A G Robinson

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INTRODUCTION

The Entomological Society of Manitoba completed one of its most successful years in 1948. This was due in no small measure to the enthusiastic support, from the members, of all Society activities.

The main event of the year was the meeting of the "International Great Plains Conference of Entomologists" under the auspices of the Entomological Society of Manitoba. The meeting took place at Riding Mountain National Park, August 23 - 25. A special report on the conference was printed and distributed by the Manitoba Society.

As usual, the regular spring and fall meetings were well attended. A perusal of the account of the spring meeting will convey some idea of the scope and variety of entomological work in progress in Manitoba. Three excellent review papers were delivered at the fall meeting. These papers are reproduced in these Proceedings.

R. R. LEJEUNE,
President.

THE APRIL GENERAL MEETING

Fourteen members attended the spring meeting which was held in the Horticulture Building, University of Manitoba on April 27, 1948.

The Business Session

A brief business meeting was held from 10 to 11 A.M.

The members approved a resolution that the Entomological Society of Manitoba should urge the Committee on National Entomological Organization to continue their efforts to establish a Canadian Entomological Society in the near future. Correspondence from Mr. W. A. Ross, Chairman of the Committee on National Entomological Organization, was read on this matter.

The invitation extended by the Society to the International Great Plains Conference of Entomologists to meet in Manitoba in 1948 had been accepted and committee chairmen reported on preparations for this event to be held in August. A discussion of the conference plans followed.

A financial report submitted by the Secretary-Treasurer was approved. Members agreed also on a method of financing Conference expenses.

Officers elected for the year 1948 were: Mr. R.R. Lejeune, President; Mr. C.A.S. Smith, Vice President; Dr. B.N. Smallman, Secretary-Treasurer, and Mrs. W.S. Barker, Editor-Librarian.

The minutes of this meeting are included as Appendix I of these Proceedings.

The Scientific Session

The meeting continued with the informal presentation and discussion by the members of reviews of their current work.

Current Work of Members

Field Crop Insects: Dr. Bird gave a brief outline of the projects of the Dominion Entomological Laboratory, indicating the members of his staff engaged on each project.

TAXONOMIC WORK

He reported that the laboratory was fortunate during the past year to obtain the assistance of Mr. J.B. Wallis for taxonomic work on the collection of the late Mr. Norman Criddle. This collection had been given to the Brandon Laboratory.

DDT RESIDUES ON CELERY

Mr. G. Thomas reported the results of a study of DDT residues on treated celery plants. This study had been undertaken by Mr. W. R. Allen and himself during the summer of 1947. A power duster was used to apply a copper dust containing 3 per cent DDT at the rate of 35 pounds to the acre. The celery was treated four times during the summer on the following dates: July 15, August 1, 14 and 23.

Outside stalks were gathered on September 15 and the weight of the trimmed stalks obtained so that the amount of DDT in parts per million by weight could be calculated. Untreated celery stalks served as the control sample. A colorimetric method, involving the use of a spectrophotometer, was used to determine the amount of DDT residue. This work was done in the Stored Product Insect Laboratory at Winnipeg. The results of the analyses gave an average concentration of DDT residue of approximately 2 parts per million. Since this concentration was well below the limit of 7 parts per million, the celery was considered fit for human consumption. The analyses were done on the outside stalks, on which concentration of DDT would be expected to be heaviest.

DDT RESIDUES ON CABBAGE

Mr. W. R. Allen stated that cabbages treated three times in season with DDT showed only a trace of DDT residue on the outside leaves. Concentrations of one quarter, one half, and one pound of DDT per 100 gallons of water were used at the rates of 100 and 50 gallons per acre. DDT appeared from these tests to be quite safe for this use. It was Mr. Allen's intention to check these results during the 1948 season.

SURVEY OF VEGETABLE AND SUGAR BEET INSECTS

Mr. H. Westdal stated that during the 1947 season the ecological survey of vegetable and sugar beet insects had been continued in Manitoba. Survey methods, involving detailed searching of plants and counting of insects,

proved extremely time consuming. Experience gained during the past three seasons indicates that this may be overcome without undue loss of accuracy. Points within the area surveyed were classified as primary or secondary. Primary points included the major vegetable growing areas of the province: Brandon, Portage la Prairie, St. Vital, North Kildonan, East St. Paul, East Lockport, Old Kildonan, Morden and Dauphin. The secondary points were Teulon, St. Pierre, Dufrost, Emerson, Rosenfeld, Manitou, Pilot Mound, Killarney, Boissevain, Lyleton, Horndean, Plum Coulee, Gnadenthal, Winkler, Carman, Melita, Virden, Roblin, Swan River and Grandview. Additional inspections were made by workers whenever possible at 20 mile intervals en route between the points designated as primary or secondary.

The first survey trip from June 10 to 19 was to determine the amount of cutworm and early flea beetle damage in the primary vegetable growing areas. A second survey, from July 14 to 31, and a third and final survey, from August 18 to 30, each covered the primary and secondary points. The July survey was planned to give information on potato beetles, flea beetles, leafhoppers and beet webworm.

To determine some of the factors affecting insect populations, vegetable growers were asked for information about tillage methods, time of planting the crop, previous crops, surrounding habitat, and methods of control for insects and disease in practice.

The chief garden pests in 1947 were cutworm, flea beetle, potato beetle and imported cabbageworm. Onion maggot, which was prevalent in 1945 and 1946, appeared practically non-existent in 1947. Potato leafhopper was also much reduced in numbers. Beet webworm infestations reached the outbreak stage in 1947 and diamondback moth began to rival the imported cabbage moth in numbers and in damage.

ALFALFA INSECTS

Mr. W. P. Stephen reported on a survey of alfalfa insects. The failure of alfalfa to set seed in the seed-producing areas of Manitoba prompted this survey as the initial step in determining whether any marked differences in insect populations occurred in sections having good and poor seed sets. Only those insects known to be useful or harmful in relation to the alfalfa seed set were recorded. The entire survey was conducted through the week of July 28 to August 2, 1947, and because of the limited time spent, it can only be regarded as a preliminary reconnaissance survey.

From the recorded data it appears that the "blossom drop", attributed to the work of Lygus and Adelphocoris, can be explained by a simple lack of fertilization of the alfalfa flower. Adelphocoris lineolatus Goeze is by far the most common of the mirids on alfalfa in Manitoba, comprising 73.2 per cent of all the plant bugs swept. A. rapidus (14.8 per cent) and Lygus spp. (12 per cent) were of secondary importance, occurring generally throughout the alfalfa districts. Except for one case in the South Junction area, the Manitoba alfalfa grower is not seriously troubled by the prevalence of plant bugs.

Preliminary observations indicate that the seed set in alfalfa is directly proportional to the wild bee population of the area. All species of the leaf-cutter bees (Megachilidae) excelled in rapidity and thoroughness of tripping the alfalfa flower. The effectiveness of bumble bees, however, appeared to vary with the species. Bremus borealis Kirby, B. fervidus Fab. and Bremus sp. (believed to be americanorum) were noted to be the most effective trippers of this genus, while B. vagans Smith, B. ternarius Say and B. terricola Kirby were relatively ineffective in their flower tripping capacity.

Honey bees, despite exceptional numbers, were observed to trip approximately 3 per cent of the flowers visited. This observation, accompanied by a poor yield--high population ratio in one area, would indicate that honey bees do not exert a great influence upon the alfalfa seed yield under present conditions.

Dr. Bird added the comment that further work to be undertaken involves caging of honey bees in an alfalfa area, training them to seek alfalfa by feeding them alfalfa-treated nectar and obtaining pollen pellets for analysis by the use of pollen traps at the entrance to the hive. The pollen gatherers are much more important than the nectar gatherers in alfalfa pollinations.

SUNFLOWER INSECTS

Mr. J. Kelleher informed the meeting that in 1947, about 25,000 acres of Manitoba farm lands were planted to sunflowers. Most of this acreage was in the region between Morden and Rosenfeld, from Myrtle to the United States border.

Two species of moths had been found attacking sunflowers. In 1944, Mr. W. R. Allen had studied the life history of the sunflower moth, Homoeosoma electellum. The other species, Phalonia (sp. near lavana) is similar in

size and habits to Homoeosoma electellum. The damage done by Phalonia sp. is similar to that of the sunflower moth but the larva enters the seed and is usually found in frass in silken webbing. The damage done by a single Homoeosoma larva exceeds that of a Phalonia larva.

Sunflower heads examined in a badly infested field near Gretna showed that Phalonia damaged the soft seeds more than the firm seeds in large heads. Soft seeds were damaged to about the same extent in the central area and in the peripheral area of the head (23.5 per cent and 19.6 per cent respectively). Firm seeds in the central area were 17.5 per cent damaged; in the peripheral area, 4.7 per cent. Damage to small heads averaged about 57 per cent.

During a survey of insect pests attacking sunflowers, 26 examinations were made in the Winkler-Rosenfeld-Altona area, 2 at the Morden Experimental Station, and 2 in the Morden district. The average infestation per head was determined for 5 or 6 small and 5 or 6 large heads chosen at random at each examination.

Although Homoeosoma occurred throughout the area, 17 of the fields examined had only a trace of it and the others had none. Infestation by Phalonia exceeded that by Homoeosoma and was heaviest in the southeast (Altona) district. However, yields would be affected in only a few cases. Populations ran as high as 14.4 larvae per head but most fields had a much lower population.

Soil sifting performed in the fall in heavily infested fields yielded an average 6.33 larvae per square foot in or near the rows and 2.27 larvae per square foot between rows.

Dr. Bird commented that there is more likelihood of seed being infested with Homoeosoma larvae than with Phalonia larvae.

SWEETCLOVER WEEVIL

Mr. Kelleher then spoke on the major portion of his work which concerns sweetclover weevil, Sitona cylindricollis Fahr. In 1947, it had been reported as far west as the Peace River Block in Alberta.

Fifteen points in southeastern Saskatchewan and southern Manitoba were visited during a survey in the spring of 1947 to determine the spring population and winter mortality of the weevil. At each point, ten one square foot soil samples were sifted and the number of living and dead weevils was recorded. They were found in every case; the maximum population of 20.7 per square foot occurred at Portage la Prairie.

Mortality reached 20.4 per cent at one field but at more than half of them there was no evident winter kill.

Population and life history studies of the weevil were continued at Graysville, Manitoba, by soil sifting of a series of one square foot samples during the period June 13 to July 22. Unaccountably, there were no larvae found until July 8 when they appeared in great abundance. Most of the larvae occurred in the 2 to 3 inch level. The first pupae were found on July 11 and the new generation emerged from July 23 to August 21.

Dead weevils found in the spring surveys and in tillage control experiments were sent to Mr. A. M. Brown of the Dominion Laboratory of Plant Pathology at Winnipeg for identification of disease. Organisms isolated included Beauvaria, Penicillium, Fusarium, and Alternaria.

Weather observations were recorded and correlated with weevil emergence at Graysville. On the basis of three years records, a tentative conclusion is that when temperature and precipitation fall below normal in May and June, there is an increased population. If, however, the temperature is above, and precipitation below normal, there is a decline in population.

Low weevil populations in Brandon in 1946 prevented continuation of fall tillage control experiments. Summer tillage control experiments were conducted at Graysville. Four methods were employed: ploughing (5 inches) followed 10 days later with one way discing (3 to 4 inches), ploughing (5 inches), using a cultivator, one way discing (3 to 4 inches). Two replicate plots of each were laid out with 20 emergence cages per plot. These, with check plots, made a total of 200 cages. The remainder of the field was ploughed and one wayed. Results showed no significant difference between tillage methods used but considerable control was obtained with each. Good control in the field was shown by the fact that an adjoining field of first year clover suffered negligible damage from migration.

On the basis of this and other years' work, the laboratory now recommends shallow tillage in late July as soon as the hay crop is taken off. By this means the susceptible larvae are thrown into the heat of the summer sun where they perish. Crop rotation and planting of clover at a distance from other fields are obviously practical. In addition, deep ploughing of a marginally defoliated field in the fall is thought to provide some measure of control by burying the hibernating weevils.

FRUIT INSECTS

Mr. H. Richardson reported on work carried out by Mr. W. R. Allen and himself during the summer of 1947. This work consisted of a fairly extensive field test of DDT for the control of the adult currant fruit fly in currant patches near Morden and Miami and at the Morden Experimental Station. The DDT was applied in the form of a spray at the rate of one pound of DDT per 100 gallons of water per acre. At this rate approximately one half pint of spray was applied per bush. Two applications were made, one at blossom fall and one a week later.

Control was estimated from three one half pint samples of fruit taken at three successive dates from each plot. The first sample was taken when the first fruit infestation was noted and the other two at 10 day intervals. The fruit samples were suspended in wax paper cartons and kept until the larvae emerged and pupated. The infestation counts were made from the number of pupae in the samples. Reductions of fly infestation expressed in per cent were:

Red currants - - - - 97 to 100
Black currants - - - 55 to 85
Gooseberries - - - - 85
Missouri currants - 43.5 to 99

DDT residue analyses made on the ripe fruit, expressed in parts per million by weight were:

Red currants - - - - 1.04 to 3.87 P.P.M.
Black currants - - - 7.88
Gooseberries - - - - 1.38

The DDT tolerance is set tentatively at 7 P.P.M. Thus only in the case of the black currants was the residue over the tolerance limit and then only by .88 P.P.M. However, Mr. B. Berck, who ran the analysis, reported having difficulty in clearing the sample of colouring matter and it is thought that the colouring matter may have caused the determination figure to be higher than was the actual case.

Using this work and that of previous years, a control pamphlet has been drawn up by Dr. Bird and Mr. Allen and at present is in press.

GRASSHOPPER INFESTATION

Mr. D. S. Smith stated that there was no extensive economic infestation of grasshoppers in 1947 but that local infestations had been recorded in the south Red River valley near Morden and at several points farther west.

GRASSHOPPER NUTRITION

Mr. Smith summarized results of grasshopper nutrition studies carried out with the assistance of Miss F. E. Northcott. These concerned the effect of food plants on survival and oviposition of Melanoplus mexicanus mexicanus (Sauss.). Different cereal varieties were tested using grasshoppers hatched in the laboratory from eggs collected in the field rather than with partially-developed field-collected hoppers as had been done in previous years. The insects were reared in cages over flower pots in which the cereal varieties were grown. The pots were set in the ground in an open field. The tests used five varieties of wheat, five of barley and two of oats. Percentage survival of nymphs was determined for each variety.

Differences between the survivals of the grasshoppers fed on the different varieties of each cereal were not significant. Cumulative results of survival from the years 1944 to 1947 on the varieties which had been used continuously were also analyzed but again no significant differences could be discovered.

The previous season (1946) was the only year in which an appreciable number of eggs was obtained from rearings. The insects which fed on Regent and Carleton wheat produced considerably more eggs than those feeding on Renown or Nabawa. Those feeding on OAC 21 barley produced considerably less eggs than those feeding on Newal, Wisconsin 38 and Glacier.

Miss Northcott described another study of grasshopper nutrition in which her object was to determine the effect on survival, development and fecundity of M. mexicanus of differing nitrogen levels in one kind of food plant. Using sand culture methods with nutrient solutions, she attempted to produce plants of Renown wheat which differed because of various amounts of nitrogen available to them.

Two series of 50 nymphs each were raised on each of three different plant treatments which were designated Low, Medium and High Nitrogen. The grasshoppers, kept in two-quart sealers with screen tops, were fed cuttings from these plants. Mortality and development were checked daily. Upon reaching the adult stage, they were mated and allowed to oviposit.

Analyses of older plants, taken from pots of grain which had been used for feeding for several days, gave the following percentages of nitrogen: Low, 2.59; Medium, 3.12; High, 3.74. New material consisted of seedlings approximately one

week old which had not yet been cut for feeding. Analyses gave the following percentages of nitrogen: Low, 3.02; Medium, 3.52; High, 3.89.

The number of insects surviving at mating for the two series was almost parallel:

	1st	2nd
Low Nitrogen	25	11
Medium "	13	7
High "	12	4

High temperatures appeared to bring about a high mortality amongst those fed on Medium and High Nitrogen while a corresponding mortality did not occur in grasshoppers fed on Low Nitrogen.

Survival was so low that the number of eggs obtained was too small to be of much value for comparison, but it is noteworthy that no eggs were obtained from High Nitrogen insects in either series whereas Medium Nitrogen insects produced 0.64 pods per female and Low Nitrogen insects, 0.77 pods per female.

Stored Product Insect Laboratory: Dr. B. N. Smallman reviewed the work of the laboratory.

SPIDER BEETLE INVESTIGATION

The economic importance of spider beetles (Ptinidae) is due to their habit of ovipositing through the mesh of cotton flour sacks. The duration of the oviposition period is therefore important in timing the application of control measures. By placing indicator sacks in an experimental flour shed and sifting the enclosed flour for eggs at close intervals, it was determined that the oviposition period extends from about May 1 to July 15. There is an emergence of adults in the early fall but no eggs are laid until the following spring. These findings form the basis for the recommendation that control measures must be in effect during the period April to July.

Repeated observations have shown that adult spider beetles exposed in flour sheds throughout the winter suffer complete mortality. Yet adult beetles must survive the winter somewhere in the vicinity of the shed in order to account for the egg-laying activity in the early spring. Temperature measurements made during the past winter have shown that close to the ground under flour sheds the temperature remains markedly higher than in the shed proper

and spider beetles exposed under the shed survive the winter with low mortality. It is therefore concluded that the overwintering locale is the space under the flour sheds.

MILL INVESTIGATIONS

During the summer of 1947 a survey of insect populations in two large mills was carried out during the period March to October. The data were very disperse and significant differences were demonstrated only between mills and sampling periods. The mills were fumigated in March - four months after, the population had recovered to the pre-fumigation level. Certain milling machines and certain types of stock appeared to be more susceptible than others. A sampling study on a moving mill stream indicated that small samples taken at hourly intervals over an eight-hour period gave significantly higher counts of insects than larger samples taken at shorter intervals.

The above survey has provided a basis for planning an investigation of control methods in flour mills to be undertaken in the summer of 1948. The experiment will be carried out in four large mills and is designed to evaluate the effectiveness of eight types of treatment for controlling insects in elevator boots.

FUMIGANT STUDIES

Mills commonly apply "spot fumigants" to individual mill machines with the object of killing insects which build up heavy populations in dead stock in such machines. The control obtained is of short duration because the fumigant soon evaporates and provides no protection against re-invasion. Laboratory tests had been carried out to determine whether certain low vapour pressure fumigants can be retained in open vessels of flour in sufficient concentration to kill insects for considerable periods of time. A marked relationship between vapour pressure and longevity of fumigant action has been demonstrated. Fumigants of moderately high vapour pressure fail to kill insects a few days after application, whereas, under the same conditions, low vapour pressure fumigants have continued to kill insects for 100 days or more.

IMPREGNATION OF PACKING MATERIALS WITH RESIDUAL INSECTICIDES

During the investigation of control methods for spider beetles it was shown that cotton flour sacks impregnated with DDT were highly effective in protecting the enclosed

flour. Because of the toxic hazard of DDT in direct contact with food stuffs, it was impossible to exploit this finding. However, the recently developed insecticide combination of piperonyl butoxide with pyrethrins is non-toxic and is said to have residual properties comparable to DDT. Accordingly, an investigation is being carried out at the present time to determine the protection afforded against insect infestation when cotton flour sacks are impregnated with this insecticide. Another study, presently under way, is concerned with the possibility of depositing a DDT residue on cardboard food cartons during the process of manufacture by means of a Tifa Aerosol Generator.

CHEMICAL STUDIES WITH DDT

Mr. B. Berck reported on chemical studies with DDT during the past year.

Certain problems undertaken by the laboratory require the use of chemical methods for measuring DDT. The Schechter-Haller spectrochemical method with slight modifications has been adapted as a standard procedure for DDT residue analysis. In addition, the labile Chlorine semi-micro method has been applied to certain problems, and found to be relatively simple, and rapid for the range 2 - 750 mg. DDT.

A study of the loss of DDT residue from the surfaces of railway box cars during transit indicated that distinctly smaller losses occurred with water-emulsion or oil-solution formulations than with a water-suspension formulation. A more refined study, involving better control of the initial DDT residue and an attempt to isolate some of the factors affecting the residue, is planned for the summer of 1948.

Determinations of DDT residues on fruits and vegetables were made at the request of other Dominion Entomological Laboratories. The labile Chlorine method was used to determine the DDT content of certain proprietary insecticides.

Present assignments include the determination of DDT in river water in amounts ranging from 1:5,000,000 to 1:100,000,000, and determination of DDT residues applied to food packaging materials. Further co-operative studies of DDT residues on fruits and vegetables have been planned with the Dominion Entomological Laboratory at Brandon.

PUBLICATIONS

During the year a bulletin entitled "The Control of Spider Beetles in Western Canada" under the joint authorship of B.N. Smallman and H.E. Gray, was issued by the Canadian National Millers' Association. A paper "Effectiveness of Residual Insecticides for the Control of Spider Beetles (Ptinidae) in Cereal Warehouses" by B. N. Smallman, and a paper "Chemical Methods of Measuring DDT" by B. Berck and B.N. Smallman, were submitted for publication.

Plant Inspection Office: The Plant Inspection Office at Winnipeg collaborated with the Dominion Entomological Laboratory at Brandon during 1947 by assuming responsibility for a portion of the adult grasshopper survey conducted by that laboratory. A triangular area bounded by Winnipeg, Poplar Point and Riverton was covered by this staff in August and September.

In July and August the Plant Inspection Office covered a number of market gardens in the Winnipeg area in further collaboration with the Brandon laboratory which was conducting a garden insect survey.

The latter survey was both qualitative and quantitative in its scope while the grasshopper survey was to determine the adult populations of economic species.

Department of Entomology, University of Manitoba: Mr. W. S. McLeod reported on a seasonal survey of alfalfa insects.

SEASONAL SURVEY OF ALFALFA INSECTS

During the summer of 1947 a survey of insects in the alfalfa plots at the University of Manitoba was made by Mr. W. J. Turnock, student assistant in the Department of Entomology, as a contribution to the work of the Committee on Seed-Setting in Alfalfa. Samples of the insect population were taken every week, starting on June 11 and ending on September 16.

The aphid population was found to build up slowly through June to a tremendous population on July 15, decreasing rapidly to a very low level at the end of July. On July 15, 4500 aphids were collected in a few minutes by sweeping with a net.

The alfalfa plant bug, Adelphocoris lineolatus (Goeze), showed a considerable population of immature forms on July 2 but decreased during the latter part of that month. Another peak of immature bugs was found on August 21, with

large numbers of adults present at this date. Adults continued to be numerous throughout the latter half of August, diminishing in numbers during September.

The rapid plant bug, Adelphocoris rapidus (Say), was found in small numbers in late August and early September while considerable numbers of the tarnished plant bug, Lygus oblineatus (Say), were found in September. Miscellaneous Miridae were found in small numbers throughout the season with peaks of population occurring on July 2, August 6 and the period from August 27 to September 9 inclusive.

The population of wild bees was low, 5 being taken on July 8, 9 on August 6 and 8 on September 2, though 2 or 3 were taken on several other dates. The numbers of honey bees, Apis mellifera L., ranged from 20 to 30 in each weekly collection from July 22 to August 21. A smaller number was taken on August 27 but the population in alfalfa plots rose to 39 on September 9, dropping to none on September 16.

BEE-KEEPING STUDIES

Professor A. V. Mitchener briefly reviewed his paper recently published in the Journal of Economic Entomology on Manitoba honey flows. Over the past 20 years, the peak of honey flow has moved forward about a week.

Current work includes the maintenance of swarming records and a study of the winter food requirements of bees at various temperatures. The bees, kept at constant temperature and humidity, were fed saturated sugar solution in measured amounts. The bees died before spring possibly owing to lack of protein in the food.

Professor Mitchener also commented on the general importance of honey bees to agriculture. It has been estimated that they are worth ten to twenty times the value of their honey.

Forest Insects: Mr. R. R. Lejeune outlined the projects of the Dominion Forest Insect Laboratory at Winnipeg and then spoke briefly about the Forest Insects Control Board.

FOREST INSECTS CONTROL BOARD

One of the most significant advances in Forest Entomology in the Prairie Region during the past year was the appointment of Mr. D. M. Stephens, Deputy Minister, Manitoba Department of Mines and Resources, as the Prairie

Provinces Representative on the Forest Insects Control Board. Acting on an invitation from Mr. Stephens, a regular scheduled meeting of the Control Board was held in Winnipeg in February, 1948, jointly with a newly formed advisory committee on Forest Entomology for the Prairie Provinces. The latter was also formed largely through the backing of Mr. Stephens. Regional forest insect problems were thoroughly discussed at this organizational meeting of the Prairie Committee and its views and recommendations submitted to the Forest Insects Control Board.

FOREST INSECT SURVEY

Mrs. W. S. Barker, reporting on the forest insect survey, one of the major projects of the Winnipeg laboratory, said that Mr. H. R. Wong and herself are employed on the survey and are to be assisted for the summer of 1948 by Mr. W. J. Turnock. The field staff of forest insect rangers consists of a head ranger and six others working in various districts of Manitoba and Saskatchewan. The forest insect survey is closely integrated with the other laboratory projects. The following is an outline of the 1948 program:

Sample plots and stations

Continuation of establishment of permanent sample plots and stations in all forest districts to provide needed continuity in observing fluctuations of insect populations.

Larch sawfly

Samples and observations to determine distribution, intensity of infestation and damage.

Search for evidence of disease in larch sawfly. (The diseased material will be forwarded promptly to insect disease specialists for culturing.)

Continued surveys to determine efficiency of parasites, predators and other natural controls.

Survey of conditions in tamarack stands: moisture and drainage of the site, type of ground cover, composition and density of the stand and age classes represented.

Determination of areas where heavy mortality is anticipated in tamarack of commercial size.

Studies on the establishment and dispersal of parasites liberated in selected areas.

Spruce budworm and jack pine budworm

Detection of these insects in Manitoba and Saskatchewan.

Mass collections to provide information on parasites, predators and diseases.

Search for evidence of disease.

Observations on infested stands; stand composition and

density, age classes represented, etc.
Study of the effects of a planned cutting program on the jack pine budworm infestation in Sandilands Forest Reserve, Manitoba. (Some control of the infestation may be achieved by the elimination of stands which are susceptible to budworm attack.)

Plantations
Survey of insect conditions to determine the foremost insect pests and extent of their damage.

Bronze birch borer
Survey of birch stands to determine the extent of 'die-back' and presence of bronze birch borer in unhealthy trees.

Other studies concern methods of insect feeding, sampling methods and insect life histories. Mr. Wong is making a special study of sawflies.

Dr. Bird added the comment that drought weakens poplar. Several fungi, of which one is Fomes ignarius, attack the weakened trees. The poplar borer also attacks such trees as well as those damaged by winds.

THE RELATIONSHIP OF JACK PINE BUDWORM POPULATION FLUCTUATIONS TO POLLEN PRODUCTION

Mr. W. F. Black stated that, for a number of years, one of the major projects of the Forest Insect Laboratory in Winnipeg has been the study of the relationship of pollen to the budworm. To date, a number of important points have been established:

(1) Jack pine budworm larvae show a definite preference for staminate cones as a feeding site as compared to terminals. This has been established through population counts.
(2) There is a definite migration of budworm larvae to staminate cones in the spring and away from them when pollen is shed. This was established through population counts taken throughout the feeding period. Actual migration of larvae on their silken threads is readily observed in the spring, in areas where high populations prevail.
(3) Larvae having access to staminate cones have a greater rate of development during their early stadia than larvae feeding on foliage. This usually results in the 'terminal' larvae being several days later in maturing than 'staminate' larvae.

(4) Graphical representation of pollen production and larval population densities for successive years indicates that larval populations are proportional to pollen production.

That budworm population fluctuations are correlated with pollen production seems very likely from the foregoing evidence. To establish this relationship definitely, it is necessary to discover some way in which the budworm benefits from its association with staminate cones in such a way as to influence population fluctuations.

For several years, experiments have been conducted on the influence of pollen on larval survival and on oviposition and fecundity. From these experiments, pollen does not appear to exert a differential effect on oviposition and fecundity. This negative relationship may, however, be due to errors in our procedure. Further experimentation on this phase is contemplated for 1948.

It has been thought for some years that staminate cones as a food constituted a beneficial factor in building up budworm populations by increasing the rate of survival. While a significant difference in the rates of survival of 'staminate' and 'terminal' larvae has been found for several years, this difference may be due to errors in technique and procedure. Procedure and methods have varied from year to year in order to decrease the possibility of error in our experiment.

Originally large cages containing large numbers of larvae were used in the rearings. In the following years, the cage size and contained number of larvae have been reduced while the number of replicate cages have been increased. In 1948, the larvae will be reared individually in a special type of rearing jar, which is 'larva tight' and which allows for conditions of high temperature and high humidity. Using this type of jar in a 1947 preliminary experiment, 100 per cent survival for larvae on both food types was obtained. These results led us to suspect that microclimatic conditions in the cones were a major factor in larval survival rather than pollen itself. With this possibility in mind, series of both types of larvae will be reared under conditions of controlled temperature and humidity.

With the evidence so far secured, and should the experiments planned for 1948 prove satisfactory, it may be

possible to show that budworm population fluctuations are influenced by pollen production through an increase in the rate of survival and to determine tentatively whether it is the microclimatic or the nutritional factors in staminate cones which cause the differential rate of survival.

Assuming that pollen production is a factor in budworm outbreaks and their rise and fall, the Manitoba Forest Service has inaugurated an extensive cutting program whereby heavily infested timber and chronic pollen-producing timber will be removed. The areas to be cut will be examined before cutting and for several years afterwards to see just what effect such a system of cutting has on budworm infestations and the damage caused by the budworm.

LARCH SAWFLY

Mr. B. Filuk spoke on work done during the 1947 season on the larch sawfly which has become the principal problem of the laboratory. A study of the effect of moisture conditions in tamarack swamps on hibernating larvae in cocoons had been started the previous fall. Moss-packed, screened frames containing cocoons were placed at various levels above and below the normal water level. Fall examinations of sample cocoons from these frames showed no mortality. The spring examination in 1947 was delayed by flood conditions until June 12. Complete mortality was observed in those submerged continuously and intermittently. Some survival was noted of those buried above the water level.

In laboratory studies, some larvae in cocoons subjected to wet conditions in the fall and dry conditions in the spring survived whereas those kept dry in the fall and wet in the spring all died.

Indications are that the 'pronymph' larva may be the critical stage for flooding. Under natural conditions in the spring cocoons picked up at random contained insects in the 'conymph' larval stage if under water, but, if above water, some were further developed to the 'pronymph' stage or to the pupal stage.

A four-year study of a method of estimating sawfly populations by successive cocoon counts in a unit area of ground cover beneath each quadrant of a tree's canopy has shown inter-tree variability to be much greater than intra-tree variability.

Mr. Filuk outlined the distribution of larch sawfly in Manitoba and Saskatchewan. Most tamarack stands were attacked to some degree but the main body of the outbreak was confined to Manitoba and a limited area of eastern Saskatchewan.

Mr. J. Muldrew spoke briefly on larch sawfly work which he planned to do during the 1948 season. Population estimates based on tamarack defoliation had proved inaccurate because defoliation was difficult to judge visually. Cocoon counts for the purpose had proved very time consuming. A method of estimating populations by the number of curled twigs which indicate egg-laying was to be tested.

Another study, concerning the relationship of larch sawfly to its parasite, Mesoleius aulicus, was to be undertaken to explain an evident resistance by the host to the parasite. The oviposition period of Mesoleius was to be determined.

Ecological work planned included the recording of temperatures and pH's of swamp waters and their chemical analysis.

THE NOVEMBER MEETING

The fall meeting was held in the Horticulture Building, University of Manitoba, Fort Garry on November 16, 1948.

The Business Session

The meeting began with a brief business session which was attended by twenty-eight members.

Mrs. W. S. Barker reported that Volume 3 of the Proceedings of the Society, long overdue, would appear soon.

The International Great Plains Conference of Entomologists had been held on invitation of the Society at Wasagaming in Riding Mountain National Park from August 23 to August 25, 1948. The Secretary-Treasurer presented a statement on the financing of this very successful twenty-first annual meeting. Mr. C. A. S. Smith who acted as editor of the report of the I.G.P.C.E. meeting, received congratulations for his excellent and prompt publication.

The members of the Manitoba Society were pleased to learn that the Entomological Society of Ontario had accepted an invitation to hold its 1949 Annual Meeting in Winnipeg. The executive was empowered to set up committees to make preparations for this event.

A letter was read from Mr. W. A. Ross, Chairman of the Committee for the formation of a Canadian Entomological Society, which stated that the committee had been forced by lack of governmental support to abandon its objective temporarily and to concentrate on strengthening existing organizations and The Canadian Entomologist. The Secretary-Treasurer reported on the Montreal meetings of the Entomological Society of Ontario which he had attended. With regard to matters of organization, it was evident that emphasis had shifted from national organization to an adequate journal for Canadian entomologists. To this end, improvements were to be made in the publication mentioned.

The minutes of this meeting are included as Appendix I of these Proceedings.

The Scientific Session

When the business session had concluded, visitors and members heard three speakers who presented reviews of topics of entomological interest. To allow increased time for discussion by audience and speakers, the number of papers was reduced from that of the November 1947 meeting.

In the morning, Mr. W. R. Allen of the Dominion Entomological Laboratory, Brandon, gave the first review, on some of the equipment and techniques applicable to insect physiology. He used blackboard sketches to illustrate the equipment which he described.

During the afternoon, Dr. A. J. Thorsteinson of the Department of Entomology, University of Manitoba, spoke on the subject "Chemotropisms", with particular reference to plants and insects. Mr. W. B. McTavish then presented a paper, "Recent Work on Mites and Diseases". He illustrated his talk with slides of some mite vectors of disease.

At 6.30 P.M. a banquet was held in the Marlborough Hotel in Winnipeg. Dr. A. Savage of the Provincial Veterinary Laboratory was the guest speaker. His topic, "Cycles", in nature and in economic affairs, aroused great interest and led to a lively and enjoyable discussion.

Texts of the papers presented by Dr. Thorsteinson and Messrs. Allen and McTavish are included in the following pages of these Proceedings.

THE APPLICATION OF SOME EQUIPMENT AND TECHNIQUES TO INSECT PHYSIOLOGY WITH SPECIAL REFERENCE TO USES AND LIMITATIONS

W. R. Allen

The techniques which may be applied to the study of insect physiology are numerous and diverse. It is not the object here to discuss thoroughly all the methods which have been used to establish a better understanding of the living processes in insects, but to consider some of the recent approaches which have been made.

The purpose is rather to show how several branches of science, too often considered to be mutually exclusive, may bring forth in concert information of biological significance. It appears that this trend is to be expected when a branch of science begins to occupy itself with systematic quantitative results from which an interrelated and logically consistent scheme will be built up. This trend probably began in biology with the invention of the microscope, for then the biologist became involved in at least an appreciation of optics.

The microscope now has many forms for diverse purposes. Each type of microscope elucidates a different facet of the biological story. No one instrument reveals all that can be known about the nature of a particular structure, tissue or compound, but it may yield characteristic information about them, or at least corroborate similar information obtained with another instrument or even by another experimental method.

The arbitrarily chosen examples will be illustrative of these points.

The fluorescent microscope.

The fluorescent microscope has been applied to insect physiology by R. L. Metcalf and R. L. Patton. They have discussed (13) the equipment necessary and the technique used in intravital work made possible by the fluorescence of biological products, such as riboflavin or vitamin A, or by the use of nontoxic fluorescent dyes. Also, they have considered the use of fluorescent dyes in fixed preparations.

Fluorescence is a phenomenon observable in substances which, when exposed to ultraviolet irradiation, absorb energy and emit part of this in the form of light, of a longer wavelength than the activating rays. The production of fluorescence in biological material is excited effectively by rays between 3500 and 4000A°. The most satisfactory light source is a high-pressure mercury vapor arc lamp, although a 500 watt tungsten projection lamp may be used for less critical work. The lamp should be enclosed in a lamp housing equipped with a condenser and a diaphragm, and it should be mounted on a rod or track so that its position relative to the microscope can be accurately adjusted. A filter must be interposed between the light source and the mirror of the microscope to remove all the visible light, so that the fluorescent light produced by the ultraviolet beam can be observed. A suitable filter prepared by Corning transmits radiations between 3000 and 4000A° and a very

small amount of visible light. The latter should be absorbed by using a glass cell one centimeter in thickness containing a 5-10% $CuSO_4$ solution plus a few drops of H_2SO_4. When the fluorescing substance is red, this is particularly important.

The usual plane microscope mirror is satisfactory, unless the intensity of fluorescence is low; then aluminum-coated mirrors, or reflecting disks made of this metal are required.

Quartz lenses are not needed in the substage condenser because the fluorescence in biological material is excited principally by light with wavelengths between 3500 and 4000A° and a high percentage of these rays readily penetrate glass. The aplanatic condenser allows for a greater concentration of light, but the Abbé condenser is also satisfactory. It is important that the condenser be fitted with a removable dark field disk so that the luminous object shows up conspicuously against a black background. Standard microscope equipment satisfactorily completes the system. However, an auxiliary filter to absorb stray ultraviolet light within the microscope is used to prevent a disturbing fluorescence of the eye or the fogging of a photographic film. Ordinary glass microscope slides can be used but not the ordinary permanent mounting media, which contain fluorescent components.

The authors describe a simple vertical illuminator for intravital studies. A microscope is adapted so that the ultraviolet beam enters a side opening in the objective and is directed down by a mirror through the lenses of the objective, which condenses the beam on the object being viewed. Fluorescence is then maximal at a close working distance and there is no optical distortion due to oblique illumination.

Fluorescence finds its greatest application in the differentiation of functional tissues within an organism. Some tissues contain naturally fluorescent pigments and they may be easily traced. Several flavin compounds (e.g. riboflavin), carotenes (vitamin A), porphyrins, and some alkaloids may be localized. The color of fluorescein dye varies with pH and accordingly may be used as an intravital (7) pH indicator. The differentiation of various tissues, including muscle, nerve, and fat, can be accomplished to some extent by the use of fluorescent dyes, some of which are fairly selective in their action.

It has been demonstrated (11, 12), using the fluorescent microscope, that the malpighian tubules of Periplaneta contain a green yellow fluorescent fluid in the lumina of the distal portions of the tubes. This is "free riboflavin". In the basal portions of the tubes, orange fluorescent grain (0.5 - 1.5 microns in diameter) in the form of "bound" or cytoplasmic riboflavin occurs in the cytoplasm of the cells comprising the tube walls. It is non-diffusible and unaffected by oxidation and reduction agents. This large concentration of riboflavin in the malpighian tubules (30 times that of beef liver) is believed to be present as a storage supply, not as an intermediate in the excretion of the material. Free riboflavin is absorbed from the blood by the

distal portions of the tubes and is stored in the "bound" metabolized form in the proximal portions of the tubes. On prolonged riboflavin deficiency the storage is gradually mobilized. It was also shown that certain other B-vitamins present in the tubules exert an important influence upon the riboflavin storage and mobilization. Pantothenic acid is effective in converting the cytoplasmic form of flavin to the free form. Thiamin acts in much the same way but is slower and less effective.

Coon (6) has shown how the fluorescent dye, fluorescein, may be used as an indicator of blood circulation. This is accomplished by injecting fluorescein into one of the cerci so that the indicator enters the posterior opening in the dorsal vessel. After the blood is pumped forward the fluorescence can be detected under ultraviolet light. And it is visible in unsclerotized areas, on the ventral part of the body and on the appendages, as it moves back to the point of injection. It is indicated that this technique could be used in studying the toxicology of various poisons.

The phase microscope.

The phase microscope is something new in microscopy. It is useful because many tissues and cells which are too transparent to be viewed under the ordinary bright field microscope may be visualized and photographed without chemical treatment. The microscope decreases the apparent optical homogenity in such cases by utilizing the optical path difference within the instrument to increase or decrease contrast in the image. In other words, slight optical path (thickness x refractive index) differences in an apparently homogeneous specimen are magnified by the instrument.

The phase microscope has an annular diaphragm at the front focal plane of the condenser, and a diffraction plate is located in the objective between the lens systems in such a way that the light reaching the plate from the annulus is brought to a focus as a bright ring of light, and covers what is termed the conjugate or image area. Descriptive diagrams and articles (2, 3, 18, 20) should be consulted for the details. There are several types of diffraction plates. In the common bright contrast type, the conjugate area of the optical glass plate is covered by thin layers of a dielectric and a metal. With this diffraction plate the specimen is observed with bright contrast (regions of greater optical path will appear brighter than regions of the same size whose optical path is shorter). This may be partially explained in the following way. When a specimen is in focus on the type of diffraction plate described, light passing through an area of lesser optical path in the specimen is undeviated and enters the conjugate area where its phase is retarded by approximately one-quarter of a wavelength relative to a deviated ray, by the dielectric and metal. Also the amplitude of this wave front is decreased. This area of the specimen, of shorter optical path, would appear dark because the amplitude difference can be recognized by the eye and the phase change will cause the destruction of rays which are completely out of phase. Intermediate tones would result from different mixtures of phase retardation and decreases in amplitude. The history of a ray which is deviated by an area

of greater optical path in the specimen is different. It misses the conjugate area, its phase would be retarded but little and the amplitude probably not altered at all. The degree of phase change depends on the amount the ray is deviated, which is an expression of the optical path encountered in the specimen. Both wave fronts have drawn energy from all parts of the object and as interference takes place the lighter areas in the image corresponds to areas of greater optical path in the specimen. The sum total of light in the image plane is unaffected since there is only a redistribution rather than a destruction of luminous energy.

The construction of the diffraction plate can affect differentially both the deviated and undeviated light from the specimen and the undeviated light from the background. A diffraction plate constructed in a reverse fashion from the one described, so that the deviated rays are retarded and partially absorbed, gives rise to dark contrast. This corresponds to the usual absorption type of image seen in the bright field microscope. Such images are preferred for measuring objects or resolving fine detail.

The resolution in this microscope is about as good as in the ordinary microscope and can be somewhat improved by the use of monochromatic light. Its most promising possibilities in biology lie in the experimentation with living material for the effects of drugs, vitamins and other agents on protoplasm may be studied. Differences between unstained living protoplasm and fixed and stained specimens, such as protozoa and other microorganisms, may well be observed. With the motion picture camera the details of ciliary action and of amoeboid and flagellar movements can be clearly recorded. The determination of refractive index by the immersion method using this instrument (20) becomes very accurate.

The electron microscope.

The electron microscope has marked a great step forward in our desire to perceive and understand the very minute. Our vision has been extended a hundredfold (22) and now spans the range of organized matter that extends from the animate to the lifeless macromolecules which are the basic units of chemistry.

The great advantage of this instrument (21) is its great powers of resolution. The eye can distinguish spots about 0.1 mm. apart. Accordingly, if two spots are to be clearly seen, they must be magnified up to this scale at least. Firstly, however, the particles must be separated to the extent that the first light wave diffracted by the particles can come into view between them. The physical limit to this distance is about half a wavelength, and only if this distance is exceeded can two spots be recognized as distinct. Secondly, then, the degree of resolution depends on the wavelength of the light used. For visible light, particles about 0.2 microns apart are resolved, with ultraviolet light particles 0.1 microns apart appear distinct. Electrons, however, act like waves and their wavelength depends on their speed. With

cathode rays having an energy of 45 kv., a resolving power of 0.01 microns is readily obtainable and results two or three times as good are possible, the latter being not too far below those predicted by theory. However, 300 kv. instruments are in operation which approach a resolving power of 25.0A°. The instrument consists essentially of three magnetic lenses which correspond to the condenser, objective and ocular of an ordinary microscope. A stream of electrons is generated in a hot cathode and are accelerated by 45 - 300 kv. through the evacuated system. They are deflected by the magnetic lenses and brought to a focus on either a photographic plate or a fluorescent screen.

Although extreme magnifications of 20,000 to 150,000 diameters are obtained there are several limitations. The voltage supply which accelerates the cathode beam must be maintained within one volt, because electrons travelling at different speeds are bent differently by the magnetic lenses and good definition becomes impossible because of the patterns produced by stray electrons.

Serious limitations are that living material cannot stand (10, 22, 23) the high vacuums and the electron beam is very destructive (15) and may even burn up organic material.

It is also true that tissue sections have to be generally less than 0.5 microns in thickness (preferably the order of 0.1 microns) to be viewed. One reason is that even when driven by 45 kv. the penetrating power of electrons is low. More serious however, is the requirement that they must penetrate with little loss of speed or the electrons cannot be properly focused, as was indicated above. It is partially because of this limitation that bacteria, viruses and bacterio-phage, by virtue of their extreme thinness, have provided excellent objects for study. Finally, a serious limitation in electron microscopy is the very real difficulty in interpreting the pictures prepared. Verification by alternative methods must be sought to support interpretations of micrographs because artifacts may easily be produced.

The electron microscope with its great resolving power has been used extensively to study the micro structure of the insect cuticle. With this instrument two types of structures (1) responsible for the physical color in insects have been studied.

The structure of the cuticle of Periplaneta (15) was investigated in detail. The pore canals were minutely described and it was shown that at least in the cockroach they do not reach the surface of the epicuticle. The laminate nature of the exo- and endocuticle, indistinctly observed by means of the bright field microscope, was clearly pictured, and it became evident that these layers demarcate material of different densities, inasmuch as electron micrographs are essentially density pictures. Removal of the protein and other non-chitinous material destroys the laminar structure and it may be that the chitin micelles are more closely packed in the dense laminae and this packing is more tightly polymerized with protein.

The respiratory system was examined. Taenidia were shown to be present (16) in the tracheole, being represented by thickenings about 0.01 microns wide. They had been beyond the resolving power of the light microscope. Recently (17) microfibrils 100 - 300A° wide were found in tracheae on partial purification, i.e., after most of the protein was removed. The nature and function of such structures, or why they occur following such treatment, is unknown. They may represent the grouping together of 5 to 20 chitin lattice units which are arranged with their long axes along the tube proper and, oppositely, with the long axes across the tube in the taenidia. If this view is correct, a pattern of a strong structural design is provided.

Fast motion picture technique.

Fast motion cine-photomicrography has led to very significant advances in our knowledge of living cells. This technique has been assisted by improved, microphotographic and tissue culture methods. Speidel (19) has successfully used the frog tadpole in his studies. The tadpole is placed in a cell arranged on a microscope slide so that the transparent tail region can be observed with a microscope. The microscope is linked up to a motion picture camera which is driven by an electric motor in such a manner that the rate at which the pictures are taken can be controlled. If pictures are taken at a rate of one frame every eight seconds, then projected on the screen at the rate of 16 frames per second, movement is accelerated 128 times. One minute on the screen then represents more than two hours of actual life. The main features of the method are that a record is made from a living animal, minute detail is revealed because oil-immersion magnification is commonly used, and a day-to-day study of the cells in a particular region over an extended period may be accomplished.

As an example, the information obtained about the growth and regeneration of nerves is of considerable interest. The growth cones of nerves extend and retract delicate fingerlike processes with an amoeboid-like locomotion as if exploring a route through the tissue. When they are blocked by some obstacle, as by a connective cell process, they retract, then start off in another direction. A pioneer fibre is first shot out from the growing tip and the growing tips of the other fibres follow more or less closely its path through the tissue.

One theory of nerve regeneration has held that the sheath or "Schwann cells" oriented themselves in a chainlike formation and then generated the nerve fibre substance. The other theory maintained that nerve fibres grew out from the existing nerve fibres and that the sheath cell though present played no part. This theory has been confirmed. It is now evident as a result of these studies that the sheath cells originating from the central nervous system have an affinity for nerve fibres and glide along them, multiplying by mitotic division. The sheath cells continue migrating and dividing until there is an ample supply capable of lining up 'tandem-

like' to form a tubular neurilemma. The ensheathment of fibres with myelin, when myelinization occurs, proceeds as follows. Sheath cells slide out along the fibre from a myelinated portion of the nerve and take up positions at suitable intervals. New myelin segments form between the sheath cell and the fibre. This seems to be a true co-operative activity between them because tissues are necessary for the formation of myelin.

This method of study has revealed some of the interesting movements of leukocytes and lymphocytes in and out of blood and lymph vessels, and also the anastomosing of blood vessels. Fast motion photography also portrays excellently the return of red blood cells, from the surrounding tissues into which they may have escaped, to the blood vessels via the lymphatic system.

Partition chromatography.

Partition chromatography on paper which has been developed in the last four years (4, 5, 9) offers a technique which is particularly adapted to physiological investigations of insects. This technique provides a relatively simple method for the qualitative analysis of amino acids and it is being rapidly extended for analysis of sugars, flavins, purine and other substances. Particularly advantageous is the fact that small quantities of substances may be analysed. Workers at Cornell (14) have found that most of the free amino acids in 25.0 microliters of insect blood can be qualitatively identified by this method.

Chromatography was developed (24) by Tswett in 1906 and it has found application in many fields. The method depends on the fact that adsorption phenomena are highly selective; if there are several compounds in a solution, each one displays a different degree of affinity for a particular solid. For instance, if a solution of leaf pigments is allowed to percolate slowly through a column of magnesium oxide (9) the chlorophylls are most strongly adsorbed at the top of the column and appear as a green band, the yellow xanthophylls are isolated below them, and further down the column the brownish yellow carotenes, having the least affinity for this adsorbent, are retained in a band. Separation of these materials can be effected by cutting the appropriate sections out of the tube and removing the compounds with another solvent.

If a drop of fluid containing four amino acids is placed on the top of a strip of filter paper and it is hung from a glass trough in an atmosphere saturated with butanol and water and if solvent saturated with water is allowed to siphon over and down the strip for 4 - 48 hours, the amino acids are concentrated at different locations on the paper. These locations may be observed by allowing the paper to dry and then developing a typically bluish color by spraying with a solution of ninhydrin (14) and heating for a short period. The four blue spots can be identified from their relative positions.

But since no single solvent has been found which will separate all the common amino acids on a long strip of paper, better separation has been obtained by using a two-dimensional technique (4, 9). The mixture for analysis is applied near one corner of a rectangular sheet of filter paper and chromatographed in one direction with one solvent, then in a direction at right angles with another solvent. The components are distributed over the area of the paper and by choosing two solvents with different properties, such as water-saturated phenol for one direction and water-saturated s-collidine for the other, most of the common amino acids can be separated and their position indicated by treatment with ninhydrin. For the constituents of some biological mixtures, maps have been prepared which show the characteristic positions which the amino acids occupy after certain solvents have been used.

Heavy water as a tracer.

An interesting study by Govaerts and Leclercq (8) demonstrates one use of heavy water in physiological studies. Insects were kept in air saturated with water vapor which contained 8.0% heavy water, and it was demonstrated that the body water comes into equilibrium with atmospheric moisture in a few days. The body moisture of Tenebrio larvae contained 8.0% heavy water after 13.0 days, that of Tenebrio adults after 9 days, Leptinotarsa and Graphosoma adults came to equilibration in 9.0 and 5.0 days respectively. There is apparently a continuous moisture exchange in saturated air.

Genetics and organic chemistry.

Zechmeister (24) gives an excellent example of how some of the modern techniques of organic chemistry, which are basically physical in method, may be co-operatively used to produce results which are biological in outlook.

It has been known for a long time that a certain red yeast mutates to produce orange, yellow and white forms upon surviving an exposure to ultraviolet light. By means of chromatography and spectroscopy, the component pigments responsible for color in each of the mutants were determined. The original red cells contained torulene, a purplish red carotenoid; several orange and yellow components; and a colorless compound called phytofluene, the isolation of which was made possible by its fluorescence in ultraviolet light. The orange form contained little red pigment but greater amounts of the orange and yellow carotenoids and phytofluene, while the albino had only traces of any of these pigments. "All molecules of the colorless, orange, and purplish-red representatives of this class of compounds are built on the same general pattern, but they differ from each other essentially in their hydrogen content. The less hydrogen that is present the more double bonds there will be contained in the molecule, and the more intense will be the color in most cases." The biosynthesis of these pigments is outlined in the following manner.

"Starting from colorless precursors and phytofluene, a stepwise elimination of hydrogen ('dehydrogenation') takes place which is terminated by the formation of purplish-red torulene. In the orange mutant this normal process is genetically blocked just before the last step. However, in the albino mutant such a blocking occurs at a much earlier stage of the biosynthesis, before even phytofluene could accumulate. So far no mutant has been observed in which blocking occurred just after the phytofluene stage had been reached; this would produce a colorless mutant whose extract would fluoresce strongly. However, such mutants (and other new types) may well be detected in the future.

REFERENCES

1. Anderson, T.F., and A.G. Richards. An electron microscope study of some structural colors of insects. J. Appl. Physics 13:748-758. 1942.

2. Bennet, A.H., H. Jupnik, H. Osterberg, and O.W. Richards. Phase microscopy. Trans. Am. Micr. Soc. 65:99-131. 1944.

3. Burch and Stock. Phase-contrast microscopy. J. Sci. Instrum. 19(5):71-75. 1942.

4. Consden, R., H.H. Gordon, and A.J.P. Martin. Qualitative analysis of proteins: a partition chromatographic method using paper. Biochem. J. 38:224-232. 1944.

5. Consden, R. Partition chromatography on paper, its scope and application. Nature 162:359-361. 1948.

6. Coon, B.F. Effects of paralytic insecticides on heart pulsations and blood circulation in the American roach as determined with a fluorescein indicator. J. Econ. Ent. 37(6):785-789. 1944.

7. Ellinger, P. The site of acidification of urine in frogs' and rats' kidneys. Quart. J. Expt. Physiol. 30:205-218. 1940.

8. Govaerts, J., and J. Leclercq. Water exchange between insects and air moisture. Nature 157:483. 1946.

9. Martin, A.J.P. The principles of chromatography. Endeavour 6(21):21-28. 1947.

10. Marton, L., N.N. Das Gupta, and C. Marton. Modifications of specimens in electron microscopy. Science 104:35-36. 1946.

11. Metcalf, R.L., and R.L. Patton. A study of riboflavin metabolism in the American roach by fluorescence microscopy. J. Cell. and Comp. Physiol. 19(3):373-376. 1942.

12. Metcalf, R.L. The storage and interaction of water soluble

vitamins in malpighian system of Periplaneta americana (L.). Arch. Biochem. 2:55-62. 1943.

13. Metcalf, R.L., and R.L. Patton. Fluorescence microscopy applied to entomology and allied fields. Stain Tech. 19(1):11-27. 1944.

14. Pratt, J.J., and J.L. Auclair. Sensitivity of the ninhydrin reaction in paper partition chromatography. Science 108:213-214. 1948.

15. Richards, A.G., and T.F. Anderson. Electron microscope studies of insect cuticle with a discussion of the application of electron optics to this problem. J. Morph. 71:135-183. 1942.

16. Richards, A.G., and T.F. Anderson. Electron micrographs of insect tracheae. J. N.Y. Ent. Soc. 50:147-167. 1942.

17. Richards, A.G., and F.H. Korda. Studies on arthropod cuticle. II. Electron microscope studies on extracted cuticle. Biol. Bull. 94:212-235. 1948.

18. Richards, O.W. Phase photomicrography. J. Biol. Phot. Assoc. 16(1):29-38. 1947.

19. Speidel, C.C. Living cells in action. Am. Scientist 36(2):237-257. 1948.

20. Taylor, E.W. The practical application of phase-contrast to the biologist microscope. J. Roy. Micr. Soc. 66:1-8. 1946.

21. Thomson, George. The electron microscope. Endeavour 2(8):125-135. 1943.

22. Wyckoff, R.W.G. Some recent developments in the field of electron microscopy. Science 104:21-26. 1946.

23. Wyckoff, R.W.G. Frozen-dried preparations for the electron microscope. Science 104:36-37. 1946.

24. Zechmeister, L. Chromatography and spectroscopy in organic chemistry and stereochemistry. Am. Scientist 36(4):505-515. 1948.

THE CHEMICAL SENSE IN PHYTOPHAGOUS INSECTS

A. J. Thorsteinson

The chemical sense of vertebrates is conceived to admit classification into three categories, namely smell, taste and the common chemical sense.

The common chemical sense is unspecialized in that it is sensitive only to high concentrations of irritant substances. It has been shown that insects are equipped with this general chemical sense although no specific sense organs appear to be essential to its function, and its significance in biology is not of great importance.

While the senses of smell and taste are highly developed in insects, the distinction between them is by no means always definite and is sometimes quite obscure. For instance, the distribution of sense organs on the body of insects is not particularly helpful.

Olfactory sensilla occur principally on the antennae but also on the maxillae and labium. Gustatory sensilla may also occur on the antennae, maxillae and labium as well as on the hypopharynx, epipharynx and the tarsi.

Although it is known that olfactory sensilla consist typically of cones, pegs and pore plates and that thin walled hairs may perceive tastes, it is not certain that olfactory sensilla may not also be sensitive to gustatory stimuli.

One of the distinctions between smell and taste depends on a comparison of the threshold concentrations of response to chemical stimuli in terms of the number of molecules per unit volume of gas or liquid. On this basis, the olfactory sense is usually more sensitive than the gustatory sense although the two scales overlap.

It does not even hold that a chemical substance stimulus can affect only one type of receptor. Even sugar at close range is said to stimulate the olfactory sense of bees while the alcohols, fatty acids,etc. can as solutions stimulate the gustatory sense and as vapours may be perceived by olfaction.

In aquatic insects the distinction between taste and smell breaks down almost completely as all stimuli must function in solution and a classification by inference based on threshold concentrations and loci of sensilla has not yet been established by adequate experiments.

A similar difficulty obtains in the study of chemotropisms of soil insects such as wireworms which find and recognize their food by responding to chemical stimuli derived from plants in the soil solution. An excellent recent study by Thorpe et al has shown that wireworms respond to two categories of stimuli. A highly sensitive orientation or aggregation

response to very low concentrations of aspartic acid and its derivatives (activity 9-11)* leads wireworms to their food. However, they do not feed unless stimulated by sugars, fats and polypeptides at fairly high concentrations (activity of sugar is 2). Here the sensitivities of the two categories of chemoreception parallel those of olfaction and gustation but wireworms have not been shown to perceive vapours.

Modalities or classes of odours in insects are even more difficult to define for insects than for humans. It is known at least that bees in many cases confuse the same odours and are repelled by the same smells as is man. However, the same odour may be repellent for some insects and attractive for others. The functions of the olfactory sense includes the finding of mates, the location of food and the selection of sites for oviposition.

Modalities of taste are more easily classified both for insects and for humans. By various ingenious devices it has been inferred that perception of sweet, bitter, acid and salt tastes are probably distinct for at least some insects. There is also evidence that for some insects, the category bitter is not homogeneous. For instance, in the bee the repellency of acid taste is increased on the addition of quinine but not other bitter substances. This is particularly interesting in relation to the specific stimulation of feeding in phytophagous insects by some glucosides and not others although nearly all of them are bitter to the human taste.

The sense of taste determines whether or not an insect will continue to feed and to what extent after the initial biting reaction is first stimulated by olfactory response or by starvation.

A recent review on chemoreception in insects by Dethier and Chadwick and a newly published book called "Chemical Insect Attractants and Repellents" by Dethier testify to the increasing recognition of the entomological importance of the study of the chemical senses of insects. The discovery of repellents and the study of the significance of the physicochemical properties of attractants and repellents have received relatively more intensive study in recent work. However, because of both the biological and agricultural significance, I propose to confine my remarks largely to the relation of chemotropisms to the selection of host plants by phytophagous insects.

Curiously, the earliest worker to make a significant contribution to our knowledge of this question was not an entomologist but a botanist. It is of interest that the apparent botanical instinct of certain insects furnished the

* "Activity" is defined as log x to base 10 where x is the number of millilitres of water, containing 1 gram of the dissolved substance, required to reach the threshold.

key to the solution of this problem. It was observed by Verschaffelt in 1910 that certain plant species in the Amsterdam Botanical Gardens were attacked by larvae of the cabbage butterflies, Pieris rapae (L.) and P. brassicae (L.). He carried out feeding experiments to determine which plants would be accepted by these larvae and found that they would eat nearly all Cruciferae as well as species of certain other families such as Tropaeolaceae, Resedaceae, etc.

Since the distribution of acceptable plants corresponds with that of a group of chemical substances called the mustard oil glucosides, it occurred to Verschaffelt to test the feeding responses of these larvae to the mustard oil glucoside, sinigrin. He found that leaves of some plants, otherwise unacceptable, were readily eaten if painted with a solution of sinigrin. Some unacceptable plants however could not be rendered palatable by this method presumably because of the presence of repellent substances or because the leaves were too tough.

Although he did not test the fission products of the glucosides, namely the mustard oils, he thought perhaps it was really they that attracted the larvae rather than the glucosides themselves which he suggested might be hydrolized in the mouth of the larvae. This rather improbable conclusion has never been criticized in the numerous references in the literature to Verschaffelt's paper.

In spite of the considerable interest stimulated by this early work there have been comparatively few successful attempts to discover similar relationships in other insects. Among the more interesting contributions are those of Trouvelot et al who worked with the potato beetle and Dethier who studied the food preferences of the genus, Papilio.

Trouvelot and his co-workers were able to extract the attractive principle of the potato in crude form and learn something of its characteristics. They tested the extract by impregnating it in various dilutions in a disc of pith and estimated the response by measuring the area of pith consumed by the beetles. However, the rather nice relationship which they observed between feeding and the concentration of the attractant is misleading because the nutrients in the extract were diluted along with the attractive principle. My own results indicate that the feeding response to a specific attractant is not manifest except in the presence of an adequate concentration of nutrients and that dilution would approach the threshold of response very rapidly unless the concentration of food is kept constant.

McIndoo, Folsom and others demonstrated that larvae respond to the odours of their host plants. The work of Dethier with Papilio larvae confirmed the importance of odours in determining which plants will be attacked by larvae. He showed that the essential oils of Umbelliferae and Rutaceae could be used to induce larvae to feed on otherwise unacceptable plants

and even on filter paper. Dethier's results enabled him to formulate a plausible hypothesis which explains the evolution of feeding habits in the genus Papilio on the basis of the distribution of the essential oils in the host plants, involving a transfer of host preferences from the Rutaceae to the Umbelliferae.

The rather surprising fact that no one had ever confirmed the results of Verschaffelt led to the suggestion that I repeat his experiments and extend the investigation as a thesis problem.

As no preparations of mustard oil glucosides were commercially available, it was necessary first to prepare some of the glucosides in this group. Sinigrin and sinalbin were obtained in pure form and glucocheirolin in an impure preparation from the seeds of mustard and wallflower respectively. In order to test the effect of the fission products it was also necessary to prepare allyl mustard oil and the enzyme, myrosin, which hydrolyses the glucosides.

The experiments of Verschaffelt were repeated, testing the three glucoside preparations as well as allyl mustard oil on Pieris brassicae (L.). The resources of Kew Gardens provided numerous species of plants in addition to the various native plants that contain mustard oil glucosides. It was confirmed that all of these except those with very tough leaves were eaten by Pieris brassicae (L.) while plants that do not contain these glucosides were not accepted. It was possible to induce the larvae to feed on some otherwise unacceptable plants, notably onion and cucumber by treating them with the glucoside solution. This response could not be obtained by treating them with allyl mustard oil.

To test various combinations of attractants and nutrients, a more elaborate experimental arrangement was required than those described in the literature. The food medium consisted of agar in which powdered, dehydrated leaves or other artificial diets as well as test attractants could be incorporated. A count of the frass pellets produced by the larvae furnished a quantitive estimate of the attractiveness of the preparations. Because of the ease with which it may be reared, the diamondback moth, Plutella maculipennis (Curt.) was used in the tests.

Some of the results obtained in this study are indicated in the following:

a. Larval feeding responses are markedly affected by the concentration of total nutrients in the diet.

b. The attractive principles in leaf powder samples are in the water soluble fraction.

c. Small differences in texture or hydrogen ion concentration do not appreciably modify the attractiveness of diets.

d. The feeding responses to cabbage leaf powder gel are not inferior to those of fresh cabbage leaves.

e. Pea leaf powder treated with the glucoside, sinigrin, is substantially as attractive as the leaf powder of a host plant. Sinalbin is somewhat less effective in this respect. Glucocheirolin is probably also attractive. The activities of sinigrin and sinalbin, in the units of the logarithmic scale proposed by Thorpe and Crombie (1945), are of the order of 6 and 5 respectively.

f. The effect of adding a viable preparation of the enzyme, myrosin, to leaf powder diets of host plants was tested. This treatment results in the hydrolysis of the mustard oil glucosides. The attractiveness of the diets was reduced, indicating that the mustard oils released are less attractive than the parent glucosides.

g. No significant feeding responses to pea leaf powder gels treated only with mustard oil were obtained. Mustard oil, however, at moderate concentrations, enhanced the attractiveness of diets containing unhydrolysed sinigrin. A consideration of the rate of hydrolysis of the glucoside compared with the apparent rate of ingestion and deglutition suggests that little mustard oil is released until the food has passed into the oesophagous where chemoreceptors are not known to occur.

Conclusion

The precise study of the role of chemoreception in insects in relation to the selection of host plants must take into consideration the interaction of attractants in the plant tissues, the enzymes which hydrolyse them, the end products of their hydrolysis and the rates of such reactions.

While it is most probable that olfaction is the important mechanism in the selection of plants by the ovipositing adult females and that olfaction may be an important stimulus to the initiation of feeding in the larvae, the results derived in this study indicate that gustation phenomena determine whether feeding will continue. The remarkable feature of the gustation responses in Plutella maculipennis (Curt.) is the great sensitivity of this insect's perception of the taste of a specific group of organic compounds, namely the mustard oil glucosides.

Literature Cited

1. Dethier, V.G., 1941. Chemical Factors Determining Choice of Food Plants by Papilio Larvae, Amer. Nat., 75:61-73.

2. _____, 1947. Chemical Insect Attractants and Repellents, Blakiston, Philadelphia.

3. Dethier, V.G. and L.E. Chadwick, 1948. Chemoreception in Insects, Physiol. Rev., 28 (2):220-255.

4. McIndoo, N.E., 1926. An Insect Olfactometer, Jour. Econ. Ent., 19 (3): 545-571.

5. Thorpe, W.H., A.C. Crombie, L. Hill, and J.H. Darragh, 1947. Biol. Rev., 22 (1): 234-266.

6. Trouvelot, B., M. Raucourt and J. Castets, 1934. Remarques sur le Mode d'Action Physiologique des Principes Actifs de Solanum tuberosum envers les Larves de Leptinotarsa decemlineata, Comptes Rendus des Seances de l'Academie des Sciences, 199:684-686.

7. Verschaffelt, E., 1910. The Cause Determining the Selection of Food in some Herbivorous Insects, Proc. K. Akad. Wetensch., Amsterdam Ent. Sci., 13 (1): 536-542.

RECENT WORK ON MITES AND DISEASES

W. B. McTavish

Mites belong to the class Arachnida and order Acarina. They are minute arthropods and are distinguished from all other members of their class by having an unsegmented abdomen broadly united with the cephalothorax. Many families show no demarcation line. Their distribution is world-wide, extending from the Arctic to the Antarctic, but they are most numerous in the Temperate Zones. Their hosts are terrestrial and aquatic, vertebrate and invertebrate. Many are free living but the marjority are parasitic on a large variety of animals, birds and insects. The parasitic mites that I shall comment on are from two families, the Dermanyssidae and the Trombidiidae.

Mites of the family Dermanyssidae belong to the superfamily Parasitoidea. The Dermanyssid mites have the chelicerae adapted for piercing. These chelicerae are usually without teeth and fixed arms and usually without setae. An anal plate is almost always present and is distinct from the ventral plate in females. These mites are parasitic on vertebrates,. i.e. reptiles, birds and mammals.

In the family Dermanyssidae the two subfamilies which are most important in the medical field are Dermanyssinae and Lyponyssinae. Let us look at Dermanyssus - the chelicerae are long and needle-like. In contrast those of Lyponyssus are shear-like and the tips have both arms present.

I shall deal with the Lyponyssid mite first. L. bacoti (Hirst), the tropical rat mite, was originally described in Egypt and has lately been introduced into the United States. These mites are common to both the black and brown rat. L. bacoti is suspected in the transmission of typhus rickettsia from rat to man. Riley, of the University of Minnesota, has found bacoti present as far north as St. Paul. He found them in a rat infested house in the City proper. A similar case was reported in Pipestone, Minnesota in the southwestern part of the state where employees of a store showed an itching macular skin eruption which was traced to L. bacoti. It is generally considered that the flea is the main vector in transmission of disease from rat to man, but of late isolations of typhus rickettsia

from the rat mite indicate that it probably shares honours with the flea in disease transmission to the human host. Pang established strains of typhus rickettsia in guinea pigs and white rats from specimens of L. bacoti taken from a rat during a typhus epidemic at a Chinese orphanage. Although these examples seem remote from the local picture, it is within reason that 'it could happen here', for the mite goes along with the host and spreads as it does. In all likelihood Riley's experience with bacoti in St. Paul came about in this way. Another species of Lyponyssus and one that is quite common in Manitoba is the northern fowl, or feather mite, L. sylviarum. This is found on many of our fowl and has been picked up on specimens here at the University of Manitoba. It is found not only on chickens but on a wide variety of wild birds. In appearance L. sylviarum resembles Dermanyssus gallinae but it differs biologically in that it has a pronounced tendency to remain on its host at all times, taking blood meals repeatedly and even laying its eggs amongst the feathers of the bird. The eggs may hatch there. It is of importance medically because western equine virus has been isolated from this mite. I will go into more detail about this later.

Let us turn now to the subfamily Dermanyssinae. The most important species is Dermanyssus gallinae, the red mite of poultry. This is the common blood-sucking mite of domestic poultry and of a number of other birds (e.g. sparrow, swallow, dove). The species of the genus, as I mentioned previously, are characterized by the long needle-like chelicerae of the females. Another point of recognition is the great width of the genital ventral plate along with the short hairs on the dorsal shield. The female lays eggs in batches, depositing them in crevices and cracks in henhouses. Depending on the temperature, the larvae hatch within 48 hours. The larva is non-feeding and moults after a few days to the first nymphal stage. Before it can moult to the second nymphal stage, the mite requires a blood meal. After its appetite has been satisfied it drops off the fowl, again seeks a crevice or crack and in 48 hours moults and emerges as the second nymph. This stage also requires a blood meal before moulting to become an adult mite. Under ideal conditions the life cycle of D. gallinae can be completed in eight to ten days.

Therefore, if not checked, countless numbers of these mites could gather in a very short time. The life cycle and mouthparts of D. gallinae show that these Dermanyssid mites could easily act as vectors of disease. They have actually been incriminated in the carrying of neurotropic viruses in nature. Certain species of culicine mosquitoes have had neurotropic viruses isolated from them, but Smith, Blattner and Heys were, I believe, first to isolate a neurotropic virus from D. gallinae.

In St. Louis (where encephalitis epidemics occurred in 1933 to 1937) the demonstration of neutralizing antibodies in the blood of a number of year old chicks, in an area where the human population was not developing antibodies, suggested the possibility that some blood sucking vector, not biting man, was transmitting the disease to the fowl. To workers, chicken mites seemed a possible vector because under experimental conditions ticks had been found capable of being infected with two viruses (Dermacentor andersoni - W.E. type and D. variabilis - St. Louis type). In both instances the ticks were capable of transmitting the viruses to susceptible animals by bite as well as of transmitting these viruses hereditarily to their offspring. Mites were collected from coops of chickens which were shown to have neutralizing antibodies from the St. Louis type virus. Of six chickens, two were positive and two questionably positive. The mites were kept for seven days without food. Then 60 of the mites were triturated in tryptose broth in an agate mortar and high speed centifuged; .1 cc of the supernatant liquid was inoculated intraperitoneally into each of six 19-day-old-mice. Within eight days two of the six showed signs of illness with slight twitching. At the point of death these two were killed. Bacteria cultures of brain and spleen proved sterile. The brains were emulsified and diluted 1 to 10 with broth, centrifuged and .03 cc's of the supernatant fluid was inoculated intracerebrally into each of eight mice and the same q uantity of fluid placed also on the chorio-allantoic membrane of a number of developing chicken eggs. After three days all eight mice developed convulsions. Five died during the third day and the other three were killed when at the point of death. Their brains were emulsified and, following the same procedure, injections were made into other mice. On the third day again, these mice developed convulsions. The egg membranes which had been inoculated appeared slightly thickened and opaque after three days. On examination the embryos proved to be alive and the allantoic fluid, clear. The membranes were ground up and passed intra-

cerebrally to mice. On the third day after inoculation, they too developed convulsions.

It is to be remembered that the mouse brains and the egg membranes were sterile - the infective agent appeared to have been established in the mice and in the chick eggs.

A second isolation of virus was performed in mites from the original collection. These had been four weeks without feeding. They were triturated as before and injected intraperitoneally into three mice. On the ninth day after inoculation, two of the three mice developed convulsions. The brains of these two, so affected, were passed through each of six adult mice by intracerebral injection. These mice developed convulsions inside of three days. Thus St. Louis encephalitis virus was isolated from D. gallinae in nature during a non-epidemic period. In subsequent experiments Smith and co-workers made further isolations of the birus from mites. Also, they proved that the virus could be transmitted congenitally in D. gallinae. In this case, adult mites shown to have the St. Louis encephalitis virus after feeding on chickens with viremia, were watched for egg laying. When laid, the unhatched eggs were separated from the adults. The first-stage nymphs which hatched were separated into two lots. One unfed lot was triturated and inoculated into mice; then the brain tissue of the mice was subsequently injected intracerebrally into other mice. These, on inspection, yielded the St. Louis type of virus.

To demonstrate the transmission of the virus through the egg to the second generation, the other lot of unfed first-stage nymphs was used to establish a new colony. This new colony was fed on three different normal chickens, as first-and second-stage nymphs and finally as adults. The eggs laid by these adults were allowed to hatch to first-stage numphs. The adults and the second-generation nymphs were both proved by trituration and inoculation to carry the virus of St. Louis. Thus transovarian passage of the St. Louis virus into the second generation of mites was definitely proved.

Another experiment proved that an infected adult female can pass on the St. Louis virus not only through eggs laid immediately after the infective feeding, but also through eggs laid after an additional feeding on

normal blood. Subsequent work proved that experimentally infected mites and mites infected by nature were capable of transferring the St. Louis virus to chickens and that such chickens can serve as the reservoir of the virus from a blood-sucking vector.

Let us turn now to work done by Reeves, Hammon and associates. These gentlemen isolated the virus of W. E. from wild-bird mites (L. sylvarum). In 1946, they collected 1000 mites from a yellow-headed blackbird's nest. These were separated into four pools, each of which was put through the previously described trituration and inoculation process. All the inoculated mice became ill and showed signs of encephalitis. Indentification of the neurotropic virus causing this encephalitis was undertaken. After three serial passages in mice were completed, the four infective agents proved to be pathogenic guinea pigs and hamsters as well as the mice. Three of the four viruses isolated were shown to be W. E. by challenge inoculation of W.E. immune guinea pigs and by neutralization tests in mice with special W. E. antisera. The fourth was identified at the time. On further experimentation in 1947 it was found that this fourth agent was not neutralized by hyperimmune W. E. serum or St. Louis or Jap B. alone, yet a mixture of all three effectually neutralized the virus. After several serial passages through mice this virus had the immunological characteristics of St. Louis type and would not kill guinea pigs. After ten passages in chicken embryos it had only W. E. characteristics. Thus there was a possibility that this fourth strain was a mixture of virus or that it was a stem virus which could develop as either W.E. or St. Louis after passage in more selective hosts. The possibility of its being a new virus was discounted until further experimentation could be carried out.

W. E. virus was recovered by Sulken and a co-worker from D. gallinae and L. bersa (the tropical bird mite). These mites were taken from a nest that contained fledgling sparrows. Up until this period, bird mites from both wild and domesticated birds had been found to harbour in nature three different strains of encephalitis virus.

In August, 1947, Howitt, Doge and co-workers, investigating sporadic cases of encephalitis in Tennessee, followed the methods of previous workers in the isolation of a virus from D. gallinae. Identification of the virus was done by neutralization tests against known immune sera and tissue immunity tests were made by intracerebral inoculations of immune guinea pigs. It was found in this case that D. gallinae was carrying the virus of EE encephalitis.

This strain, although recovered from mites in nature, has not been shown by experimental proof to live, multiply, or be transmitted congenitally in its host.

Leaving this side of the world, let us consider a serious disease of the East, Tsutsugamashi or Japanese Flood fever. There are many synonyms for this disease, among which are Flood fever, mite fever, scrub typhus, and pseudotyphus. The causal organism of the disease is a rickettsial body, R. orientalis, and the vector of the disease is a larval mite, the larva of T. akamushi. (A slide illustrated that in the larval type, the last joint of the palpus forms a thumb with the claw of the preceding joint.) The free-living adult has a distinct cephlathorox. These mites belong to the family Trombidiidae and the members of this family which attack vertebrates while in the larval stage, belong to the subfamily Trombiculinae.

According to H. E. Ewing, the larvae remain close to the ground and climb up grass usually not more than about three inches. Thus, they easily transfer themselves to humans who enter regions infested by these mites. They migrate all over the body but usually are found at the belt-line or around garters, if these are worn. They do not burrow into skin or enter through pores but have a novel method of extracting blood or lymph from the host. They anchor themselves on the surface of the skin, usually near the mouth of a hair follicle. The mite then injects a salivary secretion which penetrates and digests the skin until a tubular structure called a stylostome is formed in the skin. This secretion hardens and forms the wall of the tube through which blood or lymph is sucked up by the mite. This stylostome is left behind when the mite leaves the host. After engorging with blood the mite drops off the host and undergoes a moult to a nymph. In a few weeks it reaches the adult stage.

Let us now look at the disease symptoms. The rickettsial body is passed in the salivary secretion and, after a period of incubation (four to ten days), the human thus infected experiences headaches in frontal and temporal regions, chills, pains in the lymphatic glands of the groin, armpits, or the neck. Then a small round ulcer appears on the genitals or arms. A line of tenderness can often be traced from the sore to the hard swollen gland. Fever then sets in and the temperature mounts in five to six days to 104 or 105 degrees. The conjunctiva of the eye becomes infected. About the sixth or seventh day an eruption of dark red papules appears on the face and extends to the limbs and trunk. The patient also has an acute bronchitis

which gives way to a harsh cough. As the disease advances the symptoms become more pronounced. Coughing is incessant, the lips crack, the tongue is dry, and profuse perspiring occurs from time to time. At the end of the second week, depending on the severity of the attack, the fever begins to break and the patient speedily recovers. The ulcer heals fairly rapidly and the enlarged glands decrease in size. The attack described would be considered as moderately severe. If it is more violent, complications usually set in which cause cardiac failure, or edema of the lungs resulting in death. This has been the case with a high percentage of those who contract the disease in Japan proper. The mortality rate has been as high as seventy per cent. On the whole, the duration of Tsutsugamushi is one to four weeks, with a three-week average. Sufferers from the disease do not have relapses.

Lewthwaite and Savoor showed that scrub typhus in Malaya and pseudotyphus of Sumatra were identical with Tsutsugamushi. There is also reason to believe that Mossman fever of Queensland is probably identical. These forms are much milder than the Tsutsugamushi of Japan.

Up to the second world war, no really effective treatment had been known, as shown by the high mortality rate in Japan. It was the practice to cauterize the site of the bite. Two men, Hayashi and Mukoyama, had some success in severe cases by using serum of cattle and monkeys which had recovered from the disease. Arsenicides were found to be useless.

With the advent of war and the stationing of United States troops in the South Pacific, the attention of the U.S. medical corps was turned to the disease which was plaguing many of the soldiers on New Guinea and other islands. The primary purpose was to get something that would control this scrub virus quickly. They began experimenting in Australia in 1943 and continued in New Guinea and Borneo. During the tests, soldiers wearing treated garments, lay in areas previously shown to be infested with Trombiculid mites. Clothing treated with either dimethyl or dibutyl phthalate provided protection from the mites. Dibutyl retained its effectiveness after the clothing was rinsed in cold water. The treatment gave better results when applied evenly over the whole surface of the clothes. McCulloch, who carried on tests in New Guinea, showed that a fluid ounce of dibutyl per set of clothes gave complete protection for a period of 22 days. In this time the clothes had been washed eight

times in cold water. Dimethyl, at the same dosage, plus DDT in oil gave less lasting protection; it was not effective after two to four washes in cold water. Studies showed that the protective efficiency of dibutyl was not affected by sweat, storage, newness, wetness, or method of drying of the cloth. Application of the chemical on the outside or inside of the clothing did not affect the period of its effectiveness.

The Australians used the method of a complete treatment of socks, trousers, and shirt every two weeks with dibutyl. The results of its use by troops in action were studied. Control of scrub itch was excellent and practically complete freedom from scrub typhus was obtained. The Americans landed a party of marines on South Bat Island in 1944 and had to evacuate the island not to the Japs but to the mites. A small party returned in late 1945 and conquered them with phthalate.

Work on New Guinea incriminated T. deliensis, as well as T. akamushi. The findings suggested that the rate of endemicity in deliensis was very high on the island. A study of the environment showed that abandoned native villages and overgrown coconut groves where grass had had a chance to come up again, were the worst centres for these mites. Workers suspected the bandicoot of acting as a reservoir for the rickettsia, but after injecting bandicoot brain tissue into mice and obtaining negative results, and after considering the fact that generation to generation of R. orientalis occurs in the mites, the bandicoot was not incriminated. For the most part the research done on this disease has been only preventative, but proportions of the disease have certainly been reduced.

The latest discovery in the fight against Tsutsugamushi was made early this year. It involved the newest antibiotic, chloromycetin. Dr. Payne of Parke-Davis gave it to 16 victims of typhus fever; 15 were facing death. All started to recover within 12 hours and all were cured in 3 days. The U.S. Army tried out chloromycetin on a typhus epidemic in Mexico City; all patients recovered. They then set out for the East to try chloromycetin on scrub typhus. The results were a complete success. Thus one of the most troublesome diseases in the South Pacific and Far East will soon be under control.

REFERENCES

Howitt, Dodge, H.R., Bishop, L.K., and Gorrie, R.H.
Proc. Soc. Exp. Biol. and Med. 68(3): 622. 1948

Reeves, W.C., Hammon, W. McD., Furman, D.P., McLure, H.E., and Brookman, B,
Science 105:411. 1947.

Hammon, W. McD., Reeves, W.C., and assoc.
Science 107:77. 1948.

Smith, M.G., Blattner, R.J., and Heys, F.M.,.
Science 100:362. 1944
Proc. Soc. Exp. Biol. and Med. 59:136. 1945
" " " " " " 84:1. 1946
" " " " " " 86:229. 1947.

Sulkin, S.E.
Science 101:381. 1945.

APPENDIX I

April Meeting

The regular spring meeting of the Entomological Society of Manitoba was held at the University of Manitoba on Tuesday, April 27, 1948. Those present were: Mr. R. R. Lejeune (President), Mrs. W. S. Barker, Dr. R. D. Bird, Dr. B. N. Smallman, Prof. A. V. Mitchener, Messrs. W. F. Black, H. P. Richardson, W. Romanow, C.A.S. Smith, D. S. Smith, Wallis, H. R. Wong, H. Westdal and W. S. McLeod (Secretary-Treasurer).

The minutes of the meeting of November 11, 1947 were read and adopted.

The following resolution was moved by Professor Mitchener and seconded by Dr. Bird: "Whereas the members of the Entomological Society of Manitoba are keenly interested in the formation of a Canadian Entomological Society and whereas no word of progress has been received by our Executive during the past six months, be it resolved that the members of this society urge the Committee on National Entomological Organization to continue their efforts to bring into existence a Canadian Entomological Society in the near future."

CARRIED

In response to a question arising out of the reading of the minutes, correspondence from Mr. W. A. Ross, Chairman of the Committee on National Entomological Organization, was read .

Minutes of an Executive Meeting held on March 1, 1948, were read. It was moved by Mr. D. S. Smith, seconded by Mr. C.A.S. Smith, that these be adopted.

CARRIED

Dr. Smallman, Dr. Bird and Mr. C.A.S. Smith reported on the work of their respective committees and a discussion of the plans for the I.G.P.C.E. followed.

The Secretary-Treasurer read a financial report which showed cash on hand as of April 22, 1948, amounting to $49.65. It was moved by Mr. McLeod, seconded by Mrs. Barker, that this report be adopted.

CARRIED

It was moved by Dr. Bird, seconded by Mr. D. S. Smith, that special contributions for Conference expenses be kept as a separate fund for the financing of expenses arising out of the Conference but that the Treasurer be empowered to use Society funds if

necessary, and subject to the approval of members of the Executive, in case the special contributions are insufficient to pay all the expenses of the Conference.

CARRIED.

It was moved by Mrs. Barker, seconded by Mr. Wallis, that the Treasurer be authorized to purchase enough stencils for mimeographing of Volume 3 of the Proceedings of the Entomological Society of Manitoba.

CARRIED

A letter of resignation submitted by Mr. W. C. McGuffin, Editor-Librarian, was read.

The final item of business on the agenda was the annual election of officers.

Mr. R. R. Lejeune was nominated by Dr. Bird for the Office of President. Moved by Mr. Wallis, seconded by Professor Mitchener, that nominations cease.

CARRIED

Mr. C. A. S. Smith was nominated by Dr. Smallman for the office of Vice-President. Moved by Mr. D. S. Smith, seconded by Dr. Bird, that nominations cease.

CARRIED

Dr. B. N. Smallman was nominated by Mr. C. A. S. Smith for the office of Secretary-Treasurer. Moved by Professor Mitchener, seconded by Mr. D. S. Smith, that nominations cease.

CARRIED

Mrs. W. S. Barker was nominated by Mr. Wong for the office of Editor-Librarian. Moved by Mr. C. A. S. Smith, seconded by Mr. Wallis, that nominations cease.

CARRIED

The business meeting was adjourned at 10:50 a.m.

R.R. Lejeune
President

W. S. McLeod
Secretary-Treasurer.

APPENDIX II

November Meeting

The regular fall meeting of the Entomological Society of Manitoba was held in the Horticultural Building, University of Manitoba, November 16, 1948. Those present were: Allen, Barker, Berck, Bird, Birt, Black, Brown, Cole, Criddle, Fraser, Fell, Kelleher, Liscombe, Martin, Mitchener, Muldrew, Maxwell, Northcott, Robinson, Romanow, C.A.S. Smith, D.S. Smith, Turnock, Thorsteinson, Watters, Westdal, Lejeune (President), Smallman (Secretary-Treasurer).

The minutes of the meeting of April 27, 1948, were read and adopted.

Mrs. W. S. Barker reported that Volume 3 of the Proceedings of the Society was being compiled and would be completed by the end of December.

The Secretary-Treasurer presented a statement on the financing of the I.G.P.C.E. meetings sponsored by the Society. The Society had solicited and received $409.00 as donations, and expenditures totaled $400.15 leaving a favourable balance of $8.85. A few small expenditures in connection with mailing the Proceedings of the I.G.P.C.E. meetings remained to be paid. Professor A. V. Mitchener congratulated the executive on the financing of this project.

Mr. C. A. S. Smith reported that the Proceedings of the I.G.P.C.E. meetings had been completed and sent out early in November. The president congratulated Mr. Smith, who acted as editor, on the prompt publication of these Proceedings and the excellence of the compilation.

The Secretary-Treasurer read a letter from Mr. W. A. Ross, Chairman of the Committee for the formation of a Canadian Entomological Society, to the effect that lack of governmental support has forced the committee to abandon its objective temporarily and to concentrate on strengthening existing organizations and The Canadian Entomologist.

The Secretary-Treasurer read an exchange of correspondence in which the Entomological Society of Manitoba invited the Entomological Society of Ontario to hold its 1949 Annual Meeting in Winnipeg, and the formal acceptance of this invitation.

The Secretary-Treasurer reported on the Montreal meetings of the Entomological Society of Ontario with particular reference to matters of organization. The Montreal Branch of the Entomological Society of Ontario is to be reorganized as the Entomological Society of Quebec in affiliation with its parent organization. A resolution passed by the Directors stated that the Entomological Society of Ontario is in purpose and function a national organization as evidenced by its Branches and Affiliates in the Dominion and its sponsorship of The Canadian Entomologist. Members of the Entomological Society of Manitoba now occupy three positions on the executive of the Entomological Society of Ontario - R. D. Bird, Membership Committee; A. V. Mitchener, Council; B. N. Smallman, Directorate. In view of Mr. Ross' report, the emphasis has shifted from a national organization to a more adequate journal for Canadian entomologists. In answer to criticism of The Canadian Entomologist, the Editor reported that improvements were to be made in the form and printing of the Journal. Increased cost of publication would necessitate an increase in fees.

Mr. W. R. Allen moved that the executive be empowered to set up committees in connection with the meeting of the Entomological Society of Ontario to be held in Winnipeg in 1949. Seconded by Mr. W. F. Black.

CARRIED

On a motion by Mr. C. A. S. Smith, the meeting adjourned at 10:30 a.m.

R. R. Lejeune,
President.

B. N. Smallman,
Secretary-Treasurer.