service column on the question and answer basis, supplying definite, useful and timely information serving more or less as an extension service. These vary in quality, depending greatly upon the contributor. In the main they are exceedingly useful as an official entomologist is usually somewhere in the background.

Another group consists of officially inspired news items embracing announcements of publications, reports of scientific meetings, items of general public interest in connection with the general and particular work of the Dominion and Provincial Services and definite direct extension work, releasing seasonably timed information upon entomological circumstances of interest or importance to the general or local public. The last may appear in a range of journals from the purely agricultural to daily newspapers, and include the control of various insect pests such as the apple maggott, imported cabbage worm, root maggots, carrot rust fly, cutworms, aphids and many others, also the history and status of insects of economic importance such as the Colorado potato beetle, corn borer, grasshopper, apple maggot and Hessian

fly, and references to imported insects likely to be of importance in Canada, such as the Japanese beetle, Mexican bean beetle and the satin moth to satisfy recognizable public interest.

Articles arising from spontaneous public interest in entomological news also frequently appear. This is exemplified by a series on the export of a Canadian parasite of the white grub to Australia which appeared in October, 1931. The first article was liberated by the railway company which shipped these parasites. After inquiry had been made from official entomologists many other contributions appeared on this subject from several sources.

Besides being of general interest to the public the entomological news appearing in the press has proven of great value to entomologists. From a review of the papers they are able to learn the public attitude to Departmental activities, the progress of campaigns and the public opinion in regard to them. Through them an opportunity is given to clear up difficulties promptly in regard to control measures, by means of writing answers to letters of enquiry and complaint published in the papers.

From a series of articles written on the grasshopper situation in Western Canada in1933, the entomologists were able to watch the progress of the campaign and the public opinion in regard to it. Early in the year warnings appeared in the press preparing the farmers for a severe outbreak of hoppers. This warning to the farmers and the education of the public had the beneficial effect of securing public support for the governmental policy of voting appropriations for the purchase of poisoned bait and for the operation of extensive campaigns against these pests. As the campaign proceeded publicity was given to the excellent progress of the work and the success of local campaigns which had the effect of heartening the farmers to renewed efforts, in what at times in many localities, looked like a hopeless task. As the season advanced and the results of the control methods could be judged, the fact that hundreds of thousands of acres of grains and other crops had been saved reassured the public as to the justification of the expenditure and aided in securing their support for further campaigns where necessary.

Another example of the way in which an insect campaign can be followed in the papers was illustrated by the news stories on the apple maggot. News of this insect started to appear early in January of 1933. Fruit growers meetings were reported, the sum and substance ofthe regulations governing the certification of orchards and the export of apples was made generally known, seasonal notices for the application of maggot sprays and complete explanations for the need of government regulations concerning the export of apples, all appeared as the season advanced. Up till October, 125 clippings on this insect were received from the Press Clipping Bureau. The press in forty-eight localities situated in Ontario, Quebec, Nova Scotia, New Brunswick and Prince Edward Island contributed to this list. With this information appearing throughout the apple growing districts of Canada, the work of the orchard inspectors was made easier and a stimulus was given to export trade.

Similarly the entomologist could follow the trend of affairs in regard to the European corn borer control campaign. From the published reports of various county council meetings it was made known that the Government of Ontario had decided at the beginning of the year to stop the usual financial assistance given to the various counties in Ontario for corn borer work. After this information had become generally known, public opinion in regard to it was frequently published. Some were in favour of repealing the act due to the alleged high cost of its enforcement, but the general consensus of opinion was that this step if taken by the government would be one of false economy and that if the money that had already been

spent on the control of the corn borer was not to be wasted the act should continue in operation. The final decision of the government that the customary 50 per cent subsidy would continue to those counties which applied for this assistance with the intention of enforcing the act through local corn borer inspectors was likewise made known widely and promptly through the press.

Not very much could be learned from the papers concerning the pale western cutworm this year. From newspaper accounts loss from this pest has occurred only in isolated sections. In 1932, however, considerable publicity was given this pest due to the alleged incorrect information on control as advocated by entomologists. In this case the press proved to be a useful outlet for a complete airing of the situation. From the newspapers it was evident that some farmers in one district who considered that they had followed the control measures as advocated by the entomologists undoubtedly suffered considerable loss from cutworm damage. The natural result of this publicity must have been that doubt existed in the minds of many as to what was the best method of procedure if control was to be effected. The publicity on this situation served the purpose of enabling the Entomological Branch to give in reply through the newspapers a complete survey of its findings and to banish any doubt as to the general efficacy of its recommended control methods. It also enabled the entomologists to show that the loss incurred by farmers in 1932 in the district in question was due to a large extent to peculiar local circumstances, associated wind drift and to incomplete application of control measures.

During the present year (1933) white grubs have been given considerable publicity. No less than one hundred clippings culled from papers published in sixty-two localities situated throughout all the provinces of Canada except Nova Scotia have been filed. It must not be interpreted from this that infestations have occurred throughout all Canada, but that an interest in insects not necessarily present in their own locality is being recognized by the press on the part of the public of Canada.

The interest shown by the press in regard to an insect which some three years ago was hardly known is worthy of notice. Here reference is made to the gladiolus thrips. From the release of about three official newspaper articles, accounts concerning this insect have appeared in papers published throughout the whole of the Dominion. That the publicity of this pest was not unwarranted is proven by the fact that many of the letters of enquiry requesting further information in regard to this insect received made reference to some article in a paper read by the correspondent.

The entomological services of the Dominion and provincial governments have found the press a most useful and valuable medium for the release of seasonably timed notices in regard to all insects of major concern. News items on the control of the hundred and one pests of interest to the public have been generously published by the press and in this way a continued and most valuable service is made available to the public with a maximum of effect and a minimum of expenditure of time and money.

A SUMMARY OF INSECT CONDITIONS IN CANADA IN 1933*

C. R. TWINN

Entomological Branch, Department of Agriculture, Ottawa, Ontario

INTRODUCTION

For many years it has been the practice of the Entomological Society of Ontario to publish in its Annual Reports, separate papers on "Insects of the Season" prepared by officers closely in touch with insect conditions in each of the provinces.

* Prepared by direction of the Dominion Entomologist.

In addition, since 1928, annual summaries of insect conditions in Canada as a whole have been prepared by the writer in connection with the Canadian Insect Pest Survey, from reports submitted by co-operating officers of the Dominion and provincial services. These summaries appeared in the mimeographed Canadian Insect Pest Review issued by the Dominion Entomological Branch, Ottawa, and the first two (1929 and 1930) were also published in Scientific Agriculture† and the Annual Report of the Quebec Society for the Protection of Plants§, respectively.

Following the 1933 annual meeting of the Entomological Society of Ontario, the Council of the society requested the Dominion Entomologist to arrange for the writer to incorporate the information contained in the papers on "Insects of the Season, for 1933, referred to above, in the summary statement for the Dominion, for publication in the Annual Report in place of them. This has been done and the present summary is the result. It is felt, however, that an effort should be made to retain for reference purposes the original articles on which the summary is partly based, and with this in view it is proposed to include them, with the summary, in the first issue of the Insect Pest Review for 1934.

Grateful thanks are extended to the following entomologists whose contributions have made this summary possible. Papers on "Insects of the Season"; NOVA SCOTIA: F. C. Gilliatt, Annapolis Royal; NEW BRUNSWICK: R. P. Gorham, G. P. Walker*, Fredericton; QUEBEC: C. E. Petch, Hemmingford, G. Maheux, Quebec City; ONTARIO: L. Caesar, Guelph, W. A. Ross, Vineland Station; MANITOBA: A. V. Mitchener, Winnipeg, R. H. Handford, Treesbank; SASKATCHEWAN: K. M. King, A. P. Arnason, Saskatoon, K. E. Stewart, Indian Head; ALBERTA: H. L. Seamans, Lethbridge, E. H. Strickland, Edmonton; BRITISH COLUMBIA: E. R. Buckell, Vernon. Among others whose reports on insect conditions were used are H. G. Crawford, A. G. Dustan, Arthur Gibson, H. A. Gilbert, J. J. deGryse, G. H. Hammond, C. B. Hutchings, L. S. McLaine, R. H. Painter, J. M. Swaine, E. B. Watson, all of Ottawa; Arthur Kelsall, Annapolis Royal, N.S.; A. D. Pickett, Wolfville, N.S.; R. E. Balch, Fredericton, N.B.; W. E. Whitehead, Macdonald College, Que.; L. Daviault, Berthierville, Que.; D. A. Arnott, R. J. Clemens, W. E. Lindsay, G. M. Stirrett, Chatham, Ont.; J. Hall, Vineland Station, Ont.; A. B. Baird, A. R. Graham, W. E. van Steenburgh, G. Wishart, Belleville, Ont.; H. F. Hudson, Strathroy, Ont.; R. W. Sheppard, Niagara Falls, Ont.; H. E. Gray, Winnipeg, Man.; L. C. Paul, Saskatoon, Sask.; C. W. Farstad, G. F. Manson, R. M. White, E. McMillan, Lethbridge, Alta.; Eric Hearle*, T. K. Moilliett, Kamloops, B.C.; A. A. Dennys, A. D. Heriot, W. G. Mathers, E. P. Venables, Vernon, B.C.; R. Glendenning, Agassiz, B.C.; W. Downes, Victoria, B.C.

In reading a report such as this it should be borne in mind that as it takes a minimum number of words to express a given fact, the amount of space devoted to the various species cannot be accepted as a measure of their relative importance; and, further, that a comparatively few major species are responsible for the bulk of crop damage. Nevertheless, all the species included are of some economic significance. For the purpose of easy reference the insects have been grouped (somewhat arbitrarily, perhaps) and discussed, under five headings; namely, field crop and garden insects, fruit insects, forest and shade tree insects, insects affecting animals and man, and household and stored product insects.

The 1933 season over Canada as a whole, was distinctly unfavourable for crop production. Crop yields of each year since 1928 were reduced in some degree by drought. In 1933, the effects of sub-normal precipitation were more widespread

† Vol. X, No. 11, July, 1930, pp. 754-758.
§ 23-24 Ann. Rep. 1930-32, pp. 149-168.
* Obit.

than usual and extended from the Prairie Provinces into Eastern Canada. Crop production was reduced sharply in Nova Scotia, Ontario, Saskatchewan and Alberta, and in certain sections of the other provinces.*

Field Crop and Garden Insects

The outstanding insect outbreak of 1933, in Canada, was that of grasshoppers in the Prairie Provinces. These insects, with the impetus of favourable weather conditions, had been on the upward trend for the past several years, but it was not until 1931 that they became sufficiently abundant to cause crop damage of a serious character. During 1931 and 1932, the outbreak increased both in intensity and extent and despite control efforts serious losses occurred. In 1933, the outbreak continued unabated and crop damage was materially increased by drought and high temperatures during the critical June period, so that heavy losses occurred over extensive areas. Grain crops suffered most severely. Other field crops and garden truck also were affected, particularly during and after grain harvesting. In July and August, extensive dispersal flights of grasshoppers occurred in many parts of the infested region. As a result, practically all of the open prairie land of the three Prairie Provinces is now involved, and the areas of severe infestation have been considerably extended, except in eastern Manitoba where there was an encouraging reduction. The species of grasshoppers chiefly involved in the outbreaks are the lesser migratory grasshopper, *Melanoplus mexicanus* Saus., the clear-winger grasshopper, *Camnula pellucida* Scud., and the two-striped grasshopper, *Melanoplus bivittatus* Say. Other species of lesser importance also occur.

In British Columbia, where grasshoppers have been at a low ebb in recent years, there were evidences, in 1933, of a general increase that may presage a further outbreak in this province in a few years, particularly on the dry cattle ranges. Several local outbreaks occurred this year in one or two small areas. In Eastern Canada, grasshopper infestations continued moderate to negligible in most localities. Scattered outbreaks were reported in certain counties of Quebec north of the St. Lawrence river, and on dyked lands in Kings and Hants counties, Nova Scotia.

Bee flies of the species *Systoechus vulgaris* Loew, which are rather important parasites of grasshopper eggs, were common throughout the grashopper-infested areas of the Prairie Provinces.

Blister beetles, notably the caragana beetle, *Lytta nuttali* Say, were again extremely abundant and widespread in the prairie areas of the three Prairie Provinces. Their increasing abundance seems to coincide with the development of the major outbreak. The caragana beetle adults attacked caragana, broad beans and other legumes. The species *L. sphaericollis* Say occurred locally on snowberry, and the black blister beetle, *Macrobasis subglabra* Fall., on caragana, in Manitoba. The species *M. debilis* Lec., was also abundant in that province on leguminous crops, notably sweet clover. The spotted blister beetle, *Epicauta maculata* Say, attacked potatoes and garden truck locally in Alberta. In Eastern Canada local infestations of the ash-gray blister beetle, *M. unicolor* Kby., were reported on potatoes and legumes in New Brunswick, southern Quebec and eastern Ontario.

The field cricket, *Gryllus assimilis* Fab., was again present in great numbers in Manitoba, particularly in the eastern portion, where it was reported in abundance in 1932. In late August the crickets became a great nuisance by invading farm homes and other buildings. The species was also generally common in southern Saskatchewan, and (as in 1932) extraordinarily abundant in districts of heavy clay soil. A slight decrease in the numbers of this species was reported in eastern Ontario. Local

* Dom. Bur. of Statistics—Agric. Branch, C. R. 36, Jan. 19, 1934.

infestations of the mormon cricket, *Anabrus simplex* Hald., of little or no economic importance, were noted in south-eastern Manitoba and in southern Saskatchewan. In the latter area the crickets were reported mostly feeding on grasshoppers.

In Saskatchewan and Alberta the pale western cutworm, *Agrotis orthogonia* Morr., which has been a major pest during the past several years, was again the most important cutworm species in these provinces, in 1933. The outbreak continued severe in south-central, central and western Saskatchewan, but in the eastern part of the infested area the outbreak was considerably reduced and damage was slight. In Alberta, the species was abundant and caused crop losses in the foothills area of the Crows Nest Pass, and in the districts of New Dayton, Enchant and Berry Creek. The severity of the outbreak in the province as a whole, was considerably reduced from that of 1932. Other species of cutworms were of little importance in the Prairie Provinces. The red-backed cutworm, *Euxoa ochrogaster* Gn., and its allies, which have been declining since 1930, were negligible in 1933. The army cutworm, *Chorizagrotis auxiliaris* Grt., was also greatly reduced in numbers and in range.

In British Columbia, cutworms appeared to be much less injurious than in 1931 and 1932, damage being reported from only a few localities in the spring. They were unimportant in the Okanagan valley. With the exception of the pale western cutworm, cutworms were considerably reduced in importance, in Canada as a whole, as compared with 1932. In Eastern Canada they were, in general, very moderate. Over the greater part of Ontario, indeed, they were remarkably scarce, having declined rapidly from outbreak proportions in 1931. In Quebec they were somewhat injurious to garden vegetables and were severe in some tobacco-growing areas, but in the Maritime Provinces a reduction in numbers over recent years was noted.

Wireworms continued to be a severe pest of field and garden crops in British Columbia and in the Prairie Provinces. In the prairies reports of wireworm damage were not so numerous as usual, probably because their attacks were largely masked by the severe grasshopper outbreak and the drought. In Eastern Canada, important damage to various crops was caused by wireworms (*Agriotes, Melanotus, Ludius* spp.) in agricultural sections of Ontario. Local damage was reported in Quebec and the Maritime Provinces.

False wireworms which were widespread and abundant in areas affected by drought in Saskatchewan, in 1932, were not noticeably numerous in 1933.

Second-year white grubs of the species *Phyllophaga anxia* Lec., were the most serious crop pest in eastern Ontario in 1933. The grubs, which developed from enormous number of eggs laid following the great June beetle flight in 1932, are exceedingly numerous over a territory of approximately 5,000 square miles, and caused crop losses amounting to many thousands of dollars. Timothy, corn and potatoes were the principal crops attacked, but a wide range of other crops also suffered injury. Elsewhere in Ontario there was no general outbreak, but local infestations were reported in southern sections. In the outbreak area in southern Quebec few reports of injury were received as most of the grubs were in their third-year.

The wheat stem sawfly, *Cephus cinctus* Nort., was again a major pest in the Prairie Provinces, particularly in Saskatchewan and parts of Alberta. In Saskatchewan, infestations were high and crop loss heavy throughout the drought area. The ravages were especially severe in localities of heavy soil in the drier prairie areas. In southern Alberta it was very abundant over a territory centering on Drumheller, northwards, and east to the Saskatchewan border. A severe local outbreak also appeared in the Macleod district about 130 miles south of Drumheller. The sawflies continued scarce in northern sections, in the Edmonton region. Moderate infestations were reported in western Manitoba. The insect is said to be less serious than formerly in that province.

The extensive and severe outbreak of the wheat stem maggot, *Meromyza americana* Fitch, reported in Manitoba in 1932, was repeated in 1933, and affected a wide area in the province. Infestation of wheat ranged from less than one per cent in the southwest and west, to as high as 22 per cent, in a few instances, in the Red River Valley where damage was most severe. Crop loss was also caused by this species in Saskatchewan. Some damage to wheat by a species of stem maggot, apparently *Hylemyia cerealis* Gill., occurred in widely separated districts in central Alberta. This species was previously reported infesting isolated fields in southern Alberta, in 1930, and prior to that in 1923.

The infestation of the hessian fly, *Phytophaga destructor* Say, in southern Ontario, which was noted to have increased somewhat during 1932, was again greatly reduced in 1933, and crop injury was negligible.

Reports from the Maritime Provinces and Quebec indicate the Colorado potato beetle, *Leptinotarsa decemlineata* Say, to have been about normally abundant in 1933. In Ontario, the infestation was reported generally high in the south, and causing moderate damage in the eastern counties. In the Prairie Provinces and the southeastern corner of British Columbia, the only portion of that province infested, the situation was apparently similar to that of the preceding year.

During 1933, there were a few reports of infestations of the red turnip beetle, *Entomoscelis adonidis* Pall., in central sections of Alberta and Saskatchewan. Cruciferous plants were chiefly attacked, and in most cases damage was moderate.

The cabbage maggot, *Hylemyia brassicae* Bouche, was noted as probably less prevalent than usual in the Annapolis valley, Nova Scotia, and in Quebec. In New Brunswick, injury to swede turnips was particularly severe and reduced grade quality at harvest time. Damage to cabbage, cauliflower and radish was well above average in Ontario, but damage to turnips was much less severe than during the previous two years. In southern Alberta probably 20 per cent of cabbage and radish plants in market gardens at Lethbridge and Macleod, were destroyed. Injury by root maggots was below normal in British Columbia. The onion maggot, *H. antiqua* Mgn., caused material damage to commercially grown onions in southern Ontario. As many as one-fifth of the plants were destroyed in certain localities in Kent and Middlesex counties. Even more severe losses were experienced in the Ottawa district. The 1932 outbreak of the seed corn maggot, *H. cilicrura* Rond., in Saskatchewan, was not repeated and the species caused only slight local loss. Some injury to seedlings was reported locally in southern Ontario and in New Brunswick.

In most agricultural sections of the Dominion, the imported cabbage worm, *Pieris rapae* L., was conspicuously abundant, particularly in late summer. Cruciferous crops were heavily infested and the species did material damage. The diamondback moth, *Plutella maculipennis* Curt., is increasing in the Lethbridge district, Alberta. There was a widespread outbreak of this species in 1930, throughout the West, since when its numbers have been negligible.

In southern Ontario, the infestation of the European corn borer, *Pyrausta nubilalis* Hbn., in general apparently did not change materially from that of 1932. Since the serious situation in 1926 when the borer caused very heavy crop losses, the percentage of infested stalks declined rapidly and reached its lowest point in 1930. During 1931 and 1932, marked increases took place, but the infestation was still much lower than it 1926 and 1927, and did not result in serious loss. During 1933 the situation appeared to be essentially as in 1932, with moderate increases in some counties and slight decreases in others.

In most parts of the Dominion the corn ear worm, *Heliothis obsoleta* Fab., was of minor importance in 1933. Slight infestations were reported in sections of Nova

Scotia and New Brunswick. In Ontario, the only province where material damage was recorded in 1932, the species was much reduced. In the western provinces the insect was not important.

The beet webworm, *Loxostege sticticalis* L., which was enormously abundant in the Prairie Provinces in 1932, particularly in Saskatchewan and Alberta, was decidedly less abundant in 1933. However, heavy flights occurred in Saskatchewan, especially in northern and eastern settled portions, and weeds, vegetables and flowering plants were attacked by the larvae. Moderate flights were reported in parts of Alberta and Manitoba and the insect did some damage to sugar beets and garden vegetables in these provinces.

Injury to tobacco, tomatoes and potatoes by the tobacco worm, *Phlegothontius quinquemaculata* Haw., occurred in various parts of southern Ontario. The species was apparently somewhat less abundant generally than during the preceding few years.

Flea beetles continued to take their annual toll in various parts of the Dominion. The potato flea beetle, *Epitrix cucumeris* Harr., caused moderate damage to potato and tomato crops in the Maritime Provinces. The damage was reported less than for several years in Nova Scotia. In Ontario and Quebec there was apparently no diminution in the abundance of this species. A severe outbreak of the turnip flea beetle, *Phyllotreta vittata* Fab., wsa noted in the Ottawa district a nd the pest was reported abundant at Macdonald College, in southern Quebec. The flea beetle species, *Disconycha xanthomelaena* Dalm. (spinach flea beetle), and *Psylliodes punctulata* Melsh. (hop flea beetle), were prevalent on sugar beets in southern Ontario. The actual damage was negligible. A slight infestation of the tobacco flea beetle, *Epitrix parvula* Fab., was found in a tobacco field in the Chatham district, Ontario. Flea beetles caused damage to crops such as cabbage, turnips, sugar beets and rhubarb in various parts of the Prairie Provinces. In some cases the damage was of serious proportions. These insects were again troublesome in the Okanagan valley, the Lower Fraser valley and southern Vancouver island, British Columbia.

In Nova Scotia the striped cucumber beetle, *Diabrotica vittata* Fab., was again injuriously abundant on cucurbits in gardens, in many localities. In New Brunswick, Quebec and Ontario reports indicate infestations of about average intensity.

Three species of weevils of European origin, identified as *Sciaphilus muricatus* Fab., *Brachyrhinus ligneus* Oliv., and *Tropiphorus* sp., were very numerous on a market-garden farm near Yarmouth, N.S., and were abundant relatively in the order named. Injury by these weevils was most pronounced to young cabbage seedlings.

The tarnished plant bug, *Lygus pratensis* L., continued rather scarce in New Brunswick, but was reported abundant in many sections of Nova Scotia. In the latter province its attacks resulted in material damage to fruit blossom buds and to various plants. In southern Ontario the species was destructive to peach nursery stock in the Niagara peninsula and to celery in the Burlington district. Its numbers were subnormal in eastern Ontario. In British Columbia very little damage was done to fruit buds in the Okanagan valley and the species was comparatively scarce. In southern Vancouver island the insect gave considerable trouble to chrysanthemum growers in late summer by attacking the flower buds.

Chinch bugs, *Blissus leucopterous* Say, were again attacking lawns in Nova Scotia (Annapolis Royal, Canning and Halifax), and in New Brunswick (Sackville and Fredericton). Their numbers, however, were much less than in 1931 and 1932 and the outbreak, which first developed in 1931, appears to have largely subsided.

Sod webworms, *Crambus* spp., were scarce in south-western Ontario in 1933 and caused no injury. There was a severe outbreak of these webworms in that part of the province, in 1931. In eastern Ontario there was a large reduction in the sod webworm population as compared with 1932, and injury to corn was much less than had been expected.

Numerous complaints of injury to squash and pumpkins by the squash bug, *Anasa tristis* DeG., were made by growers in south-western Ontario, where the species was again a troublesome pest of these plants.

Crop injury by plant lice was reported in many parts of Canada during 1933. Infestations of cabbage and turnip aphids, *Brevicoryne brassicae* Bouche, and *Rhopalosiphum pseudobrassicae* Davis, in south-western Ontario, developed into what was considered probably the most extensive and destructive outbreak in twenty years. Turnips were severely attacked by both species and hundreds of fields were almost completely ruined. Cabbage and other crucifers also suffered, but less severely. The species was abundant alsewhere in southern Ontario in late summer. In sections of Nova Scotia turnip aphids increased and caused considerable damage; in New Brunswick, however, these with other species of aphids were generally scarce. In Saskatchewan, the marked outbreak of 1932 did not recur in 1933. Turnip and cabbage aphids caused a good deal of damage in British Columbia in the Vernon and Kamloops districts. The corn leaf aphid, *Aphis maidis* Fitch, was exceedingly numerous on sweet corn in the Montreal district and on fodder corn in the eastern townships and Huntingdon county, Quebec. Potato aphids, *Illinoia solanifolii* Ashm., were injurious in parts of Nova Scotia, and the pea aphid, *I. pisi* Kalt., was general in southern Alberta with resultant damage to garden peas and sweet peas. Aphids of several species were very numerous on various crops and plants in southern Alberta and in the Lower Fraser valley and southern Vancouver island, British Columbia.

The carrot rust fly, *Psila rosae* Fab., was locally injurious in the Maritime Provinces and Quebec, but negligible in Ontario. For the past few years this species has not been particularly troublesome in Eastern Canada.

Garden springtails (*Sminthurus hortensis* Fitch) were numerous on many plants in New Brunswick, in 1933, and caused injury to seedling turnip, carrot and beet plants in Kings county, in early spring. They also occurred abundantly on seedlings locally in southern Quebec. Such infestations are not unusual.

Lepidopterous borers were reported from several localities in 1933. The potato stem borer, *Gortyna micacea* Esp., decreased to minor significance in Nova Scotia, but caused slight local damage in southern Quebec. The stalk borer, *Papaipema nitela* Gn., was common in south-western Ontario in wild hosts such as ragweed, but did little damage to crops. Light injury to garden tomato plants by the burdock borer, *P. cataphracta* Grt., was noted in one locality in eastern Ontario. The columbine borer, *P. purpurifascia* G. & R., appears to be increasing in Manitoba,and in certain sections of that province columbine suffered severely. The iris borer, *Macronoctua onusta* Grt., did much damage to irises locally in southern Quebec and eastern Ontario.

The pepper grass beetle, *Galeruca externa* Say, was destructive to cruciferous garden crops in the Treesbank district, Manitoba, and locally at Stalwart, Saskatchewan. This species has been reported from time to time during the past few years attacking wild and cultivated crucifers in Manitoba. It was also recorded in the Skeena district, British Columbia, in 1924.

The onion thrips, *Thrips tabaci* L., was more prevalent than probably at any time in a decade, in onion fields of Kent county, south-western Ontario. The insects were especially injurious in several hundreds of acres of onions in the Jeanette Creek district.

Damage to gladiolus by the gladiolus thrips, *Taeniothrips gladioli* M. & S., was reported from New Brunswick, Ontario and three Prairie Provinces. This thrips was first found in 1930, in Ontario, and was described as a new species the same year. It is believed to be an introduced pest, probably on corms from abroad, but its point of origin is doubtful. It now occurs in every province of the Dominion. During 1933 there was a pronounced decrease in thrips injury to gladioli throughout Ontario, and commercial damage was localized. Injury was also less severe in Manitoba. In southern Alberta, however, the pest was very abundant for the first time and did material damage.

As usual, various species of insects were reported attacking rose. The rose chafer, *Macrodactylus subspinosus* Fab., was again abundant and injurious in sandy sections of the Niagara peninsula and south-western Ontario. Numbers of ducks and chickens were reported to have died in two localities in Middlesex county as a result of eating the beetles. Specimens of the work of the imported rose stem girdler, *Agrilus viridis fagi* Ratz, a comparatively new rose pest, were received at Guelph, Ont., for the first time, in the autumn of 1933. Infestations of the rose curculio, *Rhynchites bicolor* Fab., were reported general in many sections of Saskatchewan and Alberta where the insects did serious damage in rose gardens. In Alberta, losses due to this species were believed to be more severe than at any time since 1921. In early summer, two species of rose slugs were reported abundant in Kent county, Ontario. Rose slugs were also noted in Glengarry county, eastern Ontario. At Lethbridge, Alberta, an unidentified species of sawfly was found boring into the tips of cultivated roses and destroying the terminal shoots.

Damage to plants by garden slugs, *Limax* sp., mostly moderate or negligible, was reported from localities in Nova Scotia and New Brunswick, south-western Ontario and Agassiz, British Columbia.

Fruit Insects

As usual, aphids of various species were injurious in orchard sections in 1933. The apple aphid, *Aphis pomi* DeG., was somewhat more numerous in Nova Scotia than in recent years, but outbreak conditions were checked by natural agencies. The species was also quite injurious to young trees in south-eastern Quebec and occurred locally in outbreak form in certain counties of southern Ontario. In other sections of Quebec and Ontario, and also in New Brunswick and British Columbia, the species was of little importance. The rosy apple aphid, *Anuraphis roseus* Baker, was not nearly so abundant in Nova Scotia as in the preceding year. In New Brunswick the species increased rapidly when apples were about half-grown, and caused the disfigurement of much fruit. In Ontario the infestation was moderate over most of the province, but severe in the Niagara district and Norfolk county. In orchard sections of British Columbia, where aphids were generally scarce, the rosy apple aphid was more common than for several years. The woolly apple aphid, *Eriosoma lanigera* Hausm., has increased in various parts of Eastern Canada, but was not important in 1933. In the Okanagan valley, British Columbia, the species has not been common enough during the past two seasons to cause damage. The black cherry aphid, *Myzus cerasi* Fab., was more than usually prevalent in Nova Scotia, and retarded the growth of young trees in parts of the Annapolis valley. In the Niagara district and elsewhere in southern Ontario, wherever sweet cherries are grown, there was a recurrence of the outbreak in 1932. In British Columbia, the black cherry aphid was more common than for several years.

Increased damage by the codling moth, *Carpocapsa pomonella* L., was reported in apple-growing sections of Eastern Canada in 1933. Injury by the late brood was more in evidence in the Annapolis valley, Nova Scotia, than formerly. Commercial

orchards in New Brunswick continued to be free from this pest, but untreated orchards were heavily infested. Commercial apple-growing sections of southern Quebec experienced a marked increase in "side-worm" injury. In Ontario, favoured by an early, hot and dry season, the species was very abundant and destructive. The second brood was exceptionally large and "side-worms" took a heavy toll of fruit, particularly in the warmer districts. It is of interest to note that codling moth larvae were found in prunes near Simcoe. In British Columbia, the codling moth is becoming of considerable importance.

The general adoption of control and eradication measures against the apple maggot, *Rhagoletis pomomella* Walsh., in the principal apple-growing districts of Eastern Canada, was largely responsible for a pronounced and gratifying decrease in injury by this pest. Emergence of adult flies commenced in Ontario (Norfolk county) on June 18; in southern Quebec on July 5 (earliest noted), and in the Annapolis valley, Nova Scotia, between July 8 and July 11.

The lesser apple worm, *Laspeyresia prunivora* Walsh., was quite common in apple orchards of Norfolk county, Ontario, but was of little or no economic importance. In the Okanagan valley, British Columbia, it was present in small numbers.

An increase of the eye-spotted budmoth, *Spilonota ocellana* D. & S., was noted in orchard sections of Nova Scotia and in the St. John river valley, New Brunswick. Damage to apple, especially of the "side-worm" type, was markedly more prevalent in New Brunswick. With minor exceptions the budmoth caused but little injury in Ontario and Quebec. It was very scarce in the Okanagan valley, British Columbia.

With the exception of the gray-banded leaf roller in Nova Scotia, leaf rollers affecting orchards were generally of negligible importance in the Dominion. The gray-banded leaf roller, *Eulia mariana* Fern., continued to increase in the Annapolis valley and many serious infestations occurred. From present indications this insect may eventually cause more concern than any other in orchard sections of the province. The fruit tree leaf roller, *Cacoecia argyrospila* Wlk., was of little importance in Ontario, even in Norfolk county, where only one heavy infestation was observed, near Windham Centre. From 1928 to 1930 this species was rather destructive locally in Ontario. A species of leaf roller believed to be the oblique-banded leaf roller, *C. rosaceana* Harr., was injurious to roses and other plants at Lethbridge, Alberta. With minor exceptions leaf rollers were very scarce in the Okanagan valley, British Columbia.

Damage by green fruit worms was not reported from Nova Scotia in 1933, and, in New Brunswick, the numbers of apples affected by these insects showed no increase. In south-eastern Quebec the fruit worms were stated to have decreased materially, where as elsewhere in southern Quebec they were reported present in numbers greater than in any year since 1915. In the Okanagan valley, British Columbia, they were noted to have caused more injury than for several seasons.

Very light infestations of the apple leaf sewer, *Ancylis nubeculana* Clem., were noted in southern New Brunswick. The yellow-necked caterpillar, *Datana ministra* Drury, was fairly common on apple trees in the Niagara peninsula, Ontario. Red-humped caterpillars, *Schizura concinna* S. & A., were very abundant locally in the Okanagan vally, British Columbia, but a large percentage were parasitized. Bruce's measuring worm, *Rachela bruceata* Hulst., was unusually abundant in certain apple orchards in the Vernon area, in the spring.

Except locally, the cigar case bearer, *Haploptilia fletcherella* Fern., caused no injury in the Maritime Provinces in 1933. It has been recorded decreasing since 1929.

It was not mentioned in reports from Quebec, Ontario and other parts of the Dominion.

In parts of Nova Scotia, the plum curculio, *Conotrachelus nenuphar* Hbst., caused severe damage to plums. At Annapolis Royal the damage was reported average, or about 20 per cent of the fruit. In southern Quebec the plum curculio has largely decreased in recent years and was of no importance in commercial orchards. In Manitoba, where certain localities are infested by the plum curculio, the species appeared less numerous than in 1932. The apple curculio, *Tachypterellus quadrigibbus* Say, increased generally in apple-growing sections of New Brunswick. In southern Quebec injury by this species showed a considerable decrease. The absence of reports from other parts of the Dominion regarding the two species would seem to indicate that they were not important pests in those regions.

A considerable reduction of injury by the round-headed apple tree borer, *Saperda candida* Fab., was reported in southern Quebec. A heavy local infestation of this insect was noted in an apple orchard in York county, New Brunswick.

Infestations and some defoliation of neglected apple orchards and trees by the apple and thorn skeletonizer, *Hemerophila pariana* Clerck., occurred in the Maritime Provinces, but was not important. No appreciable injury by the skeletonizer was observed in Ontario, and none was reported in Quebec.

Leaves of apple trees infested by the leaf miner, *Lithocolletis crataegella* Clem., were observed in various parts of Ontario.

A chrysomelid beetle, *Syneta albida* Lec., was reported damaging fruit buds at Mission, British Columbia, in spring. Reports of this species causing damage locally, to the buds, blossoms and young fruit of apple, and attacking cherries, strawberries and clover, in the Lower Fraser valley and at Salmon Arm, have been received from time to time during the past twenty years.

Holes were eaten in the bursting buds of apple trees at Newmarket, Ontario, by a species of flea beetle, *Chalcoides helxines* L.

The mealy bug, *Phenacoccus aceris* Sig., reported in Nova Scotia in 1932 as causing sooty-coloured fruit in a number of apple orchards (black fungus growing on secreted honey dew) more particularly in the Lakeville district, Kings county, was much less prevalent in 1933 and caused little or no damage.

In 1933, as in the previous year, the green apple bug, *Lygus communis* Knight, was present in very reduced numbers in practically all parts of the fruit-growing areas of Nova Scotia, and no injury of importance occurred. Moderate infestations were reported in several localities in the St. John river valley, New Brunswick.

Light infestations of the apple red bug, *Lygidea mendax* Reut., were observed in orchards locally in southern Ontario, but no outbreak occurred. This species was not reported elsewhere in the Dominion during the year.

The European apple sucker, *Psyllia mali* Schmid., was more prevalent in unsprayed orchards in the Annapolis valley, Nova Scotia, than during the previous two years. Orchards were heavily infested at Wolfville, Kings county, and the species was very numerous in Pictou county. Infestations in New Brunswick continued negligible.

In various parts of Ontario, numbers of apple and pear trees, particularly young trees in sod orchards, suffered injury by the egg laying activities of the buffalo tree hopper, *Ceresa bubalus* Fab. The usual evidence of egg scars was observed in apple orchards in the Maritime Provinces and Quebec. One orchard at Hemmingford, in the latter province, was seriously damaged.

Reports from Nova Scotia and Ontario, for 1933, indicate a distinct reduction in abundance of the white apple leafhopper, *Typhlocyba pomaria* McA., over previous years. In Ontario this was reported apparently due to two species of parasitic hymenoptera; an egg parasite *Anagrus* sp., and a species of *Aphelopus*. The apple leafhopper, *Empoasca fabae* Harr., a major pest in Ontario nurseries, was decidedly injurious to apple nursery stock in the Niagara peninsula. In New Brunswick light infestations of *Balclutha punctata* Thumb., *Empoasca maligna* Walsh., and *Dikraneura mali* Prov., on apple, were recorded. In British Columbia, leafhoppers including the rose leafhopper, *Typhlocyba rosae* LeB., caused yellowing of the foliage of apple in orchards at Kelowna in the Okanagan valley. This species was also numerous on loganberries in the Victoria district, Vancouver Island. For the third year in succession there was an outbreak of grape leafhoppers, *Erythroneura comes* Say and *E. tricincta* Fitch, in the Niagara peninsula, Ontario. The second brood appeared unusually large. Severe infestations were reported on Virginia creeper, locally, in eastern Ontario and in the Indian Head district, Saskatchewan.

Poorly sprayed pear orchards in the Niagara-Burlington district, southern Ontario, suffered heavy infestations of the pear psylla, *Psyllia pyricola* Forst., and injury was very severe on unsprayed trees.

In orchard sections of Eastern Canada the pear slug, *Eriocampoides limacina* Retz., declined in numbers in 1933 as compared with previous years. Some defoliation of unsprayed trees occurred in south-western Ontario, but in general, the insect caused little damage.

The pear leaf blister mite, *Eriophyes pyri* Pgst., recorded as abundant and increasing in the Okanagan valley in 1931 and 1932, was reported not common in British Columbia in 1933. No infestations or outbreaks were reported elsewhere in the Dominion during the year.

The oyster shell scale, *Lepidosaphes ulmi* L., continued to be one of the worst insect pests in apple orchards of British Columbia. A great increase in the infestation on unsprayed trees in the Okanagan valley was reported. This scale is also an important pest in the Saint John river valley, New Brunswick, where in certain sections special sprays were necessary to control it. In south-eastern Quebec it is reported to be decreasing rapidly owing to improved orchard spraying practices. No reports were received from other fruit-growing districts of the Dominion.

In the Niagara district and in sections of south-western Ontario, particularly in Essex and Kent counties, a marked increase in the population of the San José scale, *Aspidiotus perniciosus* Comst., was noted.

In the Niagara district, Ontario, infestation records indicate that the oriental fruit moth, *Laspeyresia molesta* Busck., damaged peaches to about the same extent as in 1932. Chrysopids and several species of introduced parasites played an important part in materially reducing the infestation.

At Vineland, in the Niagara district, Ontario, the peach borer, *Synanthedon exitiosa* Say, was reported more troublesome than usual. Near St. Catherines, in the same district, peaches growing in a small orchard adjacent to oak trees were scarred by oak and hickory plant bugs, *Lygus quercalbae* K., *L. omnivagus* L., and *L. caryae* K. In the Okanagan valley there was very little evidence of the peach twig borer, *Anarsia lineatella* Zell.

The grape crop in a vineyard at Beamsville, Ontario, in the Niagara district, was practically ruined by the grape berry moth, *Polychrosis viteana* Clem., although the adults were less prevalent than in the previous year. Elsewhere the Niagara district was free from injury of commercial importance by this pest.

Reports of crop damage by several species attacking raspberry were received during 1933. The raspberry cane borer, *Oberea bimaculata* Oliv., was reported much less injurious in Quebec than in recent years. The absence of reports possibly indicates a similar situation in southern Ontario. Infestations of the red-necked cane borer, *Agrilus ruficollis* Fab., ranging from 1-20 per cent, and averaging about five per cent, in wild and cultivated canes, were noted in several localities in eastern Ontario. At Belleville, Ontario, an infestation of the raspberry cane maggot, *Pegomyia rubivora* Coq., affecting 75 per cent of new shoots of raspberry occurred. Infestations of the raspberry sawfly, *Monaphnoides rubi* Harr., were reported locally in eastern Ontario and in the Lethbridge district, Alberta. The plants in some cases were about one-quarter defoliated. Injury by the black-horned tree cricket, *Oecanthus nigricornis* Walk., was again common on raspberry canes in the Niagara district and various other parts of Ontario. The snowy tree cricket, *O. niveus* DeG., was reported locally injurious in eastern Ontario. Raspberry foliage was attacked by the strawberry leaf beetle, *Paria canella* Fab., locally in Laval county, Quebec. In a few instances the common red spider mite, *Tetranychus telarius* L., harmed commercial raspberry patches in Manitoba. Serious injury to raspberries by this mite was reported at Leamington, Ontario. In other sections of southern Ontario the mites were scarce in raspberry plantations.

The larvae of crane flies were found attacking the roots of strawberry plants at Waterville and Annapolis Royal, Nova Scotia. Injury to strawberry patches by the black vine weevil, *Brachyrhinus sulcatus* Fab., was also reported in that province. Infestations of the strawberry weevil, *Anthonomus signatus* Say, were noted in Quebec, in the Quebec city, Three Rivers and Montreal districts, but no serious outbreaks occurred. On Vancouver island, British Columbia, strawberry root weevils, *B. ovatus* L., caused some trouble in summer by invading houses. In a plantation at Brentwood, Vancouver Island, about 3,000 strawberry plants were destroyed in the spring, by the species *Polyphylla decemlineata* Say.

In Middlesex county, Ontario, the imported currant worm, *Pteronidea ribesii* Scop., was noted as scarcer than for many years. An increased abundance of this species was reported in the Lethbridge district, Alberta. The currant spanworm, *Itame ribearia* Fitch, was reported injurious in southern Quebec and in Alberta. It was noted completely defoliating currant bushes in various localities in Saskatchewan. The currant aphid, *Myzus ribis* L., severely attacked the foliage of currants in Alberta. Normal damage by the currant fruit fly, *Epochra canadensis* Loew., occurred in Manitoba. Infestations of the currant bud mite, *Eriophyes ribis* Nal., occurred on black currants at Vineland Station, Ontario. One variety was heavily infested, but very few buds of other varieties were affected.

The cranberry fruit worm, *Mineola vaccinii* Riley, is considered probably the worst enemy of cranberries in Nova Scotia. From 5-20 per cent of the fruit in all the bogs in the vicinity of Auburn and Aylesford was infested. The fruit on the bogs at Port Mouton and Bridgewater, on the Atlantic coast, was infested to a much smaller extent. The adults of the chain-spotted geometer, *Cingilia catenaria* Dru., which, among other plants, attacks cranberries, were very numerous late in September on bogs at Beaver river, Yarmouth county, and at Port Mouton, Queens county, Nova Scotia. Cranberry spittle insects, *Clastoptera vittata* Ball, were not as abundant in the province as during 1932. The insects, however, were present in destructive numbers on cranberry in a bog at Auburn.

The European red mite, *Paratetranychus pilosus* C. & F., was moderate in Eastern Canada, in 1933. No infestations of importance occurred in Nova Scotia, and the pest apparently decreased in numbers in the Saint John river valley in New Brunswick. There were no serious outbreaks in southern Ontario. In the Niagara district, how-

ever, the species apparently was more common than usual on peach trees. Infestations on plum and apple were about normal. In British Columbia this mite is becoming abundant on apple trees throughout the Okanagan valley.

Judging from the paucity of reports, the common red spider mite, *Tetranychus telarius* L., was not an important pest in Eastern Canada, and further declined in abundance in the Prairie Provinces, where, during the years 1929 to 1931, it was recorded as a widespread and destructive pest on many plants. The species *Epitrimerus piri* Nal., was again noticeable in pear orchards of the Niagara district, Ontario, producing russetting on the under sides of the leaves. The florets of a species of grass received from Anticosti island, Quebec, were infested by a mite, *Tarsonemus* sp.

Webs of the fall webworm, *Hyphantria cunea* Dru., were again conspicuous on orchard and other trees in various parts of Eastern Canada and in British Columbia. Apparent increases were noted in New Brunswick, southern Ontario and the Okanagan valley, British Columbia, and material reductions were reported in Nova Scotia and eastern Ontario.

Forest and Shade Tree Insects

An increase in the numbers of the European spruce sawfly *Diprion polytomum* Hartig, occurred in 1933 on white and black spruce in the Gaspe peninsula, Quebec, and the heavy attack extended to young stands along the North Shore of the St. Lawrence river, and along the Matapedia valley. By late summer many of these stands were stripped of all their old foliage.

The eastern spruce bark beetle, *Dendroctonus piceaperda* Hopk., has been active during the past few years, in practically all mature spruce stands in the Gaspe peninsula, Quebec. Some have been almost completely destroyed. Farmers' woodlots and village shade trees on the coast, and the virgin timber throughout the interior suffered heavily. The number of trees killed in 1933, however, was distinctly less than in 1932 (about one-half). The decline may be attributed to winter mortality and to more effective control by woodpeckers during the winter months.

The outbreak of the spruce budworm, *Cacoecia fumiferana* Clem., at Barkerville in the Cariboo district, British Columbia, reported in 1932, subsided in 1933. This outbreak had been in progress for the past ten years covering an area of about 500 square miles. The budworm killed very few trees, but over a large part of the area, a large percentage of mature balsam, weakened by the attacks of the budworm, was killed by the western balsam bark beetle, *Dryocoetes confusus* Sw.

The yellow-headed spruce sawfly, *Pachnematus ocreatus* Harr., caused local damage to ornamental spruce trees in Manitoba. It was very troublesome in northern and eastern sections of Saskatchewan, defoliation ranging as high as 75 per cent where control measures were not applied. The infestation in this province extended considerably from 1932 and injury was much more severe. The spruce leaf miner, *Taniva albolineana* Kft., damaged the needles on the lower branches of Norway and blue spruce in many places west of Toronto, Ontario, during early spring. The spruce mite, *Paratetranychus ununguis* Jac., was again of major importance throughout Saskatchewan.

The European pine shoot moth, *Rhyacionia buoliana* Schiff., was destructive to ornamental and reforestation pines along the shore of Lake Erie and the Niagara river in Welland county, Ontario. Light and scattered infestations occurred in other parts of the county, and also in the counties of Lincoln, Haldimand and Brant. The pine budmoth, *Exotelia dodecella* L., was also numerous in reforestation plots in Welland county. In some plots of Scotch pine near Port Colborne, Ontario, heavily in-

fested with the pine shoot moth, at least 50 per cent of the total bud injury was caused by the budmoth. The pine sawfly, *Diprion simile* Hartig., was found in a nursery at Montreal, Quebec, on August 25. This insect was recorded for the first time in Canada in 1931, at Oakville, Ontario. The pine needle scale, *Chionaspis pinifoliae* Fitch, was again an important pest in Saskatchewan. In Manitoba, ornamental spruce was reported seriously injured in widely separated localities. Several square miles of the Spruce Woods Forest Reserve near Onah, Manitoba, were fairly heavily infested. The insect was reported very common on pines at Nicolet, Quebec.

An infestation of the larch sawfly, *Lygaeonematus erichsonii* Hartig, was reported in the Elk river valley in the south-eastern portion of the Kootenay district, British Columbia. Many western larch trees were defoliated as much as 75 per cent, but no trees killed by the sawfly were observed. Heaviest defoliation was noted near Fernie, but evidence of the sawfly was found over an area 60 miles in extent. The sawfly has been active in the district at least since 1930 and is apparently spreading to the south and west. Heavy infestations of the larch case bearer, *Haploptilia laricella* Hbn., again occurred on larch in larch stands in many parts of Eastern Canada.

Slow deterioration and mortality of balsam fir continues to result from attacks of the balsam woolly aphid, *Dreyfusia piceae* Ratz., in southern New Brunswick where the insect is under observation. Several new centres of infestation were found in York county in 1933. The species also occurs in balsam stands throughout Nova Scotia and has been recorded from Prince Edward Island.

The spruce pineapple gall aphid, *Adelges abietis* L., continued to be particularly severe in northern sections of Saskatchewan where damage to terminal twig growth of spruce ranged as high as 50 per cent. In the Edmonton region of Alberta where various species of plant lice were unusually common, the pineapple gall aphid was extremely abundant on transplanted spruce trees, many of which are dying.

Certain species of deciduous trees were subject to severe aphid attack in 1933, notably in the Prairie Provinces. The elm aphid, *Eriosoma americana* Riley, caused from 5-25 per cent of the leaves of elms to curl in Manitoba, Saskatchewan and Alberta, greatly marring the beauty of the trees. In southern Alberta elms, cottonwoods and Manitoba maple or boxelder all prematurely dropped their leaves owing to aphid attack. In the Edmonton region, the black willow aphid, *Melanoxantherium smithiae* Mon., continued to be a severe pest of poplars in shelter belts. The boxelder aphid, *Periphyllus negundinis* Thom., was injurious in Saskatchewan. At Annapolis Royal, Nova Scotia, various shade trees and shrubs were subject to heavy aphid infestation. In southern Quebec the elm leaf aphid, *Callipterus ulmifolii* Monell, was a pest.

The eastern tent caterpillar, *Malacosoma americana* Fab., was scarce in Nova Scotia. In southern New Brunswick and southern Quebec, however, a decided general increase was reported. In Quebec the infestation was particularly heavy in the eastern townships. In Ontario the species was common but was not in outbreak form. Outbreaks of the forest tent caterpillar, *Malacosoma disstria* Hbn., occurred in parts of New Brunswick, Ontario and Saskatchewan. In New Brunswick, poplar and birch over many square miles in York county were defoliated. Partial defoliation also occurred in many poplar stands in southern and central New Brunswick. It is expected that the attack will be heavier next year. In Ontario, large areas of woods were defoliated in the Sudbury district. There was also an outbreak in eastern Ontario east of the Rideau river. Many groves where poplar, birch and alder predominated, were completely denuded of foliage. Early in June there were numerous press reports of outbreaks of caterpillars, presumably forest tent caterpillars and canker worms, on deciduous trees, in certain parts of Ontario. Armies of caterpillars were reported moving through Algoma and stripping bare the trees in the Lee

valley area west of Sault Ste. Marie. Caterpillars were said to have done much damage at Blind river, Massey and Walford. A Canadian Pacific freight train was reported delayed for more than two hours east of Webbwood because of thousands of caterpillars on the tracks. Poplars, alder and birch were mentioned as being defoliated. In north-central Saskatchewan the outbreak of forest tent caterpillars continued. Practically all poplars over a major portion of Prince Albert National Park were defoliated. Alder, willow and birch also suffered injury.

In Nova Scotia the fall canker worm, *Alsophila pometaria* Harr., declined to a point where injury was negligible. In New Brunswick some defoliation of elm and basswood occurred, but the insect was not a noticeable pest in orchard sections. In Manitoba, there was a fairly general infestation, shelter belts around farms in many places being completely defoliated. Boxelder and elm were particularly subject to injury. In the Winnipeg district the attacks were much less severe than in 1932. In the vicinity of Indian Head, Saskatchewan, practically all boxelder was defoliated 5-15 per cent by canker worms. In eastern Ontario material damage to the foliage of elm, boxelder, basswood, poplar, willow, ash and oak occurred. Reports of considerable defoliation of woodlands by canker worms were received from Lake Rosseau, Muskoka district, Ontario, and Bigwin Island, Lake of Bays. Specimens received were the spring canker worm, *Palaeacrita vernata* Peck.

The birch skeletonizer, *Bucculatrix canadensisella* Chamb., was less abundant in the Maritime Provinces and the Gaspe peninsula, Quebec, than in 1932. There was, however, a very general and fairly heavy outbreak. The foliage of affected trees did not turn brown as in previous years of the outbreak, although on some soils much of it turned yellow in August, as a result of drought which was also responsible for considerable mortality among the larvae. Birch trees in Nova Scotia and New Brunswick were heavily infested by the European birch leaf miner, *Fenusa pumila* Klug., which destroyed much of the young foliage of grey and white birch and of the tops of large trees. The birch sawfly leaf miner, *Phyllotoma nemorata* Fall., was general on birch in New Brunswick, but not numerous.

The presence of the satin moth, *Stilpnotia salicis* L., in certain localities in the Maritime Provinces was first recorded in July, 1930. In 1933 the insect spread and increased in New Brunswick and defoliated various species of poplars at Sussex, Moncton, Sackville and on farms at intermediate points. It was present in outbreak form on shade and ornamental trees in the streets of Amherst, Nova Scotia. In southwestern British Columbia observations revealed that the satin moth has spread considerably and now infests a wide territory extending north to the Seton Lake area, and north-east to Cisco in the Upper Fraser river valley. The moths were found on Mt. McLean, above the timber line, at an altitude of 6,000 ft., an indication that mountain ranges apparently are no barrier to the spread of this insect. On southern Vancouver island considerable defoliation of poplars by this species was reported.

Several species were injurious to poplar and willow during 1933, notably in the Prairie Provinces. The poplar leaf-folding sawfly, *Pontania bozemani* Cooley, was present in destructive numbers in many parts of Saskatchewan. In the Lethbridge district, Alberta, where it is usually abundant on cottonwoods, it was very scarce. The willow sawfly, *Cimbex americana* Leach, was very common on willow and poplar in parts of Saskatchewan. Larvae of the cottonwood hawk moth, *Pachysphinx modesta* Harr., were abundant on poplar trees throughout the entire southern portion of the province of Alberta. Damage was light. The cottonwood blotch miner, *Zeugophora scutellaris* Suff., (Chrysomelidae) was generally distributed and severe in Saskatchewan with a slight increase over last year. In some localities planted cottonwoods showed 75 per cent. of the foliage mined. In certain localities in Alberta this species appeared in enormous numbers after an absence of several years. The majority of

broad-leaved cottonwood trees had over 80 per cent. of the leaves infested. The aspen poplar leaf beetle, *Lina tremulae* Fab., occurred in outbreak numbers in eastern Saskatchewan and also in southern Manitoba from Treesbank to Haywood. Larvae of the cottonwood leaf beetle, *Lina scripta* Fab., did considerable injury to planted poplars and willows in north-western Saskatchewan in the autumn. There was a fairly general infestation in the Lethbridge district, Alberta. Adults were common in early summer in south-western Ontario. In eastern Saskatchewan, planted and native stands of poplar and willow were infested to a greater extent than usual by the alder flea beetle, *Haltica bimarginata* Say. This species was injurious to alder in the Nashwaaksis valley, New Brunswick. Damage by the willow leaf beetle, *Galerucella decora* Say, was widespread and severe in plantings of willow and poplar in Manitoba Native willows were severely attacked, particularly in areas near the Riding Mountains. There was a heavy spring migration of adults of this species in Saskatchewan, resulting in considerable damage to planted poplars in scattered areas. The poplar and willow borer, *Cryptorhynchus lapathi* L., was destructive to willows locally in south-western Ontario and in southern Quebec. The willow tingid or lace bug, *Corythucha salicis* Osborn, severely defoliated native willows in south-eastern Saskatchewan. Poplar was also attacked.

The white-marked tussock moth, *Hemerocampa leucostigma* S. & A., was scarce in the Maritime Provinces and Quebec in 1933. In the former provinces the tussock moth was last recorded in conspicuous numbers in 1930. In southern Ontario, at Fort Erie, London and Chatham, shade trees such as horse chestnut and maple were partially defoliated by this species.

The maple leaf cutter, *Paraclemensia acerifoliella* Fitch, continued at a low ebb in Ontario and Quebec, where it was reduced to an endemic status by natural control agencies in 1930. In 1933, a light infestation was noted in a sugar maple bush at Apple Hill in eastern Ontario, about one-half of the trees showing infested leaves.

Reports of infestations of the cottony maple scale, *Pulvinaria innumerabilis* Rathv., were received from Montreal, Que., and the Agassiz district, British Columbia. Maple groves in Beauce county, Quebec, were subject to an outbreak of the elm spanworm, *Ennomus subsignarius* Hbn.

Larvae of the American dagger moth, *Acronycta americana* Harris, were common in southern parts of Saskatchewan attacking boxelder. Relatively light damage was done (5-10 per cent defoliation in some localities). The species is usually rather scarce in the province.

The cecropia moth, *Samia cecropia* L., was much reduced in numbers in 1933, but was still troublesome. In Alberta it occurred in abundance, for the first time, in the extreme south-east of the province. Currants and choke cherry were attacked.

Infestations (some very heavy) of the boxelder gall midge, *Cecidomyia negundinis* Gill., occurred in some localities in Saskatchewan. The two-striped grasshopper, *Melanoplus bivittatus* Say, damaged boxelder nursery trees at Lethbridge, Alberta, by feeding on the trunks. Some of the young trees were girdled and died.

Scotch elms at Guelph, Ontario, were wholly or partially defoliated by the elm leaf miner, *Kaliofenusa ulmi* Sund. Miner injury was also conspicuous at Hamilton and in the Niagara district. In eastern Ontario where the species is believed to have decidedly increased over the previous year, elms suffered 5-20 per cent reduction of foliage. At St. Catherines, Ontario, there was a general infestation of the European elm scale, *Gossyparia spuria* Mod.

Throughout south-western Ontario, walnut trees were again partially or completely defoliated by the walnut caterpillar, *Datana integerrima* G. & R. This has happened for three consecutive years and there are indications that many trees will succumb to the repeated attacks.

Insects Affecting Animals and Man

It may be stated in general terms that mosquitoes were more abundant and troublesome over a large part of the Dominion in spring and early summer, in 1933, than during the past three or four years. Various species of *Aedes* are the more serious and widespread of these pests.

Blackflies of several species also were troublesome in certain regions of the Dominion. The most abundant and widely distributed in Canada are *Simulium venustum* Say and *S. vittatum* Zett. In the West, the species*S. articum* Mall., also is dominant; in the East, *Prosimulium hirtipes* Fries. In parts of Eastern Canada, particularly in forested regions, blackflies were reported more abundant than for several years past. They were also very numerous on some of the high stock ranges in the interior of British Columbia.

In early spring, larvae of the common warble fly, *Hypoderma lineatum* DeVill., were found in more than 90 per cent of 2,100 cattle examined on Calumet island, Pontiac county, Quebec. Warble fly control campaigns have been, or are being, organized in various dairying and cattle raising districts in Ontario, Quebec and British Columbia. The insecticide used is derris.

Bot flies, *Gastrophilus* spp., were reported troublesome to horses in eastern Ontario and in Alberta and doubtless were important pests elsewhere, although not reported.

Severe myiasis in sheep was observed in spring and summer at Vavenby, British Columbia. The blow fly, *Phormia regina* Mgn., probably was responsible. Adults of this species and others, were reported as becoming annually more abundant in the Edmonton region of Alberta, where they constitute a serious household pest.

A number of moose infested by the elk or winter tick, *Dermacentor albipictus* Pack., were found dead in the spring of 1933, in New Brunswick, but the mortality was slight compared with that reported in 1931. This species apparently was more than usually abundant in the Dry Belt of British Columbia. Several stock owners in the Kamloops district complained of the pest on their cattle and horses. The paralysis tick, *Dermacentor andersoni* Stiles, was particularly numerous in early May at Quilchena and Nicola, British Columbia. On one of the ranges a herd of yearling heifers was badly infested, and several cases of paralysis occurred during late April. At Teulon, Manitoba, the bird tick, *Haemaphysalis cinnabarina* Koch., attacked turkey poults in early August.

The usual reports of infestations of fleas, *Ctenocephalus canis* Curtis and *C. felis* Bouche, in dwellings, were received during 1933. The European chicken flea, *Ceratophyllus gallinae* Schrank, was reported attacking both hens and humans at Forest, Ontario, and the human flea, *Pulex irritans* L., was taken in a dwelling at Freetown, Prince Edward Island. The human flea had previously been recorded only in British Columbia and Saskatchewan where its distribution is very localised. Bedbugs, *Cimex lectularius* L., were frequently complained of in dwellings in various parts of the Dominion, and occasional reports were received concerning head, body and crab lice, *Pediculus humanus* L., *P. humanus corporis* DeG., and *Phthirus pubis* Leach.

Household and Stored Product Insects

Many complaints regarding clothes moths, chiefly the webbing clothes moth, *Tineola biselliella* Hum., damaging such materials as clothing and upholstered furniture, were received from various parts of the Dominion. In one instance, in a residential section of Montreal, the larvae were found infesting an insulating medium used in the walls of new dwellings, consisting essentially of horse hair between layers

of paper. The emerging moths appeared in the rooms in great numbers. Chinese feather dusters stored in the basement of a large store in Ottawa also were heavily infested by this species. The case-making clothes moth, *Tinea pellionella* L,. damaged piano felts and feather pillows at Ottawa.

Black carpet beetles, *Attagenus piceus* Oliv., were frequently reported in dwellings infesting floor cracks, cupboards, trunks, etc., and in some instances damaging clothing. This species is a common pest of cereals in mills and warehouses, and was observed on a lake boat carrying flour. The buffalo carpet beetle, *Anthrenus scrophulariae* L., was noted in several localities in Ontario. The larder beetle, *Dermestes lardarius* L., was also occasionally reported. In one instance at Montreal, fibre board used in building work was found infested and riddled by larvae of this insect.

The European house cricket, *Gryllus domesticus* L., which is an annoying pest in certain urban areas in southern Ontario, is established in Ottawa, occasionally infesting dwellings, particularly furnace basements.

The silverfish or fish moth, *Thermobia domestica* Pack., is becoming increasingly important as a household pest in Canada, particularly in urban sections of Ontario and Quebec. Among other things, the fish moths have been found feeding upon artificial silk (rayon) goods.

Ants were reported troublesome in many localities in the Maritime Provinces, Quebec and Ontario, infesting dwellings, lawns and gardens. They were noted as increasingly abundant in lawns at Edmonton, Alberta. At Sydney, Nova Scotia, winged ants entered a dwelling in large numbers, in October, down the chimney flues. This was said to be an annual occurrence.

In many localities in the Prairie Provinces the boxelder bug, *Leptocoris trivittatus* Say, was abundant and proved a nuisance owing to its habit of invading dwellings. The real stink beetle, *Nomius pygmaeus* DeG., was recorded on several occasions in houses in Winnipeg and Lac du Bonnet, Manitoba. Clover mites, *Bryobia praetiosa* Koch., were reported invading houses in the Niagara peninsula, Ontario, during the winter of 1932-33 and in the following spring.

Beetles of the species *Nacerdes melanura* L., were found breeding in decaying wood beneath the floor of a gasoline service station in Ottawa. Specimens of a wood-boring beetle, *Callidum* sp., were received from a summer hotel at Pictou, Nova Scotia, where they were boring in the woodwork of the building, causing damage and annoyance with their castings.

Various insect pests of stored products continued their depredations during 1933. Grain stored in the large terminal elevators at the head of the Great Lakes remains largely cool and sweet and free from insects, owing to low winter temperatures and proper care. In smaller storage places such as farm granaries, particularly in regions of comparatively moderate winter temperature (southern British Columbia and southwestern Ontario), damage by the granary weevil, *Calendra granaria* L., the sawtoothed grain beetle, *Silvanus surinamensis* L., the confused flour beetle, *Tribolium confusum* Duv., the cadelle beetle, *Tenebroides mauritanicus* L., and other species, often occurs.

The hairy spider beetle, *Ptinus villiger* Reit., infests many warehouses in the Prairie Provinces, Ontario, Quebec and New Brunswick, where it attacks flour and other cereal products. Specimens of the white-marked spider beetle, *P. fur* L., were taken in warehouses in certain localities in Ontario. This species also occurs in the West. The species *P. tectus* Boild, was found in 1933 in a dwelling at Prince Rupert, British Columbia, feeding on coriander seeds, flour and other foodstuffs, woollen

and silk goods. It had previously been recorded only from Vancouver and Victoria. Outside of Canada, it is rather cosmopolitan in distribution, and attacks a wide range of organic substances.

In mills, warehouses and other buildings where cereal products are stored, various insects in addition to spider beetles are often troublesome pests. Among these are the Mediterranean flour moth, *Ephestia kuehniella* Zell., the Indian meal moth, *Plodia interpunctella* Hbn., the yellow meal worm, *Tenebrio molitor* L., as well as the saw-toothed grain beetle, confused flour beetle, the cadelle beetle, mites, etc. Dried fruits and nuts, particularly those imported from warmer climates are subject to attack by the Indian meal worm and certain other species.

Among other stored products infested by insects, stored beans are commonly attacked, particularly in Ontario and Quebec, by the bean weevil, *Mylabris obtectus* Say.

The mottled dermestid, *Trogoderma versicolor* Creutz., was found in small numbers in certain dried milk establishments in Ontario. This species was first recorded in Canada, in 1930, at Napanee, Ontario.

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