PROCEEDINGS OF THE

ENTOMOLOGICAL SOCIETY OF MANITOBA

VOLUME 10

1954

Proceedings of the

ENTOMOLOGICAL SOCIETY OF MANITOBA

Vol. 10 1954

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ENTOMOLOGICAL SOCIETY OF MANITOBA FINANCIAL STATEMENT

FOR YEAR ENDING DECEMBER 31, 1954.

Receipts:

Balance in Bank, Dec. 31, 1953		47.79
Receipts from members dues 1954		50.00
Receipts from members dues 1955		98.00
Registration for 1954 fall meeting	13.00	
Registration for 1954 fall smoker	33.00	46.00
Donations:		
Chipman Chemicals	15.00	
Canada Agriculture (purchase of Proceedings)	25.00	40.00
Bank interest		0.33
		$282.12

Expenditures:

Subscriptions to Entomological Society of Canada	116.00
Taylor Co. -- covers for 1953 Proceedings	16.50
Taylor Co. -- covers for 1954 Proceedings	17.33
Mays Drug Store -- gifts for stenographers	5.20
Mays Drug Store -- envelopes	.40
Smoker fall meeting	61.00
Stamps, money order and telegraph charges	18.86
Bank operating charges	0.84
Balance in hand December 31, 1954	45.99
	$282.12

Audited and found correct - January 4, 1955.

F. L. Watters
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R. M. Prentice
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Proceedings of the

ENTOMOLOGICAL SOCIETY OF MANITOBA

Vol. 10 1954

INTRODUCTION

This year is the tenth anniversary of the formation of the Entomological Society of Manitoba. The circumstances leading to the birth of our Society are recorded in Volume I of these Proceedings, by our first President, Dr. B. N. Smallman. The foresight shown by those who were active in forming our organization now seems prophetic. The decade that has since elapsed has been marked by such an increase in the complexity of entomological science that there is an imperative need for interchange of knowledge such as is provided by the regular meetings of our Society.

Whereas our Annual Meeting is customarily devoted largely to reviews of advances in entomological science and technology, this year, in observance of the tenth anniversary, it has been dedicated to memoirs on early and more recent entomological events in Manitoba and to the broad problems of classifying and disseminating entomological knowledge. Another special feature this year was the holding of the Spring Meeting at Brandon, Manitoba. I am happy to express appreciation for the hospitality of the Brandon members on that occasion.

No one can predict infallibly what will happen in the next ten years. Yet it is safe to assume that the Entomological Society of Manitoba will continue to serve a useful purpose.

It is a pleasure once again to record our thanks to the Government of Canada Entomology Laboratories for assistance in producing these Proceedings. I wish to express my appreciation for the efficient and cooperative efforts of the executive in the organization of meetings.

It has been a privilege and a pleasure to me to serve as President and I look forward with optimism to the future activities of the Entomological Society of Manitoba under the guidance of its new executive.

A. J. Thorsteinson,
President.

THE SPRING MEETING

The Business Session

A business meeting of the Entomological Society of Manitoba was held at the Entomology Laboratory, Brandon, at 11.30 A.M. on April 3, 1954. Dr. A.J. Thorsteinson presided.

The minutes of the Annual Meeting of November 10, 1953, were read and adopted on a motion by P.H. Westdal and D.R. Robertson.

The Treasurer's report was presented by G.L. Warren, and adopted as read on a motion by G.L. Warren, seconded by W.J. Turnock.

On a motion by Professor Mitchener and R.R. Lejeune, it was agreed that the Treasurer's report be published annually in the Proceedings of the Entomological Society of Manitoba.

The Editor-Librarian reported that the 1953 Proceedings would be out about July 1. He also reported that the committee to report on the future policy of the Library of the Society had not yet met.

Professor Mitchener presented a list of 19 common names for insects for consideration by the meeting, prior to being forwarded to the Committee on Common Names of the Entomological Society of Canada. One name was deleted from the list and a second changed. On a motion by Professor Mitchener and W.R. Allen, the list was approved as amended.

The President declared the meeting adjourned at 12.30 P.M.

Scientific Business

The scientific session of the regular spring meeting of 1954 assembled at the Entomology Laboratory, Brandon, Manitoba, at 12.45 P.M. on April 2. It continued during the afternoon of April 2, and for most of the morning of April 3.

The first item was a visit to the Dominion Experimental Farm, about two miles north of the city of Brandon. Mr. R.M. Hopper, Superintendent, welcomed the members of the Society, and spoke briefly on the work of the Experimental Farms Service in Canada, and gave a brief outline of the history and development of the Brandon Experimental Farm. It was interesting to hear that this Farm has been in operation since 1888. Mr. Hopper then introduced in turn various members of the Farm staff, who outlined their own particular responsibilities. Mr. W.H. Johnston spoke of their work on cereal crops, including variety testing and purity trials on cereal grains, and in particular, work being done on both feed and malting barley varieties. Mr. W.S. Ferguson outlined the work in Field Husbandry, including crop rotations, weed control (both cultural and chemical), and soil fertility, including use of fertilizers. Mr. Walters spoke to the group on Poultry Nutrition, use of antibiotics in feed rations, calcium uptake, protein supplements, and protein-energy relationships. Mr. B. Gorby outlined the work being done at various Illustration Stations which are under the supervision of the Brandon

Farm. Mr. R.M. Hopper spoke on work being done in Animal Husbandry, Forage Crops and Horticulture. The visit to the Experimental Farm terminated with a very interesting trip to the Apiary and Apiary Buildings, conducted by Mr. J. Geiger.

Members of the Society returned to the Entomology Laboratory, where the remainder of the Scientific Session was held. The first item was devoted to a panel discussion of "The Insecticide Situation". Mr. J. Howden, of Green Cross Insecticides, was chairman, and in the absence of Mr. W. Fox of Chipman Chemicals Limited, who was unable to attend due to illness, presented both of the following papers, and conducted the very interesting discussion which followed the two papers.

WHAT IS NEW IN THE FIELD OF COMMERCIAL INSECTICIDES?

J. Howden
Green Cross Insecticides, Winnipeg, Manitoba

It is not often that I am placed in the position where what I have to say is preserved for posterity by putting it in a record of any kind. Since in this instance, that will be the ultimate fate of my remarks, I feel that I must qualify them at the outset. I would like to say, therefore, that any opinions contained in this talk are my own only, that they are correct to the best of my judgement and information, and that I have not, with intent, neglected to mention any material which might rightfully have been included.

Having cleared the air, so to speak, I should get on with this presentation. The broad topic assigned to this panel or group, was "The Insecticide Situation". I have decided to review the most recent development of commercially available insecticidal materials. These are not by any means all, or even for the most part, available from commercial outlets in Canada, but when an experimental chemical reaches the state where it is registered for sale anywhere in North America, it has reached a status which makes it a potentially successful insecticide, and one which stands a fair chance of becoming commonly used.

If I may digress for a minute from the strict subject of this talk, for you must accept the stuffing with the meat, I would like to say a few words with regard to the tremendous differential between the input and the output of insecticide research and development. In this connection, two statements come to my mind, both made at different times by an executive of the Monsanto Chemical Company. The speaker, in both instances, was very well qualified to know his subject. The first statement was that in 1952 the Monsanto Chemical Company through their research facilities were producing and screening newly synthesized organic materials at the rate of approximately 2,000 individual compounds per month. These compounds were being screened for insecticidal, fungicidal, and herbicidal value, and the ratio then in effect was that one out of the 2,000 might be expected to reach the final status of a commercially feasible product. The second statement, supported by facts and figures, was that to produce and develop a single commercially successful insecticide, involves the expenditure of a million dollars. The bulk of that million dollar expenditure is spent on eliminating, at various stages, those chemicals which are not good enough. It should be remembered that the Monsanto Company is only one of the great chemical companies involved in this search for still more effective insecticides. Of comparative, or possibly greater, extent are the individual research programs of such companies as Dupont, Dow, California-Spray, Shell, and a relatively large number of other basic chemical companies.

Despite this tremendous effort, the output, as we know it in the meagre numbers of new insecticides available for purchase from readily accessible outlets, such as our own organization, is relatively minute. A recent canvass of the industry, for reports of new insecticides registered for sale in the United States in 1953, revealed that only six new insecticides had been so classified. Of these six, only a single material will be widely sold in Canada this year.

It should be realized, however, that throughout the network of testing stations in North America, there are continuously circulating a large number of chemicals under development. It is, understandably, far beyond the scope of this talk to attempt to single out any of these materials, on the basis of promising preliminary reports.

The six materials which in 1953 achieved the distinction of having successfully run the gamut of laboratory and field testing, and the discriminating eye of the toxicity specialists, to reach the ultimate goal of meriting the cost of a sales promotion are the following:

Chlorobenzilate:-
An acaricide developed by the Geigy Company which has not been reported on to any great extent. The available information indicates that it is an effective material for the control of mites on ornamentals, but it has either not been tested against these pests on fruits and vegetables or it is not suitable for these purposes because of some handling or toxicity characteristic. If this supposition is true it will not become a popular chemical.

Diazinon:-
Also a Geigy product, and another phosphatic material, it has proven to be an effective material for the control of flies and as a barn spray. It is notable in that it has a toxicity range similar to Malathion, and for the control purposes mentioned above, it is equally effective. It would be logical to believe that this material would possess equal acaricidal value also, because of its chemical make-up, but so far no reports are available on other types of insects.

In connection with these two Geigy products, I would like to mention that they have not received the widespread publicity and promotion accorded to Malathion, that their development is consequently slower, and that they should not be overlooked or dismissed as also-rans. The Geigy Co. ranks with the best in the field of chemical research, but being basically a Swiss company, it does not have the facilities available to American companies for the promotion of new materials on this continent. My personal experience with this company's representatives indicates that they are not disposed to permit the handling of their developmental materials by other organizations in quite the same manner as the American companies, and this too, tends to restrict the wide testing of their products.

Heptachlor:-

This is a Velsicol Corporation product, with an interesting chemical designation or name, which almost requires a mathematician to interpret. To be technically correct you would call it 1,4,5,6,7,8,8-heptachloro-3a,4,7,7-a tetrahydro 4,7-methanoindene. It is another in the series of chlorinated hydrocarbons, and I strongly suspect that it is slated to become a prominent member. Many of you here will have used this material, and will be familiar with it. I believe that it is a fair statement to make in saying that Heptachlor has the general specificities of the others of this series, but that it is sufficiently superior for some purposes to bring it into prominence. From reports received, it is apparently decidedly superior to aldrin, chlordane, or DDT, for the control of onion maggot, it is an effective material for control of wireworm infestations in vegetables, and is reported to leave no objectionable off-flavour, and that it has a wide range of application on other insects. Heptachlor has been reported to give good control of cutworms at the application rate of 1 pound per acre of the technical material. It has already established itself in the field of cotton insect control, which means it will be available in quantity, and this commercial availability will mean an inevitable increase in its testing and ultimate use. There is a distinct possibility that it will enter the field of wireworm control for cereal crops, for testing to date has indicated it to be effective, and germination and formulation considerations may favour its use. Against Heptachlor is the fact that it is too similar to others of the series, for chemical merchandizing companies are reluctant to stock two products for one job.

Allethrin:-

The allyl analog of cinerin I; this material was originated by the Carbide and Carbon Corporation, and is frequently called "Synthetic Pyrethrum". While listed in the canvass as a newly available commercial insecticide for 1953, it has been available since 1952. It need not be discussed at much length here, for while it is a satisfactory substitute for Pyrethrum, and is important commercially in times when Pyrethrum supplies are short, it has the same general capabilities and restrictions. The level of toxicity is comparable for the two. Considerable quantities of Allethrin are being used as pyrethrum substitutes in packaged general purpose materials.

Perthane:-

Developed and manufactured by the Rohm and Haas Co., it has the chemical name of diethyl diphenyl dichloroethane. It is the most recent of this group, and has not as yet been fully evaluated. It has been proven to be an excellent material for the control of leafhopper, clover weevil, alfalfa caterpillar, and lygus, and has also given good control of the leaf eating insects of cole crops. Tests against horn fly and lice on cattle have proven it to be an effective insecticide with considerable residual capacity. It is noteworthy in that it has a comparatively low oral toxicity, and on a comparative basis is only one thirty-second as toxic as DDT.

For purposes of interest, the acute LD-50's as listed by the U.S. Food and Drug Administration are: Perthane - 8170 mg/kg, Methoxychlor - 6,000, Rhothane (DDD) - 3,400, DDT - 250, nicotine - 50 to 60, rotenone - 132, toxaphene - 69, aldrin - 67, and parathion - 3.

Malathion:-

This chemical is undoubtedly the big development in 1954. A product of American Cyanamid Co. research, it was introduced widely during 1953, subjected to widespread testing and promotion, and proven to be undoubtedly a major development in the insecticide field. The proof of its desirable characteristics and effectiveness, is the fact that it is now being packaged for both farm and home markets by practically all the leading trade distributors. It is the only one of the chemicals discussed herein, which will be widely available on the Canadian market this year. The Green Cross line will include a 25% Wettable Powder, a 4% Dust, and a 50% Emulsion, and we will probably have a household package of less than ten-ounce size. I know that the Chipman Chemical Company will also stock Malathion products, and I expect that there will be other brands on the local markets. Dr. Cooper, of the American Cyanamid Company, gave a paper on this material last year to this Society, and I will not therefore do more than outline the uses for which we are recommending it this year.

For tree fruits it will provide effective control of most mites and all aphids. It is reported to be extremely effective against spider mites such as European red mite, two-spotted mite, and the clover mite.

For vegetables we recommend it for the control of aphids, mites if applicable, potato leafhopper, and onion thrips.

For ornamentals, it is effective for the control of spider mites, aphids, whitefly, and mealybugs. It is also recommended for the control of scale insects of ornamentals.

The other need for which we see a large potential usage of Malathion, is for the control of flies and mosquitoes, particularly where these are resistant or semi-resistant to other insecticides. However, its use is not yet recommended in homes or living quarters.

Malathion can be truly classified as a general purpose insecticide, for its range of control is extremely wide. It will apparently control all the insects controlled by DDT plus a number not controlled by DDT, but of course, does not have the residual qualities. This may be a blessing in disguise, which will prevent the development of resistance to Malathion.

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CONTROL OF SOIL-INHABITING INSECTS

W. Fox
Chipman Chemicals Ltd., Winnipeg, Manitoba.

Cutworms, wireworms and root maggots are three of the most troublesome soil-inhabiting insects, and only recently have more or less satisfactory chemical treatments been developed for their control. Ants, root weevils, tuber flea beetles, white grubs, nematodes, termites, bulb flies and carrot rust flies are also occasionally injurious. Table I indicates some of the treatments recommended for the control of various soil insects.

TABLE I

RECOMMENDED TREATMENTS* FOR VARIOUS SOIL-INHABITING INSECTS

	Treatment	Aldrin	BHC	Chlordane	DDT	D-D	Dieldrin	EDB	Heptachlor	Toxaphene
Ants	Soil	2½ lb.	2½ lb.	2½ lb.			2½ lb.		2½ lb.	
Carrot rust fly	Soil	5 lb.								
Cutworms	Soil	1 lb.		8 lb.						2 lb.
Onion maggot, Cabbage maggot	Soil	4 lb.		10 lb.					5 lb.	
Onion maggot	Seed						½ oz.			
Turnip maggot	Soil	6 lb.							5 lb.	
Seed corn maggot	Seed	¼ oz.					¼ oz.			
Nematodes	Soil					90 gal		60 gal		
Narcissus bulb fly	Soil	1½ lb.	1 lb.				3 lb.		3 lb.	
Root weevils	Soil	5 lb.								
Sod webworms	Soil	5 lb.					5 lb.			
Tuber flea beetles	Soil	4 lb.					4 lb.			
White grubs	Soil	5 lb.	5 lb.	10 lb.	25 lb.		6 lb.		5 lb.	
Wireworms	Soil	5 lb.	1 lb.	10 lb.	40 lb.	50 gal	5 lb.	20 gal	4 lb.	
Wireworms	Seed	1 oz.	1 oz.				1 oz.			
Longevity - Years		2	3	3	5	0	3	0	2	3

*Weights and volumes are of actual material per acre.

Insecticidal-Fertilizer Mixtures

Since only one application is necessary such mixtures offer an economic advantage. One difficulty is the lack of equipment for proper blending. In the U.S.A., certain of the States have regulations prohibiting such mixtures. The registration and administration of regulations concerning these mixtures also impose certain difficulties.

Formulations

Except for the soil fumigants such as D-D, EDB and MB which are liquid, the other insecticides are available as dusts, wettable powders and emulsifiable concentrates.

Application

Dusters (hand and field), sprayers (hand and field), also watering cans. Efficient seed-treaters are required for application of insecticidal seed dressings.

Mixing with the soil

Thorough mixing is most important, especially with chemicals of low volatility. The mixing, in most cases, should immediately follow the application.

Tillage implements, such as the one-way or the rototiller, or, if necessary, the disc harrow, do a much more thorough job of mixing than plows and cultivators. Harrows may be used for very shallow mixing. For small scale applications, the spade or fork is usually satisfactory.

Granular formulations

These overcome both drift loss and loss by adherence to vegetation. They can be easily applied by standard aircraft or fertilizer equipment. They can be mixed readily with fertilizers where required.

Off-flavor

Unfortunately, one of the most effective soil insecticides BHC (Lindane) is notorious for causing off-flavor. Chlordane has been also reported to have caused off-flavor in Canada and the U.S. to potatoes.

Phytocidal effects

High applications of most of the soil insecticides cause injury to seeds and plants. Some plants are more sensitive than others. Efficient rates and distribution in the soil must be carefully observed.

Residual effects

Some insecticides, such as DDT and dieldrin, have a relatively long life in the soil which is advantageous in preventing reinfestation of some insects for a number of years.

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Dr. W.R. Allen presented a report from notes made while attending the Ninth Annual Conference of the North Central Branch of the Entomological Society of America. These notes are very pertinent to work being conducted along similar lines in Manitoba, and because of this and the interest shown by members of the Entomological Society of Manitoba in Dr. Allen's report, it is hereby reproduced in full.

REPORT ON NINTH ANNUAL CONFERENCE NORTH CENTRAL BRANCH OF THE ENTOMOLOGICAL SOCIETY OF AMERICA

W.R. Allen
Entomology Laboratory, Brandon, Manitoba

Field Crop Insects

With the recent reorganization of the Entomology Research Branch of the United States Department of Agriculture a national survey of corn insect problems and research was completed. This survey showed that the lines of work most needed were research on soil insects, plant resistance, biological control, life histories, migration, and insecticidal control. The reorganized program is taking into consideration several of these requirements.

F.G. Holdaway of the University of Minnesota reported on the set-up of the regional project on corn borer. The aim of the project is to determine the factors operating, and the manner of their operation, in bringing about the fluctuations in abundance of the corn borer. The study will encompass the relationship of weather, biotic factors, genetic characteristics, and agronomic procedures as they influence the abundance of corn borer. Some information has been obtained for the period from 1948 to 1951 on how the level of abundance can vary during each season of the year. It was stated that it will probably be necessary to understand these seasonal changes in relation to the abundance recorded for each year. Preliminary conclusions drawn from all cooperating agencies have indicated, in 1953, that there are marked differences between States; for instance, the losses in yield per borer per stalk are different in all States and it has been tentatively concluded that the losses per borer per stalk are dependent on factors other than, and in addition to, the number of borers present.

It is notable that there was considerable interest in soil-infesting insects. The difficulties in completing even an extensive type of survey (13 fields in two States) were discussed by R.A. Blanchard, Entomology Research Branch, United States Department of Agriculture. Such a survey is indeed formidable when an attempt is made to recover all of the soil-inhabiting insects that may be found. The population estimated for minute forms gives a figure of about 2-1/2 billion per acre. It was concluded that not sufficient soil insect surveys have been made to evaluate their worth. It is considered that the underground environment should be better understood and something should be known about total effect of subsoil environment on control measures applied for specific insects.

Another approach to the influence that soil-inhabiting insects have on crop yield was presented by J.H. Bigger. In this study, portions of fields were treated with the insecticide aldrin and portions were left untreated. Of 60 fields examined, half of them showed benefit from the soil treatment. This resulted in an increase in plant population, increased plant height, accelerated tasseling, reduced lodging, and increased yield. For instance, in 95 fields the yield in the treated fields was increased 10 per cent over the untreated fields, and this increase apparently ranged in some cases as high as 65 per cent. As very few of these fields were materially damaged by such insects as rootworm, it seems that the response may be attributed to a partial removal of insects present.

At Minnesota, L.K. Cutkomp concluded that, in general, soil insect problems on corn and small grains are spotty in the State and perhaps seem less striking in terms of economic damage than many other areas of the northern central States. This, in his view, makes the preparation of wise recommendations for control of these soil-infesting pests somewhat difficult.

Discussing seed treatments for the control of soil insects, J.W. Apple of the University of Wisconsin stated that about 50,000 acres of sweet corn, or about 10 per cent of the acreage devoted to sweet corn in the United States, were treated in 1953. He pointed out that for sweet corn the seed is treated with insecticide commercially by the seedsman prior to planting. This is not so in the case of dent corn, and he pointed out that a great deal of difficulty was encountered because the farmers treated the seed improperly by trying to mix the insecticide with seed in the hopper at seeding time.

In a Wisconsin test against Limonius wireworms, good protection of dent corn was obtained with lindane (1 oz. per bushel) and dieldrin (2 oz. per bushel) as seed treatments, while 1 oz. of lindane, 2 oz. of dieldrin, heptachlor or aldrin to 100 pounds of oat seed provided good protection from a light infestation of Agriotes.

It has been found in Wisconsin that seed or seedling injury is not accentuated by storing lindane or dieldrin treated seed for as much as 22 months under normal room conditions. With 4 oz. of lindane a stand was reduced 25 to 40 per cent in field plots on mineral soil. It has been found that storage of the treated seed does not increase this damage.

Plant injury was less with wettable powder formulations than when emulsion concentrates were used.

J.T. Medler, discussing forage production, stated that there was not much point in treating alfalfa with insecticides before a first crop of hay is cut, because in most years a good tonnage is easily obtained. In relation to seed production he stated there are many factors, such as variety difference, winter hardiness, the influence of cutting schedules, fertilizers, and trace elements, that may produce very large differences in seed yield. In his opinion, therefore, it would be very difficult to evaluate the influence of crop treatment on seed yield.

B.A. Haws of Minnesota reported on sweet clover insects. A brief review of the literature showed that the pests of sweet clover, other than the sweetclover weevil, were relatively minor. Good sweetclover weevil control was obtained with both ground and air applications of the following quantities of actual insecticide per acre: heptachlor or dieldrin, 1/2 pound; aldrin, 1/2 to 3/4 lb.; toxaphene or chlordane, 2 to 3 lb.; DDT, 2 lb. These insecticides were rated on the basis of the amount of weevil damage on 100 leaves selected at random.

It was pointed out by Allen that, in Manitoba, dieldrin or heptachlor applied at the rate of 1/2 lb. per acre when the seedlings are emerging, significantly increased the stand of plants and that the dry weight per plant was also significantly increased.

Pollinating Insects

R.J. Walstrom led a discussion on pollination and seed production of legumes. He enumerated the following approaches that are being followed.

1. An attempt to increase the population of native pollinators by providing nesting areas, or domiciles in the case of Bombus species.

   Several workers were not convinced that the population of native pollinators had been greatly depleted by modern agronomic practices, but it was stated that animal predators are an important factor in destroying the nests that may be uncovered in legume crops that are grown for short periods.

2. The possibility of breeding honey bees for specific pollination jobs has not been attempted.

   According to the Russian workers, some races of bees are more adaptable to different climates, the Caucasian race doing better in northern areas while the Italian bee is better under warmer conditions.

3. Breeding a red clover to produce shorter pollen tubes has been an approach that was dropped because undesirable agronomic characteristics of the clover were produced and seed production was poor from these varieties.

4. The manipulation of honey bee colonies and movement into fields for short periods of time is being extensively studied.

   Recent work has shown that red clover is well pollinated up to 400 feet from the hive. The effect appears to be less concentrated where alfalfa is pollinated.

E.B. Montgomery, Indiana, observed that the Europeans first attempted to domicile bumble bees in 1880, and that Sladen in 1912 was able to establish a colony. He felt, however, that the method may not be entirely dependable because in one year 60 to 70 per cent acceptance may be obtained while in the following year results may be negligible.

The following methods were suggested for studying the activity of bumble bees in relation to pollination, but it was noted that there was no unanimity of opinion among the various workers as to which method would be best.

1. The observation method, in which the worker depends almost entirely upon his personal judgment and interpretation.

2. The bumble bees may be collected by sweeping, which permits the differentiation of species but does not permit the notation of pollination activities.

3. A unit area may be observed for a specific time. Insects may be collected for determination of species or pollen load.

4. It may also be possible, when domiciles are used, to base the activity on the collection of pollen.

It was observed by various workers that many factors, including time and temperature, development of the crop, and species of bee, would probably make unreliable any correlation between bee population observed at various times and seed yields.

<u>Vegetable Insects</u>

Reporting experiments in seed treatment for control of the onion maggot, <u>Hylemya antiqua</u> (Meig.), conducted in Minnesota during 1952 and 1953, A.G. Peterson stated:

"Pelleting onion seeds with either four ounces of 25% heptachlor, 2.5 ounces of 40% aldrin, or two ounces of 50% dieldrin and four ounces of 50% thiram per pound of seed with 3 to 3.5 ounces of 4% methyl cellulose as a sticker gave effective control of the onion maggot from planting until harvest. Yields of green bunching onions and mature onions were nearly doubled in some trials. Pelleting seed resulted in significantly less late-season injury in one of our experiments than broadcast soil treatments."

"Dry mixes of two ounces 75% aldrin or two ounces 50% dieldrin and two ounces of thiram per pound of seed without a sticker also gave excellent control of maggots; however, the limited amount of thiram that can be applied in this way may not be adequate for control of smut when low seeding rates of three to five pounds per acre are used.

"Seed treatments gave an effective control of onion maggot and as high yields as a broadcast soil application of heptachlor applied at 4.5 pounds actual heptachlor per acre. Both seed treatments and broadcast soil applications were more effective than post-emergence sprays in these experiments."

<u>General Session on Economic Entomology</u>

G.C. Decker, Illinois, gave an impressive address on methods of making estimates on insect losses. In his opinion there are many ways in which data may be obtained to provide estimates of insect damage, and by the use of appropriate statistical methods and sound logic these estimates may be made reasonably accurate. Most of this material is outlined in a paper by the same author in Agricultural Chemicals, Volume 9, No. 2, page 36, February, 1954.

B.A. Porter showed how recent developments in the use of micro-organisms that produce insect diseases have made commercial insect control feasible. In his opinion, the diseases of each insect should be surveyed, using modern micro-biological methods, so that this method of control may be exploited to greater use.

C.C. Roan pointed out the precautions that should be taken before insects that show apparent resistance to insecticides in the field can be said to have true resistance to the insecticides that have been used.

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The last item on April 2 was a tour of the Entomology Laboratory, Brandon. Members of the staff were available to explain or demonstrate the very fine exhibits listed below.

Spray Equipment

- Spray application tower

Sunflower Insects

- Mounted specimens of insects injurious to sunflowers
- Mounted specimens of parasites of some of the insects injurious to sunflowers
- Charts depicting the life history of *Phalonia hospes* Wlshm. and *Strauzia longipennis* (Wied.)
- Photographs of immature stages of insects injurious to sunflowers and their damage to plants

Grasshoppers

- Mounted specimens and photographs of the three economic species of grasshoppers and photographs of damage to plants by these species
- Mounted specimens and photographs of grasshopper egg predators

Legume Pollinators

- Mounted specimens of the predominant species of *Megachile*
- Photographs of nests of insects inhabiting punky poplar logs
- Photographs of developmental stages of two parasites of *Megachile* -- Bombyliidae and Chalcididae
- Rearing dishes containing *Megachile* and some of their parasites

Photographic

An exhibit was made of the new model (1953) Exakta VX camera synchronized for electronic flash with the Heiland Strobonar V. The camera was fitted with Novoflex bellows and extension tubes for close-up pictures of insects. This equipment is particularly well adapted for photographing living insects, as the very brilliant flash operating at 1/2,000 second permits the smallest apertures to be used, giving maximum depth of focus, and freezes all motion. Carbon dioxide gas is used to quieten very active insects.

Older photographic equipment was also demonstrated. This consisted of a pre-war Korelle reflex camera fitted with extension tubes. It was mounted on a spring-suspended table to minimize vibrations. Illumination was with daylight photoflood lamps shielded with heat-absorbing glass. Focussing was obtained by moving the object with the rack and pinion of a dissecting microscope. On account of the long exposures, this equipment is not suited for living insects but is satisfactory for dead specimens.

Reflex copying printing box, for copying articles from magazines, and resultant prints and negatives were also on display.

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The first item on the morning of April 3 was a panel discussion on Insect Pollinators. Mr. D.R. Robertson, Provincial Apiarist of the Province of Manitoba, is to be commended for the very excellent manner in which he carried out his duties as chairman of the panel. Members were H.P. Richardson, Fruit Insect Laboratory, Morden, Man., B. Furgala, Department of Entomology, The University of Manitoba, and C.F. Barrett and T.V. Cole of the Entomology Laboratory, Brandon.

The panel was conducted by a method of question and answer, with various items inserted at appropriate points by the Chairman; but contents of the various reports are given here in whole rather than in the order in which questions were answered.

CHAIRMAN'S REMARKS ON POLLINATION DISCUSSION

D.R. Robertson,
Provincial Apiarist, Province of Manitoba.

Modern agricultural trends have in some instances resulted in a noticeable upset in the balance of nature. Farm mechanization has made it advisable to increase the size of fields, with the resultant removal of fence rows and reduction of woodlots. Tremendous advances in the field of agricultural chemicals and in the development of equipment for their dispersal have resulted in the much more general use of insecticides on many crops. One group of beneficial insects that has suffered directly through these practices is the wild pollinators. With the destruction of their nesting sites and the reduction of their numbers through the application of poisonous sprays or dusts, their populations have gradually decreased in recent years. Thus the farmer has been forced to rely more and more upon the honey bee for the pollination of many of his crops.

Pollinization is the fertilization of flowers which are the reproductive structures of plants. The structures consist of pollen bearing stamens (the male organs) and carpels (female organs) containing pollen-catching stigmas and ovules, the plant's eggs. A union of the pollen with the ovules produces seeds. Most flowers with which we are familiar have both organs, male and female, in the same flower. The majority of these flowers cannot pollinate themselves, however, and require pollen from other individuals of the same species. In the long course of evolution the flowers of plants have become adapted through natural selection to the characteristics of their pollinators. Thus the various species of flower owe their structure, shape, color, odor and other attributes to the particular agents that cross pollinate them. To beekeepers, the bee flowers are of chief concern. These flowers are largely blue, or yellow, or some mixture of these two colors, and experiments show that vision of bees is mainly in this part of the spectrum. They are color blind to red. Likewise bee flowers have specific odors distinctive to bees and are always open in the daytime but often closed at night.

Bee flowers secrete nectar from special glands which often lie at the base of the flower. Bees with their long tongues can reach the nectar, but most other insects cannot. As the bee takes the nectar, its body hairs pick up pollen from the flower's stamens. When the bee has finished working on one flower it flies rapidly on to another. Bees have an instinct to confine their attention to flowers of one species at a time, therefore insuring the transfer of pollen to the right species of plant.

Inserts during reports

In the Annapolis Valley, Nova Scotia, the use of honey bees with pollen inserts resulted in a production of 300 barrels of Delicious apples on fifty-five trees in a solid block planting as compared to 25 barrels previously produced.

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The results obtained with the use of honey bees for alfalfa seed production at Regina, Saskatchewan, in 1952 are as follows:

Colony Rate	Yield (Average of duplicate 4 acre plots)
5 colonies per acre	195 lbs.
3 colonies per acre	146 lbs.
1 colony per acre	82 lbs.
0 colonies per acre	84 lbs.

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Data were obtained on the tripping rate of honey bees foraging on a block of alfalfa in the Ottawa area in 1953. A total of 6,372 individual honey bees were observed visiting 14,449 florets. The tripping rate was 5.5 per cent as compared to 0.7 per cent in similar studies in 1952.

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An investigation of the range of flight of established foragers on ladino clover at the O.A.C., Guelph, Ontario, was carried out in 1953. Foraging honey bees on a given plot were dusted with fluorescent powder and the field was examined after dark with an ultra violet lamp. Initial tests indicated that it was most unusual to find traces of marked bee activity farther than 10 yards from the marking plot.

Similar tests were carried out on bumble bees on a red clover field. Although only a limited number of bumble bees were marked it was established that they may forage at least several hundred yards from the point of marking.

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The flight range of honey bees on red clover was determined at various distances from the colonies. Maximum pollination activity extended to a distance of 730 feet from the hive. From this point on the population decreased sharply. Seed yield was at its maximum where the pollinator activity was greatest and decreased as the population of foragers decreased. These results were obtained at Ottawa and correspond remarkably well with the results obtained at the Apiculture Department, O.A.C., Guelph.

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Sweet Clover and 2,4-D

Mr. P. Pankiw, Apiculturist, now at Beaverlodge, Alberta, last year carried out some experimental work on the effect of 2,4-D drift on sweet clover bloom and seed setting.

To get an idea of extent of drift, the investigator sprayed a square rod plot with 2,4-D at the rate of 4 ounces per acre. Wind velocity at the time was 5 to 7 miles per hour and vapor drift was detected at a distance of 80 yards downwind. Seed yield near the sprayed area was substantially reduced. At thirty feet from the sprayed area 185 pounds per acre was the yield obtained, as compared to a check yield of 400 pounds per acre.

At 1/4 ounce application, effects on plants were readily seen. Flowering was delayed 2 weeks, the amount of bloom reduced and seed yield was down considerably. Even at rates as low as 1/20 ounce (about 1% of recommended field rates) bloom was delayed about 3 days and seed yield reduced to 250 pounds compared with the check of 400 pounds per acre.

The need for caution in the use of 2,4-D is obvious. Beekeepers would be well to give consideration to the use of 2,4-D when locating their apiary. These tests show what can happen to seed yields, but still more important is that even a trace of 2,4-D may be sufficient to retard or stop nectar secretion. No doubt nectar secretion and seed yield go hand in hand, therefore, this experiment proves what can happen to a honey crop.

INSECT POLLINATORS OF FRUITS

H.P. Richardson,
Fruit Insect Laboratory,
Morden, Manitoba.

Fruit trees, excepting grapes and most of the nuts, are dependent under natural conditions on insects for pollination. Grapes and most of the nuts are dependent on wind for pollination. Fruit trees show the characteristics of trees dependent on insects for pollination. Their flowers are large and showy, they exude a fragrance, and they secrete nectar presumably for the purpose of attracting insects. Besides these facts, their pollen is heavy and gummy, which prevents it from being blown about by the wind. Insects, especially the bees, are dependent on the pollen and nectar of flowers as their sole source of food. When an insect enters a flower for nectar or pollen it usually completes the process required of it, i.e. pollination. This interdependency of tree and insect is highly specialized in some instances, a striking example of which is the fig and the fig wasp. The cultivated Smyrna fig with imperfect flowers is dependent on the pollen of the perfect-flowered caprifig. The process of pollination is dependent on the fig wasp which develops only in the caprifig.

In most of our apples, pears, peaches, cherries and some plums the dependency of the tree on insects for pollination is more complicated than just the matter of transfer of pollen from stamen to pistil. Many of the above fruits are self-unfruitful, i.e. their own pollen is useless for their own fertilization. Pollen from a different variety of the same species is essential for effective pollination. The value of insects is greatly enhanced when growers organize their orchards to provide the effective kinds of pollen at the appropriate time.

Insect pollinators of fruits

I have divided the pollinators into two groups:

1. Native insects;
2. Honey bees.

1. Native Insects

When the first settlers arrived in America they found no honey bees, but there were flowers, fruits, and vegetables in forests and fields. Furthermore they were able to produce native American crops of many kinds for more than 50 years before honey bees were established. Native insects were still abundant enough to pollinate the native and introduced insect-pollinated plants. So long as cultivated areas were composed of small fields surrounded by wild land, native insects were able to handle pollination without the help of foreign labour. Inevitably however as the plow turned under large tracts of sod the native beneficial insects began to disappear. At the same time available pollinators were spread over the ever enlarging orchards and fields. Of the pollinators the order Hymenoptera, excluding the honey bee, is by far the most important order of insects in pollination of commercial crops. Flies probably rank next, although moths which are very abundant may do more pollination than they are given credit for. Beetles and thrips also do considerable pollination. In fact any of the thousands of insects that visit flowers purposely or accidentally can be agents for carrying pollen grains from the anther to the stigma.

Of the native bees, the bumble bees, leaf cutting bees, alkali bees, and carpenter bees which are specifically adapted for gathering nectar and pollen are probably the most important pollinators. These wild bees supplement the activities of honey bees in the pollination of most of the fruits, but honey bees are at least as efficient and only need to be supplied in reasonable numbers to do the job. The supplementary role of the wild bees is very important in some areas such as New England and Eastern Canada where weather unfavorable for honey bee activity is customary during the apple blossoming season. When they are present bumble bees and a few other species active at cooler temperatures are more satisfactory. In some locations, notably pear orchards, syrphid flies and blow flies are important pollinators. This is due to the low percentage of sugar in pear nectar which makes it unattractive to bees.

One of the main disadvantages of the wild bees is that in the early spring when most of the fruit trees flower they are not available in sufficient numbers. The honey bees are available in large numbers at all times of the year.

2. Honey bees

The honey bee is considered the most important pollinator of fruit trees. Its existence depends on pollen and nectar from plants. The value of the honey bee lies in its colonial habit throughout the year and therefore it is available in force at any season. Semi-domestication in man-made hives makes it available for placement wherever needed for pollination. Another important feature of the honey bee is that it visits only one kind of plant to collect either pollen or nectar -- a fortunate provision of nature owing to species incompatibility.

The honey bee has its limitations also, one of which is its preference for nectar with a high sugar content. It was noted in California that when the humidity was high the sugar content of the nectar of oranges dropped below the normal of 16%, the bees lost interest in the orange flowers and collected from mustard which had a higher sugar content. When the day was dry enough to evaporate the moisture and the sugar content of the nectar rose to 25%, the bees returned to the orange flowers. In a dry day when the sugar content rose to 40% the blossoms were sucked dry.

When almonds and apricots are grown together bees will collect from almonds as the sugar content of the nectar is 35% while apricot nectar contains 10% sugar.

In eight varieties of plums grown together at Davis, California, the nectar had average sugar contents ranging from 10-28%. Three other varieties had no collectible nectar.

The pear produces small amounts of nectar low in sugar. In pear orchards the honey bee is not considered an efficient pollinizer. The syrphids and the blow flies are quite efficient as pollinizers in pear orchards.

The quantity and type of pollen produced by plants also affect the value of honey bees. Some pollen is too scanty, too sticky, or too dry to attract the bees.

It is the practice in some orchard areas in the United States and probably in Canada to bring in hives of bees to do the pollinating. Often these bees are rented from commercial beekeepers. In most instances the beekeeper gets no honey from the operation as orchards are more important for their abundant supply of pollen than for honey. Also almond honey is bitter, and prune honey ferments readily. In some circumstances the beekeepers are forced to feed the bees.

The use of honey bees for pollination is considered very worthwhile. In a Michigan apple orchard where the largest crop in 8 years had been 1,500 bushels, 40 colonies of bees were introduced in 1927 and 5,200 bushels of apples were harvested. In a cherry orchard because of the use of honey bees the owner made an estimated 10,000 dollars more from his crop than he would have without the bees.

In another instance an 87 acre, 22 year old apple orchard had never produced a profitable crop, 480 bushels being the highest yield. Thirty colonies of bees were moved in and the crop jumped to 1,580 barrels in 1930, 1,400 in 1931 and 2,000 barrels in 1932. Another orchard 16 years old, which had never produced more than 18 bushels, yielded 1,000 bushels when an apiary was established near by. A number of hives of bees were placed on one side of a peach orchard. It resulted in a full crop on one side of the orchard. The following year the bees were dispersed throughout the orchard and a full crop was obtained.

In the cranberry industry in North Eastern United States bumble bees and honey bees are the chief agents of pollination, but as the former is not always abundant the growers resort to honey bees. Without adequate pollination cranberries are apt to mature over a long period.

Pollinators and Insecticides

Even in the process of pollination man is usurping the function of the bee. This is particularly true in fruit orchards, especially apple orchards of the United States. The growers have exterminated the native insects by their intensive spray programs and discouraged beekeepers by similar methods. As a consequence they have been forced to hand-pollinate their trees. They have found that hand-pollination is more profitable than depending on the few remaining insects, especially as these few insects are affected by the weather.

It is generally thought that artificial pollination should be considered as a temporary expedient to be used only until natural means can be established. It is considered a dangerous practice to attempt to reduce thinning costs by setting a complete crop by hand as considerable fruit may be set by natural means.

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LEGUME POLLINATORS

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The most important pollinators of alfalfa are leaf-cutter bees, Megachile spp., and bumble bees, Bombus spp. Bees of the genus Megachile most numerous in the Wanless area are M. frigida Sm., M. inermis Prov., and M. relativa Cress. The highest count of Megachile (all species) on alfalfa during July and August was 0.06 per square yard. Twelve species of Bombus were collected at Wanless in 1953. The five species frequently encountered were B. terricola K., B. vagans F. Smith, B. frigidus F. Smith, B. rufocinctus Cress., and B. ternarius Say. The average number of bumble bees (all species) on alfalfa during July and August was 0.3 per square yard.

It is hoped to increase the wild bee population in the Wanless area by improving the bee habitat through land management, and by establishing colonies of bumble bees in artificial domiciles in desired locations. Land has been cleared only on the higher, well-drained areas. The fields are small, narrow, and irregular, with an average of 25 to 40 acres tilled per quarter section. To provide nesting sites for the log-inhabiting leaf-cutter bees, logs cleared from the fields were piled in windrows along the edges, and also along the centre of those fields that are over 100 yards wide. A cleared strip of land, 10 yards wide, was left beside the log windrows to provide nesting sites for soil-inhabiting bees.

In 1953, spring emergent bumble bee queens (mainly B. terricola) were caught and placed singly in 50 artificial domiciles. These queens were cared for in the domiciles until first brood emerged. These domiciles were then to be moved to locations around the alfalfa fields so that resulting fall queens would hibernate nearby and start colonies in the vicinity in the following spring.

Leaf-cutter bees are more efficient trippers of alfalfa florets than bumble bees. During a total of 789 seconds of observation on tripping ability of Megachile spp., the number of florets tripped per minute ranged between 12.0 and 22.5 with an average of 17.0 for nine individuals considered. During a total of 1285 seconds of observation of B. terricola, the number of florets tripped per minute ranged between 0.0 and 19.2 for individual bees with an average of 7.8 for ten bees observed.

Though the percentage of florets tripped of those visited by bumble bees was considerably lower than that of leaf-cutters, the much larger number of bumble bees present in the alfalfa fields made them an important group of pollinators.

From one season's observations, the main factors limiting the abundance of Megachile appeared to be: (1) suitability of habitat, (2) availability of food, and (3) mortality of immature bees. There was little indication of the presence of leaf-cutter bees in heavily forested areas or in areas that had been cleared for only one year. Nests and adults were readily located along the edges of old clearings where logs had been piled in exposed positions. Few nectar-secreting plants grow where forest prevails, while in clearings food is provided by fireweed, volunteer Dutch clover, and other plants.

The mortality of immature Megachile spp. was heavy. Of 92 cells examined, only 15 contained healthy larvae. Thirty-nine cells contained parasites, including one species of each of Phoridae, Bombyliidae, Chalcididae, Braconidae, a species of mite, and a species of nematode. Thirty-eight died of other causes suspected to be (1) parasites that had matured and left or had died, (2) mould, (3) disease, (4) desiccation, and (5) egg infertility.

SUNFLOWER POLLINATION

C.F. Barrett,
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Entomology Laboratory,
Brandon, Man.

Flowering processes

In a study of insect pollination of sunflowers it is important to know the flowering processes of the plant. The sunflower florets are grouped into a composite head and each floret is perfect. Flowering begins at the periphery of the head and progresses inward at the rate of 1 to 4 rows per day.

Data collected by Putt (8) show that for a given head flowering is complete in about 1 week from the date of opening of the ray flowers. He found that on the morning on which a given floret opens, its anther tube reaches its full extension by about 7.00 a.m. "Immediately after this stage is reached the pollen sacs discharge their pollen inside the anther tube ...." "This stage is followed by an elongation of the lower portion of the style which pushes the two-lobed stigma up through the anther tube." "About 5.00 p.m. the tips of the stigma lobes begin to appear ...." "By the following morning the stigma lobes are fully emerged and the receptive surfaces exposed for pollination."

In an examination of 216 stigmas, Putt (9) found that germination of pollen grains occurred only upon the inner surfaces of the stigma. This accounts in part for the fact that stigmas are not affected when moving up through the pollen mass in the anther tube.

Stigma and pollen viability

By means of emasculation, Putt (9) was able to study duration of stigma and pollen viability. In a 3-year study the average percentage seed setting for stigmas 1, 4, 5, and 9 days old was 74.4, 63.0, 43.3, and 9.6 per cent, respectively. The duration of pollen viability showed no decrease over a period of 6 days when stored in cork-stoppered vials, and this same pollen carried over for one year was not viable. This is in contrast to a finding of Arnoldova (2) who claims sunflower pollen stored for a period of 11 months gave fair seed setting. In another test on the duration of pollen viability, Putt (9) showed that 15-day-old pollen was as viable as 2-day-old pollen.

Self fertility

In a test of bagging materials for head isolation, Hamilton (3) found self fertility to range from 15 to 50 per cent under a large manila paper bag. Putt (9) found that selfing in bagged heads was increased from an average of 14.38 per cent to an average of 29.27 per cent by manipulating the heads with a cotton batting brush.

It is evident that selfing produces little seed, and as sunflower pollen is wind borne only to a small degree, bees and other insect pollinators appear to be of primary importance in pollination.

Bees as pollinators

Although honey bees are generally good pollinators and are easily reared and handled in large numbers, they are not readily induced to pollinate specific crops, such as alfalfa, red clover, and sunflower. The quantity and sugar content of nectar and the ease with which the nectar of a plant is gathered are important factors in determining which crops bees will visit. This is a problem of competing bloom and is vastly complicated by the wide foraging range of bees. This competition may be overcome by isolation, overpopulation, or bee conditioning. However, none of these methods appears to be very practical on the prairies.

Crop isolation.- Isolation of a specific crop is difficult. It is generally assumed that bees can forage up to 3 miles, which would allow them to cover a township. This represents nearly 25,000 acres, of which about 800 acres are road allowance. However, an approach to isolation can be obtained through control of uncultivated bloom, through selection of other crops that bloom during different periods, and through selection of sites where natural barriers will limit the foraging range of the bee.

Overpopulation.- Overpopulation of areas will force bees to concentrate on pasture that they normally would ignore. However, if there is insufficient nectar and pollen in the bloom, overpopulation will not help.

Bee conditioning.- Palmer-Jones and Smellie (4) have reviewed methods used by von Frisch and by Russian investigators to determine the value of bee conditioning as a means of controlling pollination. There are three methods available:

(1) "Outdoor feeding on the flowers: . . . (This) method is used when honey yield is the main object .... Weakly scented blossoms give good results provided the bees are fed the conditioning mixture in the open."

(2) "Aromatic substances on flowers and inside hives: Visitation of weakly scented flowers can be increased by putting an artificial aromatic substance in a sugar solution in the hive and then spraying the flowers with the same substance."

(3) "Feeding of syrup inside hives: This method, which requires about 1/2 lb. of syrup per hive nightly, is used for increasing pollination. The bees should be presented with fresh blossoms each day to ensure continuous flights to a specific blossom. Large scale experiments in Germany showed that the method caused an increase in the beekeeper's surplus, in some cases considerable, with red clover, lucerne, buckwheat, onions, and some wild nectar plants. Bees were observed to work the plants more energetically, and an increase of seed yield was proved. In Russia seed yield was reported to increase."

Von Frisch found that feeding an infusion of the crop bloom was successful where the florets used had a strong aroma. To prepare the infusion, 1 pint of water, 1-1/4 lbs. of sugar, and, with red clover, about 150 flowers are allowed to infuse for about 5 hours before it is fed to the bees. A Russian worker trained bees to concentrate their flights on vetch, sunflower, and lucerne by the infusion method. Increases in bee visitation of up to 30 times and increases in seed set of up to 3 times were reported.

Palmer-Jones and Smellie (4) state, "It is apparent that bees can be directed or conditioned to a scent ...."

<u>Other investigations</u>

In Russia sunflower pollination, especially by honey bees, is receiving much attention. Akin'Shin (1), Arnoldova (2), Lopatnikov (5), Luttso (6 and 7), and Shimanskii (10) are some of the Russian workers investigating sunflower pollination.

At Brandon, Manitoba, cage tests in 1951 showed that honey bees were effective pollinators of sunflowers and increased seed yield. A preliminary field test in 1953 showed that competing bloom was more attractive than sunflowers to honey bees.

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THE EFFECT OF THE HONEY BEE, *Apis mellifera* (L.), ON THE SEED SET, YIELD AND HYBRIDIZATION OF THE CULTIVATED SUNFLOWER, *Helianthus annuus* L.

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Plot and field investigations were carried out in the sunflower growing area of Manitoba to determine the effect of populations of honey bees on sunflower seed set, yield and hybridization. The plot investigations were carried out in 1952 and 1953 at The University of Manitoba. The field experiments were carried out in 1953 in the Altona, Plum Coulee, Roland and Homewood areas.

The plot studies revealed that the per cent seed set and the yields of the open-pollinated plots were considerably higher than those of the mesh-bagged and kraft-bagged plots. These increases may be ascribed to the presence of the larger pollinating insects, particularly the honey bee, since the honey bee was by far the most numerous visitor of the larger pollinators.

The field experiments revealed that:

(1) Sunflowers can compete with buckwheat for honey bee attention. The data showed that between 36 and 62 per cent of the honey bees examined carried sunflower pollen.

(2) Sunflower seed yields are significantly decreased as the distance from the honey bee colonies is increased. Colonies should be placed in rows across the field about 300 to 400 yards apart beginning preferably on the east side of the field at the rate of approximately one colony per acre.

(3) Commercial crossing blocks populated with honey bees had approximately 87 to 92 per cent more hybrids than the unpopulated fields.

(4) There appears to be an increase in the oil content in the immediate first generation seed of the fields populated with honey bees.

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SEQUENTIAL SAMPLING OF INSECT POPULATIONS

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Before describing a sequential sampling scheme it is probably wise to offer a few words of introduction. There is one basic difference between conventional sampling, with a fixed sample size, and sequential sampling, with a variable sample size. In conventional sampling a decision is made that is based upon the data contained in the sample as a whole, while in sequential sampling a decision is made after each unit is drawn. Consequently, the sample size in sequential sampling varies with each sample drawn. On the average, however, the size of sample in sequential sampling is considerably smaller, for an equal degree of accuracy, than with a sample of fixed size. The saving in number of observations is often as great as fifty per cent.

To explain why this saving in number of observations may be obtained by the use of sequential sampling a brief outline of the principles behind the conventional and sequential sampling schemes is required. In ordinary sampling, with a fixed sample size, there are three variables involved, two of which are fixed in advance. These are: (a) n -- the sample size; and (b) α -- the probability of rejecting H_0 (the null hypothesis) when H_0 is true (Type I Error). The third variable is β, the probability that H_0 will be accepted when H_1 (the alternative hypothesis) is true (Type II Error). The power of the test is equal to $1-\beta$. The usual procedure in fixed sampling is to choose the values of n and α and then use the test that gives the best power for the hypothesis being tested, which can be seen to give the smallest β. With the conventional sampling scheme a sample is drawn and on the basis of the sample data a decision is made. The null hypothesis is either accepted or rejected at the α confidence level.

A different approach is used in sequential sampling. Instead of n and α being fixed, α and β are chosen in advance and n allowed to vary. The sample is drawn one at a time, and at each draw a decision is made. The H_0 may be accepted, rejected or no decision reached. If no decision is reached, the sampling is continued. If either of the other events occurs sampling is terminated.

Before a sequential sampling scheme can be applied to estimate the density of a given insect population something must be known about the type of distribution followed. Two common distributions are the Binomial and the Normal. The Binomial distribution applies to a series of individual observations from a discrete population, in which each observation may be placed in one of two mutually exclusive classes. The Normal distribution is a continuous distribution, but many discrete distributions approach normality as the sample size increases.

As an example of the Binomial distribution, consider the estimation of the ratio of oviposition sites to total shoots of the current season's growth for the larch sawfly, Pristiphora erichsonii (Htg.). This insect lays its eggs in the shoots of the current season's growth of tamarack, which often gives a characteristic curling to the shoots involved. The distribution of the oviposition sites in relation to total shoots appears to be random, so that the ratio of the two should follow the Binomial distribution if observations are taken one at a time. Before sampling starts it must be determined what decisions are to be made. Suppose it is decided to classify the ratio into the categories of light, medium or heavy. In order to do this, sufficient information from previous sampling must be available to decide what values of the ratio are to be classed as light, medium or heavy. These ratios will be different for different types of trees, but that aspect will not be discussed here.

Assuming that suitable values have been decided upon for the ratio, and suitable values chosen for the confidence levels α and β, a chart is set up as shown below.

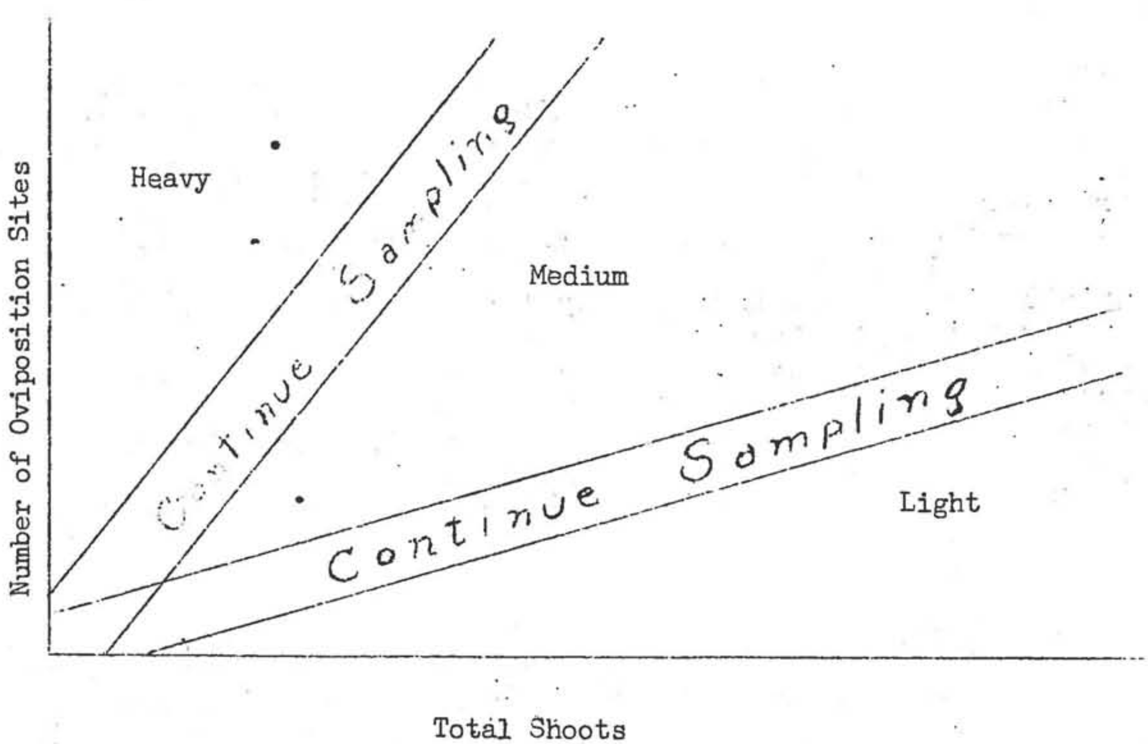

Fig. 1 - Sequential sampling chart for Binomial distribution

The actual sampling procedure is quite simple. Examine a shoot and determine whether or not it bears oviposition scars. Then plot a point on the chart. Examine another shoot and plot another point, etc. Sampling terminates when one of the points falls into a critical region. It is often more convenient to examine a group of shoots, say ten at a time, and then plot the results. This does not alter the character of the test, hence this procedure would usually be followed.

Suitable randomization techniques are required for the above test to be valid, but this aspect of the problem will not be discussed here.

As an example of the sequential sampling from a normally distributed population Stark's sequential sampling method for estimating population densities of the lodgepole needle miner[1] can be considered. He used the number of mined needles per five-year tip as the index of population density. The Chi-square test was applied to the data and indicated normality.

The rates of infestation, based on number of mines per tip, were grouped as follows:

1) light -- less than 5;
2) medium -- more than 15 but less than 25;
and 3) heavy -- over 35.

The chart is similar to that for the Binomial distribution, although, of course, different formulae were used in drawing the lines.

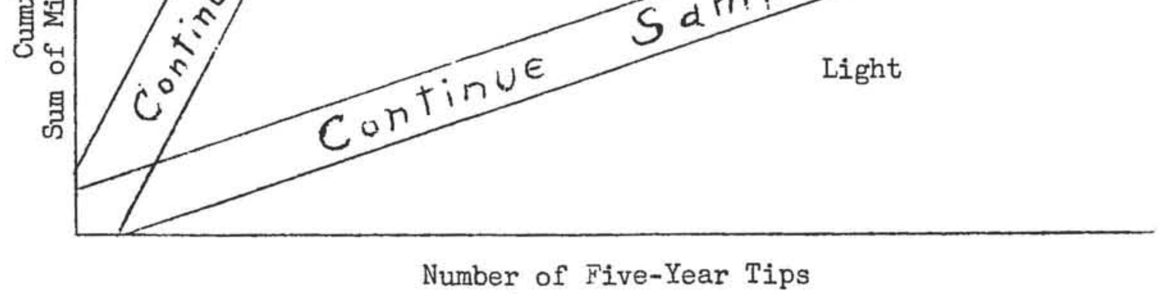

Fig. 2 - Sequential sampling chart for Normal distribution.

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[1]Stark, R.W. Sequential Sampling of the Lodgepole Needle Miner. Forestry Chronicle, Vol. 28, No. 2, pp. 57-60, 1952.

The principle in this case is exactly the same as with the Binomial, except that the number of samples is plotted against the cumulative sum of the samples instead of total number of observations against number defective in the case of the Binomial. Sampling is again terminated as soon as a point falls in one of the three critical regions.

Sequential sampling schemes have also been devised for:

1. Poisson distributions;
2. Negative Binomial distributions;
3. Negative Hypergeometric distributions.

However, for purposes of illustration, the two distributions already discussed should suffice.

In conclusion, the chief advantage of a sequential sampling scheme in estimating the density of insect populations is in the reduction of the sample size required for a given degree of accuracy. Insect populations are usually very variable. Consequently, a large sample is required for reasonably accurate estimates, if a conventional sampling scheme is used. If by using sequential sampling, the sample size can be reduced by an appreciable amount, without sacrificing accuracy, then such a saving can be very worthwhile.

THE ANNUAL MEETING

The Business Session

The business session of the 1954 Annual Meeting of the Society was convened in the Department of Entomology, The University of Manitoba, at 9:00 A.M., November 19, 1954. The President, Dr. A. J. Thorsteinson, presided.

The minutes of the spring meeting were read. It was moved by P. H. Westdal, seconded by T. V. Cole, that the minutes be adopted as read. CARRIED.

The Treasurer's report was read by G. L. Warren. The Society was reported as having no outstanding debts. Members were reminded that fees are payable in advance.

The Editor-Librarian's report was presented by A. G. Robinson. It included a summary of a meeting of the library committee on June 4, 1954, and a report on the sale of 50 copies of Volume 8 of the Proceedings. The meeting was informed that the Proceedings is now being sent to Entomological News and Biological Abstracts. Adoption of this report was moved by A. G. Robinson and seconded by J. Heron. CARRIED.

Professor A. V. Mitchener reported for the common names committee on a list forwarded to the Canadian committee on common names, and that he wished to be relieved as chairman of the local committee because he had been asked to be chairman of the Canadian Committee. The adoption of this report was moved by A. V. Mitchener and seconded by R. M. Prentice. CARRIED.

It was moved by R. R. Lejeune, and seconded by W. Turnock that the executive be directed to appoint a new committee on common names, and to name a chairman. CARRIED.

It was moved by A. G. Robinson, seconded by W. R. Allen, that the Editor-Librarian be permitted to present to new members, on joining the Society, copies of former volumes of the Proceedings, where surpluses exist.
CARRIED. Contrary - A. V. Mitchener.

On motion of W. R. Allen, seconded by A. G. Robinson, it was agreed that in future an Editorial Board of the Entomological Society of Manitoba be empowered to accept for publication in the Proceedings papers submitted by any person, but that preference be given to members of the Society. The purpose of this motion was to encourage publication of papers other than those presented at the spring and fall meetings of the Society. CARRIED.

It was moved by F. Birt, seconded by W. Ives, that the executive be directed to appoint an Editorial Board consisting of the Editor-Librarian as chairman and two others.
CARRIED.

On a motion by W. R. Allen, seconded by J. Heron, the executive was directed to investigate the matter of appointment of all present standing committees. CARRIED.

The President informed the meeting that the resolution regarding the mail ballot, forwarded by the Entomological Society of Manitoba, was passed at the annual meeting of the Entomological Society of Canada, November 1-3, 1954.

A nominating committee, composed of R. R. Lejeune, A. V. Mitchener and R. D. Bird, presented a slate of officers as follows:

President	F. L. Watters
Vice-President	G. L. Warren
Secretary	R. M. Prentice
Treasurer	T. V. Cole
Editor-Librarian	A. G. Robinson
Auditors	F. Birt and S. Pugh

The Chairman called for nominations from members present. It was moved by W. Romanow, seconded by W. R. Allen, that nominations cease. CARRIED.

The meeting was adjourned at 11:00 A. M.

Scientific Business

The scientific session of the annual meeting was held in the Department of Entomology, The University of Manitoba, on the afternoon of November 19, and on November 20.

An enjoyable smoker was held on the evening of November 19.

The scientific session opened with some timely remarks by the President emphasizing the occasion as the tenth anniversary of the Society. A welcome to members was extended by Dr. J. R. Weir, Dean of the Faculty of Agriculture and Home Economics, of The University of Manitoba.

Two films were shown on the afternoon of November 19, entitled Mites and Monsters, and Butterfly Botanists.

The Society is much indebted to Messrs. H. L. Seamans, R.H. Painter, J. B. Wallis and B. Hocking for presentation of papers which follow.

CHANGES IN ENTOMOLOGICAL RESEARCH IN WESTERN CANADA IN THE LAST DECADE (1944-1954)

by H. L. Seamans

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If one were to study the list of projects being carried on by the Entomology Division of the Canada Department of Agriculture and other institutions, he would not be impressed by the changes that have taken place in entomological research in Western Canada in the past ten years. To be sure, there are many new projects and a few new fields of research, but the lists do not indicate marked changes in methods of attack, techniques, or general program. However, the study of project outlines, reports, and published papers is exceedingly revealing. I do not think this is the time or the place to single out individuals or laboratories as having made the greatest contribution to these changes, but I want to show that changes have taken place and what I think are the factors responsible for them.

Throughout this discussion, I shall avoid the use of the word "fundamental" in discussing research. This word has been misused and misinterpreted and has finally taken on a meaning that tends to separate ivory tower laboratory research from research done in the field. In entomology, the location of the research is no criterion of its fundamentality.

The decade 1944-1954 can be looked upon as one of expansion. In 1944 we were still at war. Entomological research in Western Canada was restricted to the most pressing economic problems. Organizations were short-staffed, with many of the men in the armed services. Funds were limited; equipment was difficult to obtain; insecticides were in short supply; travel was restricted by gasolene rationing and field work was curtailed. However, 1944 was the beginning of a new era in entomological research and since then staffs and funds have increased and equipment has been greatly improved.

Effects of DDT on Entomological Research

Between 1942 and 1944, rumors were heard that the armed services were using a new and powerful insecticide for the control of house flies, mosquitoes, and body lice. The supplies were controlled by the armed services and none was available for experimental work. Rumor said that, when it became available, DDT would be the perfect insecticide, controlling all insects. Everyone wanted to get on the DDT band wagon, and Western Canadian entomologists were no exception. Biological studies were almost forgotten. Because any insect could be controlled with DDT, why bother to study the lives and loves of the bug?

The war ended in 1945 and entomological research took a new lease on life. Staff returned to work; new positions were created; funds were adequate; new equipment was procurable; and salaries became more reasonable. DDT became available for experimental use and soon turned out to be an exceptionally good insecticide, but not all-powerful.

The initial success of DDT stimulated the chemists to produce other organic compounds with value as insecticides. Some of these were deliberately compounded; others were the results of the search for chemicals of possible use in chemical warfare. With this flood of new materials, the entomologists were forced to conduct investigations to determine the value and limitations of each. There were many failures and many startling successes. The conflicting results indicated a need for reasearch on insect physiology and toxicology to determine how and why these insecticides killed.

In general, these new insecticides were extremely toxic to insects. Effective dosages were found to be unbelievably low. This stimulated research on methods of applying insecticides in low volume. Entomologists in Western Canada directed this research to concentrate sprayers, improved nozzles, the use of insecticidal fogs, smokes, and aerosols, and improvements in both ground and air equipment. Droplet size, spray patterns, and insecticide distribution all had to be considered, and new carriers and diluents that would meet required specifications had to be formulated. The investigations alternated between the laboratory and the field, and between the entomologist, the toxicologist, and the chemist. The outcome, to date, has been a more effective control of insects and a more effective application of insecticides.

One of the most startling changes in the research program has been the use of the new insecticides for the control of soil-infesting insects. Research on the control of wireworms, root maggots, cutworms, white grubs, the tuber flea beetle, the carrot rust fly, and other insects attacking the underground portions of plants changed almost overnight from cultural practices, the use of soil fumigants, and poisoned baits to soil insecticides and methods of applying them. How these insecticides kill when applied to the soil has yet to be determined. They are not volatile like ethylene dibromide, DDT, and other recognized soil fumigants, and yet it is difficult to imagine that an insect moving through the soil would come in contact with the small amount of insecticide that has been introduced. Seed dressings were found to give excellent control of wireworms, at one or two ounces of insecticide per acre, and research with seed dressings was expanded for other insects. Applications of insecticide to the soil by spraying, dusting, or through sprinkler irrigation have shown promise in controlling cutworms. Restricted soil treatments, such as applying the insecticide in the seed furrow, or as a band treatment along the drill rows, seem to be particularly effective as a control for root maggots.

Research on grasshopper control has been completely revised by the new insecticides. Experiments with poisoned baits have been dropped and the research has been concentrated on the value of the new insecticides and methods of application. Concentrate sprays applied with low-volume sprayers or by aircraft have controlled grasshoppers almost to the point of eradication.

As good as these new insecticides are, they created new problems. Some of them, and in many cases only certain formulations, are phytotoxic to a varying degree. Some are dissipated rapidly and others persist for varying lengths of time as residues that are important from the standpoint of insect control but that also may endanger human health. Some cause a disagreeable taint in edible roots, limiting the crops on which they can be used. It was necessary, therefore, to determine the maximum amount of insecticide that could be used without undue hazard and the minimum dose for insect control.

Another feature of the new insecticides brought the entomologist back to the study of insects. None of them would control all insects. Some were not equally effective against all the species of one family or even of one genus, and yet were very effective against a great number of species in all orders; others were more effective against certain related groups. Laboratory tests could indicate the value of an insecticide to control specific insects but could not forecast the complications that arose when the insecticide was used in the field.

DDT was found to be exceptionally effective in the control of the codling moth. When used in the orchard it destroyed not only the codling moth but also the most important predators and parasites of orchard mites, without affecting the mites themselves. The result was an extremely serious outbreak of mites. Out of it came a complete revision of the research on insects affecting apple trees, first in Nova Scotia and then in British Columbia. While the chemists bestirred themselves to find something to control mites, the entomologists studied orchard insects on an ecological basis. In the research program, sprays were used for the control of scab, and insecticides were eliminated in some cases. Parasites and predators were allowed to take over the control of the pest species. When something happened that allowed one pest species to increase, a carefully chosen insecticide was used to check it where possible without disrupting the parasite-predator relationship of other species.

Conflicting results in the control of root maggots led to a critical study of the species involved. The results of this study revealed that the maggots found in cruciferous roots are not all the cabbage maggot, Hylemyia brassicae (Bouche), but represent several species with different habits and life-histories. This has resulted in the entomologists studying the life-histories, habits, and behaviour of individual species, particularly in parts of the West where it is now know that H. brassicae does not occur or is not the most common species. In other areas and on other plants, mixtures of species have been found attacking roots, requiring research on the timing of spray applications, to secure the most effective control with the least effort.

There is another phase of research stimulated by DDT and the other organic insecticides. It has not yet affected the entomologists of Western Canada, but may be expected to do so before long. A few years ago it was reported that house flies were becoming resistant to DDT, and immediately physiologists and toxicologists started investigations to determine why the insecticide was becoming less effective. Since then, other insects have been showing signs of developing strains resistant to DDT. The more serious aspect is that strains resistant to DDT develop resistance to other hydrocarbon insecticides more readily than do non-resistant strains. Unless the physiologist, the toxicologist, and the chemist can find a solution, some of these new insecticides may become ineffective.

The fear that this situation may arise in the not-too-distant future has focused the attention of the entomologist on the need for more information on the biology of the insects affecting crops. There has been a marked increase in the amount of time being spent on the details of life-history, ecology, behaviour, and physiology. The interest thus aroused has created a desire for more intimate knowledge of factors such as the embryological development within the egg, the ecology and physiology of the different stages, the physiological and ecological factors in diapause and breaking of diapause, and the habits and behaviour of all stages.

Use of Radio-activity in Entomological Research

One of the newest tools in scientific research is radio-active tracers. Radio-active material is dangerous to handle and must be used in specially equipped laboratories commonly known as "hot" laboratories. In Western Canada radio-active material has been used to tag wireworms and cutworms so that their movements in the soil can be traced by means of a Geiger counter. The dispersal of grasshoppers in the field has been studied by treating their food with radioactive material and liberating them in the field. Collections of grasshoppers made at different times after liberation and at different distances from the liberation point were checked with a Geiger counter to determine the distance and direction of dispersal.

Radio-activity has also been used in the study of mosquito and black fly dispersal in the north and on the prairies. Radio-active material added to the pools containing mosquito larvae rendered the larvae radio-active and this activity could still be detected after they emerged as adults. Dispersal was then determined by checking field collections of adults with a Geiger counter.

Insect-resistant Crops

The development of Rescue, a wheat resistant to attack by the wheat stem sawfly, has led to the investigation of resistance of other crops to other insects. In most cases these investigations are in the initial stages of determining the differential feeding of a species on a number of varieties of the host plant. In others, some breeding work has been started with a resistant variety for at least one of the parents.

In the West, this work has consisted of investigations on sawfly-resistant wheat, grasshopper-resistant wheat and barley, and sweet clover resistant to the sweet clover weevil. As a matter of interest, in other parts of Canada studies are being conducted on potatoes resistant to aphids and the Colorado potato beetle; corn resistant to the European corn borer; turnips resistant to root maggots; cabbage resistant to the cabbage maggot and peas resistant to the pea aphid.

In the last few years, the research on resistance has gone much deeper than the mere screening of varieties. More attention is being given to the causes of resistance. In some cases resistance may be purely mechanical, such as a toughness of tissue, preventing the insect from penetrating the stems or feeding on the leaves, or an arrested or accelerated plant development, resulting in the plants being in a non-susceptible stage when the insects are abundant.

There is also a chemical resistance, which may consist of substances in the plant repellent to the insect or incompatible with the insect physiology or nutrition. In the first case, the insect is not destroyed but merely avoids the crop and seeks other hosts; in the second, the insect may be destroyed or reduced in numbers by feeding on the host. The early work on the effect of the food plant on the insect has been refined by a study of the chemical composition of the plant tissue in relation to insect survival and fecundity. For example, the fact that there appears to be a relationship between the total nitrogen and the susceptibility of a plant to insect attack is not so important as what amino acids and the quantity of each make up the bulk of this nitrogen. Thus, empirical breeding for resistance is being refined and put on a more nearly sound scientific basis.

These investigations revealed the necessity for research on insect nutrition and particularly the basic dietary requirements of insects. The work along this line is just getting under way in the West. It must be evident to anyone who has ever given it a thought that the dietary requirements of insects differ widely; otherwise all insects could survive and reproduce on the same plant. The research has progressed to the point where the vitamins, enzymes, and other nutrients essential for development are known for one or two species, as well as the effect of leaving one or more of the essentials out of the diet. It is interesting to note that, though the incentive for dietary research came from the resistance studies, the most progress has been made with species not concerned with these studies.

Team Work and Composite Laboratories

Just ten years ago, I was asked to give a talk to the Entomologists Group of the Professional Institute on trends in field crop insect research. In this talk I stated that in much of our research the entomologists had reached a point where help was required, either from entomologists trained along special lines or from specialists in other fields. I cited the Rust Research Laboratory as a restricted beginning when plant pathologist and plant breeders combined their efforts to fight rust. I felt at that time that at least an entomologist should have been working with these men to determine the susceptibility of rust-resistant wheat to insect attack. I visualized a series of composite laboratories where entomologists, insect physiologists, toxicologists, chemists, biochemists, plant pathologists, plant physiologists, ecologists, geneticists, statisticians, and plant breeders would be housed together and, when necessary, work together on a common problem. The audience reaction was interesting. The consensus was that as a pipe dream this was pretty good, but as a practical working scheme it was impossible and would never be accomplished, at least not in our lifetime.

Today, several such laboratories have been established. Though the staffs are not as complete as those I visualized, they are coming nearer to it each year. Specialists and special equipment have been installed, and on more than one occasion men from other laboratories have taken their problems to these laboratories and have either had the specialist work on them or have worked on them themselves under guidance of the specialist.

In general, the quality of the research has been greatly improved at the composite, or Science Service, laboratories. This has consciously or unconsciously influenced the work at other laboratories and research institutions.

General

I have not attempted to go into detail on the new work or new approaches to old projects that have taken place in Western Canada since 1944.

Of the 216 projects listed in the 1954 projects list of the Entomology Division as being conducted in Western Canada, 164 were started in 1944 or later. Some of these are revisions or refinements of old projects but many of them are on new work, including experiments with the new insecticides, life history studies, ecology, population dynamics, physiology, nutrition, and development. Entomological research at institutions other than the Entomology Division of the Canada Department of Agriculture covers much the same field but with fewer long-term studies and a tendency to morphology. In the Forest Biology Division, ecology and population dynamics have taken a more prominent place in the research program.

The livestock insect research in the Prairie Provinces has been developed in the last ten years. This has included studies on the life-histories, ecology, behaviour, and control of warble flies, horn flies, the sheep ked, cattle lice, mosquitoes, horse flies, and black flies.

The importance of the Canadian Arctic in the defence of North America and the necessity of establishing air bases and radar stations throughout the region required that something be done about the biting flies that make the Arctic almost uninhabitable during much of the summer. The Systematic and Veterinary and Medical Entomology units of the Entomology Division in cooperation with the Defence Research Board initiated surveys of the biting flies of the Arctic regions and a research program on the biology and control of biting flies.

The survey became a general faunal survey of the Arctic with special emphasis on the biting flies. This paved the way for general faunal surveys in the agricultural areas of Canada. The program got under way in the West when a systematist was permanently established at one of the Western laboratories, and was further advanced when two field parties spent the summer in different agricultural areas of British Columbia. The purpose of the faunal survey is twofold, to become better acquainted with the species occurring in an area and to collect material for the National Collection of Insects.

Research on the diseases of insects and the possibility of using diseases for the control of insects has been developed extensively in the Forest Biology Division. The Biological Control Unit of the Entomology Division has initiated a study of the diseases of prairie grasshoppers.

There has been a marked increase in the amount of time and staff devoted to research on forage crop insects in Western Canada. The main effort at present is on insects affecting alfalfa seed production. The research follows two main lines: the insects attacking the blossoms and seed, and the insects responsible for pollination. The first is a study of life-history, habits, and control; the second is largely ecological, a study of the life-history, habits, and habitats of pollinators. Methods of clearing and cultivating land to preserve or create ideal habitats to maintain maximum pollinator populations are being investigated as a study in field management.

A new field of research in the control of insects affecting stored products is the use of radio frequency and dielectric heating.

Except in a few instances, the titles of the projects do not indicate any marked change in the research program. However, the project statements, outlines, and reports in the Entomology Division show that there is an attention to detail that was lacking ten years ago. Research programs are more carefully planned so that results can be thoroughly analysed. Interpretation of results of biological observations where statistical analysis is impossible is given more thought and study. There is a greater tendency to find out why a thing happened than to just chronicle what happened.

One factor that has probably influenced this improvement in research attitude and accomplishment more than any other is postgraduate study. Ten years ago the men who had advanced degrees were in the minority in Western Canada. Today, there are more men with Ph.D. than with Bachelor degrees and there are very few of the latter who have not had at least one year of postgraduate study. The contacts made with other workers, students as well as professors, and the informal discussions on methods, techniques, and equipment, are just as valuable for conducting a future research program as the advanced courses taken for the degree. Together, they undoubtedly have had a profound effect on the research outlook.

A less important factor that has had an influence on research is the attendance at conferences of research workers. The majority of the members of the staffs of the Western laboratories have attended one or more conferences in the last ten years, where they have had opportunities to discuss research programs, accumulate new ideas, and compare notes with other workers in the same fields. The inspiration and stimulus received from such contacts is reflected in the improved attitude towards research.

In conclusion, I should like to make one statement that has been made by others under similar circumstances. After visiting research stations and comparing research programs in the United States and overseas, I think that entomological research in Canada can hold its own with any of them, and needs no apology.

THE ROLE OF LIAISON IN ENTOMOLOGY

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Liaison in entomology is merely another term for public relations or extension in this field. It is necessary because of the development of intense specialization in research with a resultant neglect of the overall picture. In addition, many research workers feel that the preparation of popular articles and extension take too much time from research.

The main functions of a liaison officer may be outlined as follows.

1. Preparation of extension material

(a) Processed publications

Processed publications are a good medium for presenting the results of research to the producer. But, these publications lack appeal. Compared with extension material distributed by commerce, who have something to sell, most processed publications leave much to be desired. It is essential that they be attractive, and above all, that they be written in the language of the producer rather than in the language of research.

(b) Popular articles and press releases

Much of the value in articles of this nature depends on the time of release. Their value is largely lost if they are not of topical interest. Articles passing through Information Service, Department of Agriculture, may often fall into this category if they are unduly delayed. The liaison officer could be of assistance to the Information Service in suggesting the most suitable type of article and time of release.

(c) Exhibits

One of the main features of exhibits should be their public appeal rather than research appeal.

(d) Reviews of improved control techniques for use of Provincial officials

It should be the duty of the liaison officer to review all control material on any one insect species and to summarize the information for the extension services; this to be made appropriate for different areas, e.g., ranches vs. prairie farms.

2. Information and public relations

The liaison officer should deal with enquiries by personal interviews, correspondence, and by addressing producer association meetings. There should be representatives from each of the specialized fields, i.e., field crop insects, fruit insects, stored product insects, etc. These officers would relieve research workers of extension duties.

3. Liaison

In this field the liaison officer acts as a go-between from researcher to producer and, equally as important, from the producer to the research worker. By attending producer meetings the liaison officer may become more familiar with the actual problems existing and thus be in a better position to suggest research requirements. There should also be liaison between research, industry, and the producer in such fields as the chemical and machinery industries. Many of the chemicals and machines with which to apply them, offered to the producer, are not suitable for the job required.

The liaison officer should arrange demonstrations of approved control practices, materials, and equipment and should assist in the organization of provincial and other control campaigns. He should not, however, organize any meetings or demonstrations except through a provincial official.

4. Keeping up-to-date on insect problems

The liaison officer must keep abreast of new developments. It is obvious that with the vast amount of literature published today the liaison officer must have assistance in this aspect of his work. He must receive a summary of the latest information from the research specialist, who is in a better position to glean the literature in his own field.

In performing these functions the liaison officer can be of great assistance in acting as a buffer between the research worker and the public.

PIONEERS OF ENTOMOLOGY IN MANITOBA

by J. B. Wallis
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In preparing the following incomplete and brief account of the pioneer entomologists of Manitoba I found it impossible to obtain much statistical data or even information concerning the majority of those hereafter mentioned. Hence it was necessary to depend upon my own personal knowledge and memory in compiling this report.

The first actual list of insects taken in what is now Manitoba, so far as I can discover, appears to be a list of thirty-eight species --- twenty-two butterflies and sixteen beetles --- published as Appendix IV to the Report of the Geological Survey of Canada in 1880. The Report covered explorations by Dr. Robert Bell on the Churchill and Nelson Rivers and around God's and Island Lakes. However, the insects were taken by that remarkable Churchman, the Venerable Archdeacon Kirby, who, in spite of the dangers, discomforts, and difficulties of northern travel in those days, still found opportunity to carry on his entomological studies. Kirby's work for the Anglican Church took him to many parts of the North West Territories but he can scarcely be considered as a pioneer of entomology in Manitoba as he was not a permanent resident.

As seems to have been a general rule our early entomologists were amateurs, collecting and studying insects for the sheer love of Nature, and before the turn of the century there were two great names, Heath and Hanham.

E. Firmstone Heath was an Englishman who settled at Cartwright, apparently in the late '70's or early '80's. Characteristically he named his farm dwelling "The Hermitage". Lepidoptera were his chief entomological interest and of them he made an extensive local collection, the identification of most of which was done by J.B. Smith, Professor of Entomology at Rutger's College in the U.S.A., who was, at that time, one of the three North American authorities on the macrolepidoptera.. On Heath's death, which occurred in 1914, the Manitoba Government bought his collection and turned it over to the Winnipeg Board of Trade for placing in their museum and the Chairman of the Museum Section, Dr. Bond, asked me to put the collection in shape for reference and exhibition. Unfortunately, the collection proper was mounted in the European fashion on short pins but as nothing could be done about this a case was bought and the work of organizing the material went on.

Specimens for identification were sent to specialists in the various groups and F. H. Wolley Dod, the distinguished authority on the Phalaenidae was generous enough to come from Calgary and spend two weeks of his time in arranging them. The identifications thus represented the latest knowledge and opinions of the times. A few years later the building housing the museum was dismantled and its exhibits were either reclaimed by their donors or destroyed. Probably the latter was to have been the fate of the Heath Collection, when, by the greatest of good fortune, it was seen by Professor A. V. Mitchener, who recognized its value and had it removed to the Agricultural College in Fort Garry. The collection, considering its adventures, still in good condition, is now housed in the Museum in the Entomological Building of the University of Manitoba. There it stands, a monument to the skill and interest of its collector, and a mine of information concerning the Lepidoptera of southern Manitoba.

The second great name is that of A. W. Hanham, a bank manager who came to Winnipeg in the late '80's from Ontario, where he was already well known as a zealous and successful collector of almost omnivorous tastes. In Manitoba he gave most of his attention to Coleoptera and Lepidoptera publishing the first comprehensive lists of those orders from our province. Some of his records have not been repeated and, while doubtless some of them may have been incorrect identifications, a study of the specimens, if still in existence, would be of value. Hanham was transferred to Duncan's on Vancouver Island about 1900 and continued actively collecting for some years. On his death his collection was deposited in the Victoria Museum.

Besides these two outstanding collectors there were during the period 1900-1925 a small number of men who, though doing no extensive collecting, kept alive the interest in insect hunting.

Among these was Marmont of Rounthwaite who, for a short time, collected beetles quite extensively. He, too, moved to B. C. where he continued his collecting. What became of his collection I do not know. Then there were J. D. Duthie who loved to get together a group of young people to go out sugaring for moths; Dr. A. J. Hunter who had a hospital in Teulon and yet found time with the help of the school teacher there, W. A. Cummings, to inspire many of the school pupils with a love of Nature. Dennis of Beulah contributed to our knowledge of the diurnal Lepidoptera, and his collection, bought by G. Shirley Brooks, is now in the Winnipeg Museum.

Two men of the period 1913-1940 are of more importance because of the rather extensive collections made by them. L. H. D. Roberts came from England as a lad in 1913 and soon began a collection of Coleoptera and Lepidoptera. He was a most industrious collector spending all his spare time and holidays at his hobby, so that in a relatively few years he had a good representation of local material. Following his marriage and with constantly increasing responsibility in his work with the C.N.R. he felt compelled to dispose of his collections, giving his butterflies and moths to the Winnipeg Museum and his beetles to me. I, in turn, deposited most of them in the Museum of the Department of Entomology of The University of Manitoba. He never gave up hope of again turning to his beloved insects but intense concentration on his work brought on an illness which resulted in his death in 1953.

Another prominent figure in the development of Entomology in Manitoba was G. Shirley Brooks. He, too, was an Englishman, and, too, earned his living with the C.N.R.. We met first at the newly formed Natural History Society of Manitoba in 1922 and, until his death, were from that time in close association. While he collected more or less generally as occasion served, his love, first and last, was for the butterflies. At his summer cottage at Victoria Beach and later on several holiday trips to Gillam and Churchill in northern Manitoba he added considerably to our knowledge of our northern butterflies. For several years before his death he acted as unofficial curator of Insects in the Manitoba Museum and it is to his skill and interest that we owe the fine cabinet of butterflies in that institution.

This paper has so far dealt only with collectors who are dead, but I feel constrained to add the names of J. F. May and his wife Margôt who are still helping to widen popular interest in insects. A forest ranger in the Riding Mts., May was stationed in one of the most interesting collecting grounds in Manitoba. He had a brother in Brazil who, too, was a collector, and who sent him many of the beautiful Morphos and Papilios from that country. May was the most enthusiastic and energetic collector I have known. He thought nothing of carrying a 40 lb. light trap through a quarter of a mile of dense bush, up the highest hill in the Riding Mts., and then climbing with the trap to the top of a forty foot tree, from whence the light could be seen for miles. Besides energetically collecting local insects in which he was ably assisted by his wife, he exchanged specimens with correspondents all over the world. He did not, however, build up a scientific local collection, his interests running to the beautiful, the unusual and the large.

He left the Government service some years ago and went to the United States to live, building himself a home near Colorado Springs. Here he has a permanent fire-proof museum from which he sends by trailers two large exhibits to fairs and shows. Recently he has built a museum in Southern Florida and will probably cease the arduous displays at Sportsmens' Shows and the like. While not strictly scientific his collections are really magnificent, appealing to the love of beauty and of the strange that is inherent in nearly everyone. A number of Manitoban insects have been named after him or after his wife, and he has extended the interest in the Manitoban insect fauna far and wide.

Finally, the greatest name of all, Norman Criddle.

Norman was the eldest son of Percy Criddle who came from England in the '70's to settle at Aweme some twenty-six miles south-east of Brandon. At this time Aweme was a prosperous little farming community the sandy soil with plenty of sub-surface moisture producing the best wheat in Manitoba. Grasshoppers, dry weather and winds changed this. The grasshoppers cleaned off all growth of grain on the fields, dry weather permitted the high winds to blow all the sandy top soil away right down to the gravelly hard pan, and the settlers gave up the fight and moved away.

But the Criddles stayed. Percy Criddle was an amazing man. Highly educated and cultured he was an outstanding musician both performer and composer. He had a very large library including many medical and legal books. Having a most retentive memory he knew, theoretically at least, as much about medicine as many doctors and as much law as many lawyers. Little wonder then that he was looked upon for miles around as an oracle who could settle medical, legal, or even purely domestic problems. Mrs. Criddle was, in her own right, an authority on Old English, and, in addition was highly cultured in those arts considered to be necessary in the education of a lady of her time.

In this atmosphere of knowledge and culture the young Criddles grew up and developed an interest in all things around them. They gave their own names to the birds and animals, to the flowers, and to the larger insects. They learned the habits of the living things and amazed that great naturalist Thompson Seton with their knowledge.

Norman was especially fascinated by the beauty of the flowers which then grew in great abundance and variety on the warm moist sandy soil, and with some assistance from his mother made paintings of a number. These he sent to Dr. James Fletcher, Dominion Entomologist and Botanist, at Ottawa for identification. Fletcher, always desirous of helping and encouraging, gave the names but, in addition, made comments on how the paintings could be made more suitable for reproduction. A visit by Fletcher to the Criddles not long afterwards resulted in the employment of Norman to illustrate some of the Department's publications. Thus Norman's work with the Government began as a botanist.

Interest in insects seems to date from their father bringing home a silkworm moth --- possibly Cecropia but, in my opinion, more likely Nokomis. Anyhow, his four sisters and three brothers were all soon helping with "Norman's" collection, and by the time he was transferred from flowers to "bugs" he had already a fine collection especially of beetles, moths and grasshoppers.

So valuable was Norman's contribution to entomology considered to be that, after his appointment to the Division he was permitted to live at home and a laboratory was built for him almost at his front door. There, until his death in 1933 he continued to build up the collection, and Aweme became one of the best known and best worked collecting areas in North America.

Yet, although one of the finest field naturalists in North America most of his knowledge died with him. For some years before his death he had worked on our western grasshoppers. He had everything complete, text and drawings from the egg, each nymphal instar, to the adult of all but two or three of our species. But he would not publish until all was done.

But death came first and, today, no one seems to know even where the manuscript is. The collection is broken up --- integrated in part with the National Collection, part in Brandon, Manitoba.

"Sic transit gloria mundi."

ON THE CLASSIFICATION OF ENTOMOLOGICAL KNOWLEDGE

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The problem which I want to present to you is one which I think is likely to assume increasing importance as entomological research proceeds into the future, and yet, to understand it a brief look into the past is first necessary. It is hard now to realize that perhaps a hundred years ago, in Darwin's day, perhaps somewhat more, a capable and enthusiastic man could hold in his head virtually all that was then known in the science of entomology. Horn and Schenkling, listing entomological information published prior to 1863, recorded a mere 25,000 papers, of which we might note in passing that less than a quarter were on economic entomology. By the turn of the century things had begun to change. Fifty years of economic entomology in America had added its share of writing to a growing literature of the pure science, and perhaps all that the most prodigious memory could then hope to hold was the knowledge of where information on every entomological topic could be found. The more pedestrian workers, even then, leaned heavily on a card index or similar artificial memory. The first such publicly provided memory, Zoological Record, had in fact been started in 1864. In 1905 some 3,000 entomological papers were published, of which about one third were on economic subjects. This perhaps too lusty offspring of the pure science soon began to outgrow its parent, and in 1913 the Review of Applied Entomology was started, largely to relieve Zoological Record of the burden of indexing the economic literature.

Today entomological literature has grown vastly, and continues to grow at an apparently increasing rate. In 1950 some 6,000 economic papers were published, as well as about 4,500 in the pure science. The World List of Scientific Periodicals in 1937 contained the titles of about 25,000 regular periodicals; in 1952, about 50,000; entomology claims a fair share of these. Small wonder that every conscientious worker in the field finds it increasingly difficult to keep abreast of the literature. I find it necessary to see (but not, you note, to read!) every issue of some 45 periodicals, to say nothing of new books and mimeographed material.

It is true that many of today's papers are rehashed repeats produced by men whose bosses insist on so many papers regardless of what is in them; or single page notes of which the first half is title and introduction, and the second half summary and references; or something dug out of the archives by the convention hound who must present a paper in order to get there. There remains however, a solid core of new information to be absorbed, which is far larger than it ever was. If the rate of increase is only linear, which I think is unlikely, we may expect nearly 20,000 entomological titles annually by the end of the century. Or, looking at it another way, one reference only per species, will, if we consider the world fauna to be our responsibility, already give us nearly a million titles; even if we take a provincial viewpoint, which few of us care to admit to, we in Alberta already need 10,000.

What is the solution? The card index, helpful though it is, becomes cumbersome and demands a cross reference system when it grows to over a few thousand titles. For anybody concerned with more than a small segment of the field this can happen very quickly. Subject indexing can be quite a problem even with less than 1,000 cards.

I cannot claim to have solved this problem, and I hope I haven't led you to suppose that I had. Frankly, I am here pleading for help towards what I hope may prove a solution. The solution we propose to attempt at the University of Alberta is in two parts; the first is an item which many of you probably are familiar with, the punched card, and the second -- without which the punched card in itself is useless -- a comprehensive, logical and well planned entomological subject index. This is where I hope you may be able to help me.

For those of you who are not familiar with punched cards I should perhaps briefly explain their use. The holes around the margin of the card are usually arranged in groups of four, and the holes in each group are labelled 7, 4, 2, 1, figures which can be added to give any number from 1 to 10 (or, if necessary, to 14). Any hole or combination of holes can be punched out to the margin, so that if a needle is run through a particular hole in a stack of cards, all those with the hole punched out will drop off the needle. If successive groups of holes are used to represent units, tens, hundreds, etc., a 7 1/2" x 3 1/4" card with 80 holes can be used to represent any one of 10^{20} different subjects or categories, all the cards in each of which could be readily withdrawn from a stack of (almost) unlimited size. In practice it is usually desirable to categorize references in more than one way, as for instance, author's name alphabetically, year of publication chronologically, taxonomic group, and perhaps a second subject category. This rapidly reduces the total number of categories available, for instance 20 blocks of holes divided equally between four groups allows for 10^5 categories in each group, making a total of only 400,000 categories instead of 10^{20}. For authors' names or other alphabetical purposes the letters may be given numerical values. Better, if the alphabet is divided into halves, one hole can be used to indicate which half a letter falls in, and a block of four to give its number within that half. Fifteen holes will then serve to give the first three letters of an author's name. The system is a flexible one, and many variations are possible.

A subject index is a more difficult matter than the choice of a card, and a more important one. Clearly it is unwise to start punching cards until the subject index is in its final satisfactory form; at the same time it is difficult to discover the faults in a subject index until one has used it punching cards. Since it seems that it is no longer possible for one man to know even the full extent and content of the field of entomology, it is from this dilemma that I solicit your aid. With this type of card, and since many of us still prefer to count on our fingers, a decimal numerical system of arrangement is to be preferred. Here is our tentative index. Each of you, when your pet field comes up, will I am sure find something of arrangement or omission to criticize in it; your criticisms will be most welcome. We have not yet found it necessary or possible to break down all categories to the third figure, but I will show one from each major group taken to this stage; you may care to make suggestions regarding the others. I should mention that we have found the Universal Decimal System one of the most useful sources of ideas on this question, but we found it impossible to use this system as it stands because it does not treat entomology separately from zoology, and because of the unconventional classification of the insects adopted in it.

1. H I S T O R I C A L, G E N E R A L I T I E S
   - 1.1. HISTORICAL
   - 1.2. BIBLIOGRAPHY
   - 1.3. GENERALITIES
   - 1.4. TEACHING METHODS
   - 1.5. RESEARCH METHODS
   - 1.6. ILLUSTRATIVE METHODS
   - 1.7. PUBLICATION
   - 1.8. DEFINITIONS, LIMITS OF THE FIELD

2. M O R P H O L O G Y
   - 2.1. HISTORICAL, GENERAL, TECHNIQUE
   - 2.2. EXTERNAL - HEAD
   - 2.3. EXTERNAL - THORAX
   - 2.4. EXTERNAL - ABDOMEN
   - 2.5. INTERNAL - ALIMENTARY & EXCRETORY SYSTEMS
     - 2.5.1. Historical, bibliography, general
     - 2.5.2. Origin of Alimentary and Excretory systems.
     - 2.5.3. Oesophagus, crop and Proventriculus
     - 2.5.4. Mid-gut, general
     - 2.5.5. Gastric caeca
     - 2.5.6. Peritrophic membrane
     - 2.5.7. Malpighian tubules & nephrocytes
     - 2.5.8. Hind gut & rectal glands
     - 2.5.9. Salivary glands
   - 2.6. INTERNAL - VASCULAR & MUSCULAR SYSTEMS, FAT BODY
   - 2.7. INTERNAL - RESPIRATORY SYSTEM
   - 2.8. INTERNAL - NERVOUS SYSTEM & SENSE ORGANS
   - 2.9. INTERNAL - REPRODUCTIVE SYSTEM
   - 2.0. HISTOLOGY

3. T A X O N O M Y
   - 3.1. HISTORICAL, GENERAL, TECHNIQUE
   - 3.2. ORIGINS & RELATIONSHIPS, EVOLUTION, FOSSIL GROUPS
   - 3.3. OTHER ARTHROPODS
   - 3.4. APTERYGOTA
   - 3.5. EXOPTERYGOTA
     - 3.5.1. Historical, bibliography, general
     - 3.5.2. Ephemeroptera, Plecoptera, Odonata
     - 3.5.3. Orthoptera
     - 3.5.4. Orthoptera, Dermaptera
     - 3.5.5. Isoptera, Embioptera, Psocoptera
     - 3.5.6. Anoplura
     - 3.5.7. Thysanoptera
     - 3.5.8. Hemiptera - Heteroptera
     - 3.5.9. Hemiptera - Homoptera

3.6. ENDOPTERYGOTA
- 3.6.1. Historical, bibliography, general
- 3.6.2. Coleoptera
- 3.6.3. Coleoptera, Strepsiptera
- 3.6.4. Mecoptera, Neuroptera, Trichoptera
- 3.6.5. Lepidoptera
- 3.6.6. Lepidoptera
- 3.6.7. Diptera
- 3.6.8. Diptera, Aphaniptera
- 3.6.9. Hymenoptera
- 3.6.0. Hymenoptera

4. P H Y S I O L O G Y
- 4.1. HISTORICAL, GENERAL, TECHNIQUE
- 4.2. METABOLISM
- 4.3. GROWTH
  - 4.3.1. General, Bibliography, Historical
  - 4.3.2. Embryology
  - 4.3.3. Hatching
  - 4.3.4. Growth rates
  - 4.3.5. Moulting
  - 4.3.6. Metamorphosis
  - 4.3.7. Life cycles
  - 4.3.8. Polymorphism
  - 4.3.9. Repair and regeneration
  - 4.3.0. Diapause
- 4.4. REPRODUCTION
- 4.5. WATER RELATIONS
- 4.6. TEMPERATURE RELATIONS
- 4.7. NERVE PHYSIOLOGY
- 4.8. MUSCLE PHYSIOLOGY

5. E C O L O G Y
- 5.1. HISTORICAL, GENERAL, TECHNIQUE
- 5.2. ETHOLOGY
- 5.3. ENVIRONMENT - GENERAL
- 5.4. ENVIRONMENT - CLIMATE
- 5.5. EDAPHIC FACTORS
- 5.6. POPULATIONS & ASSOCIATIONS
  - 5.6.1. Synecology - general
  - 5.6.2. Population composition
  - 5.6.3. Population estimation
  - 5.6.4. Biotic pot: Environment resis.
  - 5.6.5. Social life
  - 5.6.6. Biocoenoses
  - 5.6.7. Commensalism
  - 5.6.8. Symbiosis
  - 5.6.9. Galls

5.6.0. Parasitism
5.7. CONFLICT & COMPETITION
5.8. ZOOGEOGRAPHY, DISTRIBUTION

6. A P P L I E D - G E N E R A L
6.1. HISTORICAL, GENERAL, TECHNIQUE
6.2. FACTORS AFFECTING INSECT NUMBERS
6.3. ECOLOGICAL CONTROL METHODS
6.4. PHYSICAL CONTROL METHODS
6.5. CHEMICAL CONTROL METHODS
6.5.1. Historical, bibliography, general
6.5.2. Repellents, deterrents, proofing materials
6.5.3. Toxicants
6.5.4. Accessory materials
6.5.5. Insecticide evaluation
6.5.6. Insecticide application
6.5.7. Hazards, precautions, toxic symptoms, antidotes
6.5.8. Legislation
6.5.9. Mode of action of insecticides
6.5.0. Resistance to insecticides
6.6. QUARANTINES & INSPECTION

7. A P P L I E D - A G R I C U L T U R A L & FOREST
7.1. HISTORICAL, GENERAL, TECHNIQUE
7.2. FIELD CROPS - GRAIN
7.3. FIELD CROPS - OTHER
7.4. TRUCK & GARDEN CROPS
7.5. FRUITS
7.6. ORNAMENTALS & HOUSE PLANTS
7.7. FOREST PESTS - DECIDUOUS TREES
7.8. FOREST PESTS - CONIFERS
7.9. SPECIAL ASPECTS OF CONTROL

8. A P P L I E D - M E D I C A L & V E T E R I N A R Y
8.1. HISTORICAL, GENERAL, TECHNIQUE
8.2. VENOM & URTICATION
8.3. BLOOD SUCKING ARTHROPODS
8.4. ACARIASIS
8.5. MYIASIS
8.6. CANTHARIASIS, SCOLECIASIS
8.7. RICKETTSIAL DISEASES
8.8. PROTOZOAN DISEASES
8.9. OTHER DISEASES
8.0. SPECIAL ASPECTS OF CONTROL

9. A P P L I E D - I N D U S T R I A L & D O M E S T I C
   - 9.1. HISTORICAL, GENERAL, TECHNIQUE
   - 9.2. DESIGN & CONSTRUCTION OF PREMISES
   - 9.3. STORAGE HYGIENE
   - 9.4. DISINFESTATION
   - 9.5. INSECT PROOF PACKAGING
   - 9.6. SPECIAL PROBLEMS - FOODSTUFFS
   - 9.7. SPECIAL PROBLEMS - OTHER COMMODITIES
   - 9.8. HOUSEHOLD PROBLEMS

0. A P P L I E D - B E N E F A C T O R Y
   - 0.1. HISTORICAL, GENERAL
   - 0.2. APICULTURE
   - 0.3. SERICULTURE
   - 0.4. OTHER INSECT CULTURE
   - 0.5. INSECTS AS HUMAN FOOD

APPENDIX I

Additions to the Library of the Entomological Society of Manitoba

The following list contains the names of publications received in exchange for the Proceedings since the list published as Appendix I to Vol. 9 of the Proceedings for 1953.

Adams, R. E. et al. 1954. A Flexible-Outlet Mist Sprayer. Albert R. Mann Library, Cornell University, Ithaca, N. Y. Bulletin 904.

Proceedings of the First Annual Meeting of the Entomological Society of Alberta. Calgary, Alberta. Oct. 2-3, 1953.

Proceedings of the Entomological Society of British Columbia. Vol. 50. Issued May 15, 1954.

Redia. Volume 38. Published by Dalla Stazione di Entomologia Agraria, Firenze.

Gyrisco, G. G. et al. 1954. Biology of the European Chafer *Amphimallon majalis*, Razoumouwsky (Scarabaeidae). Cornell University Agr. Expt. Sta. Memoir 328.

Webster, Dwight A. 1954. Smallmouth Bass, *Micropterus dolomieui* in Cayuga Lake. Part 1. Life History and Environment. Cornell University Agr. Expt. Sta. Memoir 327.

A series of publications and reprints received in exchange from Dr. Jean Leclercq, University of Liege, Belgium.

Duchateau, G. et al. 1952. Sur les acides amines, libres ou combines sous forme non proteinique, du plasma sanguin de divers insectes. Archives internationales de Physiologie. Vol. LX. Fasc. 4.

Duchateau, G. et Marcel Florkin. 1953. Teneur en acides amines non proteiniques du plasma de l'hemolymphe des Chenilles de Cossus cossus et de deux Saturnides africains (Imbrasia macrothyris et Pseudobunaea seydeli). Archives internationales de Physiologie. Vol. LXI. fasc. 2.

Duchateau, G. et al. 1953. Sur les constituants de la base inorganique de l'hemolymphe des Insectes. Journal de Physiologie, extrait du Tome 45.

Duchateau, G. et al. 1953. Concentrations des Bases Fixes et Types de Composition de la Base Totale de l'Hemolymphe des Insectes. Archives internationales de Physiologie. Vol. LXI. Fasc. 4.

Duchateau, G. et al. 1953. Acides Amines non Proteiniques d'Un Enchantillon de Ngapi seinsa. Bulletin de la Societe de Chimie biologique Tome XXXV, No. 10.

Duchateau, G. et Marcel Florkin. 1954. La Coagulation du Sang des Arthropodes. IV. - Sur le Fibrinogene et sur la "Coaguline" musculaire du Homard. Bull. Ste. Chim. Biol. 36, Nos. 2-3.

Duchateau, G. et M. Florkin. 1954. Etat des acides amines non proteiniques du plasma de l'hemolymphe des chrysalides de Lepidopteres. Archives internationales de Physiologie. Vol. LXII. fasc. 2.

Duchateau, G. et M. Florkin. 1954. Acides Amines Libres et Sous Forme de Combinaisons non Proteiniques dans la Plasma Sanguin et le Muscle Strie du Lapin et du Cof. Archives internationales de Physiologie. Vol. LXII.

Duchateau, G. and M. Florkin. 1954. Types de composition du "pool" des acides amines non proteiniques des muscles. Archives internationales de Physiologie. Vol. LXII, fasc. 2.

Florkin, M. 1952. Caracteres Biochimiques des Categories Supraspecifiques de la Systematique Animale. Extrait de Annales de la Societe Royale Zoologique de Belgique. Fasc. 1. Tome LXXXIII.

Gregoire, Ch. 1953. Coagulation de l'Hemolymphe chez les Insectes Hemipteroides. Archives Internationales de Physiologie. Vol. LXI. fasc. 2.

Gregoire, Ch. 1953. Coagulation de l'Hemolymphe chez divers Insectes Orthopteroides. Archives internationales de Physiologie. Vol. LXI. fasc. 2.

Gregoire, Ch. 1953. Sur la coagulation de l'hemolymphe des Termites. Archives internationales de Physiologie. Vol. LXI. fasc. 3.

Gregoire, Ch. 1953. Coagulation de l'hemolymphe chez les Coleopteres et les Insectes Neuropteroides. Archives internationales de Physiologie. Vol. LXI. fasc. 3.

Gregoire, Ch. et al. 1953. Trame protidique des nacres. Societe Belge de Biochimie. Vol. LXI. fasc. 3.

Gregoire, Ch. 1953. Blood coagulation in Arthropods. III. Reactions of Insect Hemalymphe to Coagulation. Inhibitors of Vertebrate Blood. Biological Bulletin, Vol. 104, No. 3.

Gregoire, Ch. 1954. Sur la coagulation de l'hemolymphe des Termites (Deuxieme note). Archives internationales de Physiologie. Vol. LXII. fasc. 1.

Gregoire, Ch. et al. La trame protidique des nacres. Experientia. Vol. X.

Jeuniaux, Charles. 1952. Influence du facteur humidite sur la distribution des Elaterides en Belgique (Coleopteres). Reprinted from: Trans. Ninth Int. Congr. Ent., Vol. 1, 1952.

Jeuniaux, Charles. 1954. Sur la Chitinase et la flore bacterienne intestinale des mollusques gasteropodes. Academie royale de Belgique. Tome XXVIII, fasc. 7.

Leclercq, Jean. 1953. Trigonalidae, Aulacidae, Evaniidae, Stephanidae et Agriotypidae de la faune Franco-belge. Extrait du Lambillionea, LIII, Nos. 1-2.

Leclercq, Jean. 1953. Notes detachees sur les Hymenopteres Aculeates de Belgique. Extrait des Bull. et Ann. Soc. Entom. de Belgique, 89, III-IV.

Leclercq, Jean. 1953. Araignees Sparassidae introduites en Belgique avec les cargaisons de fruits exotiques. Extrait des Bull. et Ann. Soc. Entom. de Belgique, 89, III-IV.

Leclercq, Jean. 1952. Liste de Braconides (Hym.) recoltes en Belgique. Extrait des Bull. et Ann. Soc. Entom. de Belgique, 88, IX-X.

Leclercq, Jean. 1953. Notule sur quelques Heteropteres de France. Extrait du Bulletin de la Societe Entomologique de Mulhouse de Juillet 1953.

Leclercq, Jean. 1953. Sur les Ichneumonides (Hymenoptera) de la Belgique et des Pays Voisins (1-10). Institut royal des Sciences naturelles de Belgique. Bulletin. Tome XXIX No. 38.

Leclercq, Jean. 1953. Notes detachees sur les Hymenopteres Aculeates de Belgique. Extrait des Bull. et Ann. Soc. Entom. de Belgique, 89, VII-VIII.

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