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W. R. Allen
Editor-Librarian

INTRODUCTION

This was an important year for our Society. In August we had the honour of being hosts to two international groups of entomologists. The first comprised delegates of the Tenth International Congress of Entomology who toured the western provinces; the second included delegates to the International Great Plains Conference of Entomologists. This year's Proceedings, therefore, contain the annual report of the I.G.P.C.E. together with the report of our Spring meeting.

The Spring meeting was held in the Entomology Laboratory, Brandon. The scientific program consisted of a paper on black flies by Mr. F. J. H. Fredeen, Entomology Laboratory, Saskatoon; a panel discussion on the larch sawfly by four members of the Forest Biology Laboratory, Winnipeg; and a paper and film on the aerial application of insecticides against the spruce budworm in New Brunswick by Mr. W. A. Reeks, Forest Biology Laboratory, Winnipeg.

The date of the fall meeting was advanced by two months to coincide with the annual meeting of the I.G.P.C.E. and the arrival of Congress delegates. Prior to the meeting, the delegates were conducted on a tour of the Dominion Experimental Farm, Morden, Manitoba. Distinguished entomologists present at the meetings included Dr. R.T. Cotton, United States Department of Agriculture, Washington, D. C., who gave the invitation address on the control of insects in stored grain. Drs. D. L. Gunn and R. C. Rainey of the anti-locust research unit in East Africa attended the meetings and were taken on a field trip through areas infested with grasshoppers. The I.G.P.C.E. banquet was held at the Motor Country Club, Lower Fort Garry. Professor R. A. Wardle gave an entertaining and thought-provoking address entited "NeoBiologos". Mr. H. E. Wood, representing the Government of Manitoba gave an informative address on agricultural production in Manitoba.

The scientific sessions were held in the Entomology Building, University of Manitoba. Reports from delegates dealt with current problems and control of insects associated with field crops, forests, livestock, fruits and vegetables, and stored products. The reports and discussions have been compiled by our editor-librarian, Dr. W.R. Allen, and are included in the Proceedings.

Many of our members contributed to the success of the Conference. Mr. R. M. Prentice acted as Secretary; Mr. S. R. Loschiavo arranged entertainment; and Mr. R. J. Heron was in charge of transportation of delegates.

To these and to the Government of Manitoba and commercial organizations who contributed financial assistance, I wish to express the appreciation of our Society.

F. L. Watters,
President.

The Spring Meeting-Entomological Society of Manitoba

Scientific Business

The following papers and panel discussion were presented at the Laboratory of Entomology, Brandon April 13 and 14th 1956. Informal discussions, over dinner at the Ranch House and at a smoker convened at the Prince Edward Hotel, on the evening of April 13, were enjoyed by the membership.

RESEARCH ON BLACK FLIES, PESTS OF LIVESTOCK AND MAN ON THE CANADIAN PRAIRIES

by F. J. H. Fredeen
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In the agricultural areas of Manitoba, Saskatchewan, and Alberta there are representatives of four of the major families of blood-sucking Diptera: the Tabanidae (horse flies and deer flies), the Heleidae or Ceratopogonidae (punkies or no-see-ums), the Culicidae (mosquitoes), and the Simuliidae (black flies or buffalo gnats). In this region black flies are commonly referred to as "sand flies" although this term more correctly applies to blood-sucking species of Psychodidae. The immature stages of these four families of blood-sucking Diptera are with few exceptions restricted to water or to saturated soil. The immature stages of the Simuliidae are further restricted to flowing water, and there are black flies in every stream and river in this region.

This paper is restricted to black flies, which are world-wide in distribution. More than 650 species have been described (Smart,1945; Vargas, 1946). Twenty-seven species, some yet unnamed, have been collected from the agricultural areas of Manitoba, Saskatchewan, and Alberta.

General Biology and Description

The number of generations per year varies from one to four or perhaps more, depending upon the species and habitat. The eggs are generally laid in masses on rocks or vegetation in streams, but some species drop their eggs while in flight over flowing water. The first-instar larva is about 0.5 mm. long and the last-instar about 6 mm. These are attached to rocks or aquatic vegetation in flowing water. The immature stages of some species are found only in rapidly flowing water, whereas other species prefer slowly flowing water.

The larva is structurally well adapted to its environment with: (1) a mouth structure modified to form cephalic fans which, when extended, collect food particles from the water flowing past; (2) blood gills; (3) a posterior circle of hooklets for attachment to the substratum; (4) an adhesive salivary secretion. The larva is generally sessile, but when the environment becomes inadequate the larva can loop along to a new position or can release its hold to be carried in the flowing water to a more favourable site. The free larva extrudes a fine thread of salivary secretion which eventually becomes entangled in some obstruction in the stream. The larva can attach itself to this obstruction by depositing a button of salivary secretion into which its posterior hooklets are anchored.

The larval stage lasts 10 days or longer. Just prior to the sixth moult the larva develops a cocoon from strands of the salivary secretion (Cameron, 1922). Each species prepares a distinctive form of cocoon and many species can be identified by the cocoon and the prominent thoracic gills, both of which are particularly useful to the taxonomist if not to the insect itself.

The adult emerges from the pupa in four days or more, is carried to the water surface in a film of air, and immediately takes flight. Some species, such as Cnephia dacotensis (D. & S.), mate and lay eggs immediately without requiring a blood meal, but the females of most species require a blood meal before eggs are developed. Some of the blood-sucking species appear to be restricted to particular host animals but others are not host-specific.

In Canada, the species that causes the most damage, in terms of measurable financial loss, is S. arcticum Mall. Major outbreaks of this species are restricted to an area in central Saskatchewan along a 200-mile section of the Saskatchewan River. The damage caused by other species is less easily measured. S. venustum Say is a notorious blood-sucking pest of man and livestock in many parts of Canada but no one has shown that it is responsible for livestock losses, other than of poultry, and this has been recently questioned (Shewell, 1955). Some black-flies are responsible for transmitting Leucocytozoon spp., blood protozoa, to birds, and losses are sometimes spectacular.

History of Investigations

Cameron (1922) made the first investigation of black flies on the Prairies from 1917-1922 and Eric Hearle studied blood-sucking flies at Indian Head in 1926-27.

In 1944, the first of a series of severe outbreaks of S. arcticum occurred on the Prairies. In the four years 1944 to 1947 more than 1,000 farm animals were killed. Drs. J. G. Rempel and A. P. Arnason investigated these and published a report in 1947.

Many entomologists other than those already mentioned have contributed to black-fly collections, particularly Norman Criddle, whose specimens date back to 1912, and Dr. E. H. Strickland, who published a list of black flies of Alberta in 1938.

Current Investigations

The present studies on black flies of the agricultural areas of the Prairie Provinces began in 1947. Since that time about 800 stream and river collections and 500 sweep-net collections have been made to determine geographical and seasonal distributions. The life histories and habits of the more important species and the control of S. arcticum in the Saskatchewan River have also been investigated.

A list of black flies from 801 stream and river collections from the agricultural areas of the prairies, 1947 to 1955, inclusive, is shown in Table 1. Twenty-five species were collected, 20 in Saskatchewan,

Table 1.
Species (25) and notes on abundance of black flies collected from the agricultural area of Manitoba, Saskatchewan, and Alberta, 1947 to 1955 inclusive

	Manitoba	Saskatchewan	Alberta	Abundance
Cnephia dacotensis (D.&S.)	x	x		rare
C. taeniatifrons End.		x		rare
Cnephia "N"		x		rare
C. saileri Stone			x	very rare
Simulium aureum Fries	x	x	x	widespread, rare
S. canonicolum (D.&S.)		x		rare
S. latipes (Mg.)	x	x		rare
S. pugetense (D.&S.)		x	x	rare
Simulium "2"		x		rare
S. vittatum Zett.	x	x	x	widely abundant
S. arcticum Mall.		x	x	locally abundant
S. bivittatum Mall.			x	rare
S. corbis Twinn			x	very rare
Simulium "C"			x	rare
S. decorum Wlk.	x	x	x	widespread, rare
S. griseum Coq.		x	x	rare
S. hunteri Mall.		x		rare
S. luggeri N. & M.	x	x	x	widely abundant
S. malyshevi D., R. & V.			x	very rare
S. meridionale Riley	x	x	x	locally abundant
S. rugglesi N. & M.	x	x		locally abundant
S. sayi D. & S.		x	x	rare
S. transiens Rubtz.		x	x	rare
S. tuberosum Lund.	x	x	x	widely abundant
S. venustum Say	x	x	x	widely abundant

17 in Alberta, and 10 in Manitoba. In addition, Cnephia taeniatifrons (End.), was collected earlier in Aweme, Manitoba, by Criddle and White. Prosimulium fulvum (Coq.) and Simulium pictipes Hbn., were reported from Alberta by Strickland (1938), but the accuracy of the records cannot be checked. Future collecting will undoubtedly reveal more species and extend the ranges of those now known.

Black-fly problems in three types of habitat have been investigated. These concern S. arcticum in the Saskatchewan River, S. venustum and other species in the smaller rivers, such as the Souris River, and a complex of species in irrigation systems.

Black flies of the Saskatchewan River.-S. arcticum is a native of western North America from California to Alaska. In Alberta and Saskatchewan it has been collected from a number of localities, but in abundance only from the Saskatchewan River and its western tributaries. In Manitoba it was collected only from the Churchill River (Twinn et al., 1948), but undoubtedly it will turn up as a minor species further south.

Damaging outbreaks of S. arcticum are known to originate only from the Saskatchewan River in central Saskatchewan. The immature stages are apparently well adapted to the swift, silty water of the Saskatchewan River where other species are rarely found, but in turn seldom occur in the numerous small rivers and streams where other species are so abundant.

S. arcticum overwinters in the egg stage in sand of the river bed (Fredeen et al., 1951). As many as 570 eggs have been extracted from one cubic foot of sand dredged from the river-bed, but usually there are fewer than 10 eggs per cubic foot. First instar larvae commence to appear in the river five or more days after the ice begins to break up. The average date of appearance since 1947 is April 28. These larvae are found only in the swiftest water in boulder-filled rapids. Up to 450 larvae and pupae per square inch have been counted, and on the basis of such counts it was estimated that there were more than seven billion pupae in a single rock-filled weir across the North Saskatchewan River at Prince Albert. This was on June 9 and 10, 1947, just prior to a destructive outbreak.

The larvae are indiscriminate feeders. The gut contents of dissected larvae are almost 100 per cent inorganic, and particles range up to 0.06 mm. in diameter. The suspended solids content of Saskatchewan River water ranges as high as 1,068 p.p.m. The effectiveness of black-fly larvicide in the river is apparently the result of larvae ingesting suspended particles containing adsorbed DDT (Fredeen et al., 1953). Other aquatic insects and fish are not harmed because they do not ingest suspended particles.

The average date of appearance of pupae in the river is May 28 and this stage lasts five to seven days. The average date of beginning of spring outbreaks of adults is June 5. Males apparently commence to emerge a day or so ahead of the females, and mating occurs in swarms at distances of up to 40 miles from the river just prior to blood-feeding.

Only the females take a blood meal, and swarms of these are carried by the wind for great distances. Livestock were killed, on one occasion, about 140 miles from the point of origin of the flight.

Damaging outbreaks occurred in 10 of the 12 years since 1944. The majority of these outbreaks originated in the sections of the North and South branches of the Saskatchewan River downstream from Saskatoon and Prince Albert to the confluence of the two branches. In these outbreaks more than 1,100 cattle, horses, sheep, and hogs were killed. The most serious aspect was the loss of bulls, which are apparently most susceptible to black-fly attack and are often the first animals in a herd to die. In herds attacked in 1944, Rempel and Arnason (1947) reported that 28 per cent of the bulls were lost, 7.4 per cent of the cows, 2.2 per cent of the yearlings, and 0.3 per cent of the calves. Most of these herd sires were purebred, high priced, and difficult to replace.

Losses that are difficult to assess include the decline in productivity of dairy and beef cattle and the reduction in breeding activity that have been observed during outbreaks.

There has been much speculation as to the cause of fatalities. Disease organisms, suffocation by inhaling the flies, anaphylactic shock, and direct toxemia have been suggested. Post-mortems (Millar and Rempel, 1944) failed to reveal disease organisms, but the finding of oedema of the lungs and large quantities of serum in the body cavities suggested that the deaths were the result of shock induced by toxemia.

Nine outbreaks of S. arcticum have occurred since a program of control was initiated in 1948. However, these outbreaks resulted in the loss of only 19 animals as compared with more than 1,100 in the five outbreaks immediately preceding 1948. This is some indication of the effectiveness of the black-fly control program recommended as a result of tests (Arnason et al., 1949: Fredeen et al., 1953). These tests showed that DDT as a 10 per cent solution in kerosene or similar solvent, applied at 0.1 p.p.m. of DDT for 15 minutes, practically eliminated larvae for distances of up to 115 miles. This larvicide was selective in action in that fish were not harmed and aquatic insects other than black-fly larvae were not greatly affected.

The current annual control program includes estimating the numbers of larvae in the larger rapids during the first two weeks of May or five to seven weeks after ice break-up in the spring. The sites and timing of the applications of larvicide are determined by the stage of development and density of infestations. Applications, where required, are made just prior to the beginning of pupation and the results of each application are checked four or five days later. In Saskatchewan larvicide is provided by the Animal Industries Branch of the Government.

The lengthy hatching period of S. arcticum always results in the reinfestation of the river after an application. The resultant outbreaks did not cause any fatalities until 1955, when three animals were killed during a rather heavy outbreak about four weeks after a successful application. This suggests that two spring applications, perhaps 20 days apart, may sometimes be required.

Also, fall outbreaks did not cause any losses until 1955, when two animals were killed. Four fall outbreaks have occurred in the past 12 years and it is apparent that populations of larvae will have to be measured and perhaps treated in late July or early August.

Despite the apparent effectiveness of the present program of control the occurrence of minor outbreaks and the occasional livestock fatalities indicate the need for vigilance on the part of farmers during the spring outbreak season, approximately May 20 to June 20. In the past, the destructive swarms of black flies appeared suddenly, sometimes overnight, when the wind was blowing steadily from rearing beds in the river. Just prior to the beginning of adult emergence each spring livestock owners are warned by the press and radio to be on the look out for black flies, and at the first appearance of attacking swarms to stable herd sires and other valuable livestock and to protect the other animals with smudges.

Black flies of small prairie rivers.- The presence of *S. arcticum* in streams other than those sections of the Saskatchewan River outlined above does not constitute a menace to livestock since the populations are exceedingly small. However, a lesser black-fly problem involving other species exists along some of the small prairie rivers, such as the Souris in Manitoba, the Battle and Beaver rivers in Saskatchewan, and some of the foothill rivers in Alberta. A questionnaire on black flies was circulated by Dr. R. D. Bird, Entomology Laboratory, Brandon, Man., among residents along the Souris River in 1951. The majority of the livestock owners whose pastures lay within half a mile of the river from Coulter to Wawanesa reported that severe outbreaks had occurred in the past. Outbreaks did not apparently extend much beyond a mile from the river except in one or two cases. No livestock fatalities were reported although the productivity of animals and man was reduced.

The major blood-sucking species along the Souris River is *S. venustum*. *S. vittatum* Zett. and *S. luggeri* N. & M. also occur, but outbreaks of these have not been reported. A non-biting black fly, *Cnephia dacotensis*, sometimes occurs in large but harmless swarms in the latter part of May.

S. venustum has a life-cycle resembling that of *S. arcticum* in some aspects. It overwinters in the egg stage and begins to hatch one to three weeks after the ice breaks up, depending upon the temperature of the water. Adults commence to emerge five to eight weeks after ice break up.

There are several generations per summer but only the adults of the first generation are abundant enough to cause trouble on occasion and populations diminish with each succeeding generation.

Stone and Jamnback (1955) consider that *S. venustum* consists of a complex of species and that the true *S. venustum* has only 1 generation per year. However, the species that we considered S. venustum at Saskatoon lays eggs that commence to hatch within about four days and produce another complete generation of adults in less than a month.

S. venustum was reared in the laboratory at Saskatoon and under optimum conditions adults commenced to emerge 13 days after the introduction of eggs. Two peculiarities that were observed were a great variation in the rates of growth of larvae under supposedly identical conditions, and a ratio of one male to two females. Davies (1950) indicated a ratio of 1:1.5 in the field.

Outbreaks of S. venustum do not occur along the Souris River every year. A high water level in the spring, especially when water flows swiftly through grass on flood bench lands for three or four weeks, promotes the development of an unusual abundance of larvae and adults. When the water remains at this high level until the emergence of adults is well underway, an outbreak results. When the water remains within its channel, clean obstructions for the larvae to attach to occur mainly in the rock-filled rapids between Bunclody and Wawanesa and minor outbreaks may originate from these. In 1951, at Hartney, a quart of larvae was collected in a few minutes from grass in swiftly flowing water on a flooded river bench. In 1953, at the same spot, the river was well within its banks and only a few larvae could be found.

S. venustum was once incriminated as a vector of Leucocytozoon simondi M. & L., a blood protozoon of birds (O'Roke, 1934). Savage and Isa (1945) reported an outbreak of Leucocytozoon disease in turkeys in Manitoba that killed about 5,000 out of a flock of 8,000. The locality was not given but the farm was apparently on an island in the Assiniboine River near Portage la Prairie. Losses occurred from late August until early November. Black flies undoubtedly caused the outbreak although none were collected and Stomoxys spp. and mosquitoes were abundant at the time. Burgess (in press) reported that Leucocytozoon simondi was not common in Saskatchewan or Manitoba, but that it was taken from three species of wild ducks.

Recent work by Shewell (1955) indicates that S. rugglesi is responsible for transmitting Leucocytozoon disease; he suggested that the specimens that O'Roke worked with may have been S. rugglesi rather than S. venustum.

Black-fly control tests were conducted on the Souris River in 1951 and 1953. The larvicide used was a 10 per cent solution of DDT in kerosene, similar to that used on the Saskatchewan River. It was supplied by the Horned Cattle Purchases Board of the Manitoba Department of Agriculture. Each application consisted of 0.1 to 0.12 p.p.m. of DDT for 15 minutes, based on water volume data obtained from H. W. Denmee, Wawanesa, or from survey engineers of the Canada Department of Northern Affairs and Natural Resources. The results of only one test in each of the two years were accurately checked by sampling populations of larvae before and after treatment. The single applications were almost 100 per cent effective for about 13 miles downstream, but not more than 50 per cent effective at a distance of about 30 miles. The applications were not harmful to fish and probably not to other aquatic insects. These results indicate that applications at 0.1 p.p.m. of DDT for 15 minutes should be made 15 to 20 miles apart on the river when it is in flood. A single application three to four miles upstream from the Bunclody rapids would probably be sufficient when the river is within its banks. Applications should be made about three weeks after the appearance of first-instar larvae or immediately upon the appearance of the first pupae. The pupae have two pairs of six respiratory filaments and are readily separated with a hand lens or a microscope from other early-pupating species in the Souris, as these have more than six respiratory filaments.

Black flies of irrigation systems.-The third black-fly problem on the prairies that has been investigated is that of black flies in the St. Mary's and Eastern Irrigation systems in Alberta. The St. Mary's at Lethbridge had more than 150,000 irrigated acres in 1954 and will probably soon have more than 500,000 irrigated acres. The Eastern Irrigation District at Brooks has about 180,000 irrigated acres.

Surveys in 1952, 1953, and 1954 showed that the immature stages of at least seven species inhabited the ditches and canals of these systems. These were, in approximate order of decreasing abundance: *S. vittatum*, *S. meridionale*, *S. griseum*, *S. bivittatum*, *S. tuberosum*, *S. venustum* and *S. arcticum*. Another species, *S. decorum*, was found in one drainage system. *S. arcticum*, the species that causes livestock fatalities, was very rare and its occurrence was believed accidental.

Black-fly larvae and pupae were more abundant in the smaller canals, particularly in the older canals of the Eastern Irrigation District at Brooks, where there was considerable aquatic vegetation. Larvae and pupae were scarce in the main canals because they were practically free from vegetation. The short, seasonal flow also prevents a build up of populations of multi-generation species. For these reasons it is not likely that black flies in the irrigation systems of Alberta will require control except where there is a long-season flow through weedy or grassy ditches.

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SUMMARY OF A PANEL DISCUSSION OF LARCH SAWFLY PROBLEMS

Introduction

W. G. Ives

A knowledge of the life history of the larch sawfly is essential to an understanding of the nature of these problems. The insect overwinters as a mature larva in a tough leathery cocoon in the moss or duff. Pupation occurs in the spring or early summer, and the adults emerge from late May until about the middle of July. Most of the adults are parthenogenetic females. There is a small percentage of males, they are apparently non-functional. The females deposit their eggs in slits cut in the new shoots of tamarack. After about 10 days the eggs hatch and the larvae begin feeding. They are gregarious throughout the feeding period, but considerable wandering may occur in the fifth instar. When they reach maturity they drop to the ground and spin cocoons. The peak of larval drop usually occurs in late July or early August.

Numerous factors influence the abundance of the insect and its effect upon the host. Mr. Turnock will discuss some of the ecological aspects; Mr. Muldrew biological and natural control; and Mr. Nairn, the forestry aspects.

PRINCIPAL PROBLEMS

Ecological Aspects

W. J. Turnock

At present the major line of ecological investigation is centered about an attempt to prepare a life table for the larch sawfly. Two preliminary studies have emphasized that the problems associated with these studies are:

(1) Sampling Problems

Because of the size of the host plant most forest insects are difficult to sample. The larch sawfly is particularly difficult to sample for because its host grows in wet places and has a very irregular crown. Also, the insect has an extended adult emergence period with greatly overlapping life stages. Some of the sampling problems in connection with egg, larval, cocoon, and adult stages of the insect are as follows.

The present method of egg sampling involves taking branches at random from the trees and counting the number of eggs per branch. Aside from mechanical difficulties in removing branches from the upper part of the crowns, the estimation of the number of branches per tree involves some error.

No satisfactory method of counting feeding larvae has been developed because, they fall easily from branches in the late instars when they are disturbed, and the feeding period is so long that at no time are all the larvae present. Sampling tends to give an underestimate of the true population.

The number of cocoons formed can be estimated by setting out "funnels", which conduct the mature larvae, dropping on a certain area, into boxes of moss where they form cocoons. This may overestimate the cocoon population because the larvae are dropping to a protected position not subject to predation.

Cubes of moss may be taken from the ground and examined for cocoons. This is a time-consuming technique, also the problem of timing has not been solved. Small mammals start to prey on the cocoons as soon as they are formed and as cocoon formation extends over a month, sampling is not likely to give a precise measure of population.

A technique for sampling the emerging adult population has been developed but the number of sampling units required to determine the average number of emerging adults per unit area has not been determined.

(2) Mortality Factors

Preliminary life tables have shown that there are striking gaps in our knowledge of the causes of larch sawfly mortality. In the 1954-55 generation 50% mortality occurred in the egg stage; 38% in the larval stage, and 10% in the cocoon stage. Most of the work to date has been on the cocoon stage, with emphasis on the predators and parasites and the effect of water-level on cocoon survival. Moreover, greater effort must be directed to the more difficult problem of determining causes of egg and larval mortality.

Biological and Natural Control

J. A. Muldrew

The larch sawfly was the first forest insect pest against which biological control measures were carried out in Canada. Parasites obtained from England were released in Ontario and Quebec in 1910 and 1911 and in Manitoba in 1912 and 1913. The most important parasite introduced was *Mesoleius tenthredinis* Morley. It built up rapidly in all areas where it was released under suitable conditions. No additional parasites were obtained from England and all subsequent colonies of *Mesoleius* released in Canada and the United States were obtained from areas of high parasitism within Canada.

Rarely, in the history of biological control experiments, have careful follow-up studies been carried out to evaluate the effectiveness of the parasite released, but in this instance Mr. Norman Criddle carried out a study at Treesbank, Manitoba. In this release area parasitism by *Mesoleius*, determined from rearings, increased progressively from 20% in 1916 to 75% in 1927.

About 1940 the larch sawfly again began to appear in epizootic numbers in Manitoba and Mesoleius was successfully parasitizing only a small proportion of the larvae. Only about 30% of the eggs deposited hatched in the host larvae. This low hatch is due to the ability of the sawfly larvae to deposit a thick translucent capsule of phogocytic blood cells around the parasite egg. The genetics and histology of this process are currently being studied.

The resistant strain of the larch sawfly is now present in Ontario, Manitoba, Saskatchewan, Alberta, and sections of the Lake States. The current effectiveness of Mesoleius in Quebec is in doubt, but the larch sawfly is still susceptible to the parasite in British Columbia, Newfoundland, and, apparently, the Maritimes.

Two other species of parasites have been released against the larch sawfly, the tachinid Bessa harveyi (Tnsd.) and the pteromolid Tritneptis klugii (Ratz.). Both of these parasites were present in the release areas prior to the introductions, but studies showed that parasitism by Bessa, subsequent to liberation, was higher in some of the release areas than it was in the areas where no releases were made. Whether or not this was due to the introduction or to other factors is unknown. Tritneptis has been recovered from only one of the release areas.

The interesting aspects of parasitism by Bessa harveyi, are, that the incidence often differs greatly even between adjacent stands, and the emergence is poorly synchronized with the life history of the larch sawfly because a large percentage may emerge after the host has dropped to the ground to spin cocoons.

Mice and shrews destroy a greater proportion of the sawfly in the cocoon than any other single factor. Mr. C. H. Buckner has found that this mortality averages about 75% and may reach 97% of the cocoons. An important aspect of this predation is that certain species discriminate between parasitized and unparasitized cocoons, rejecting the former; and overlapping of mortality factors is reduced.

But with the larch sawfly, the greatest mortality occurs during the egg and larval stages. As yet, the agents responsible for this have not been well studied; these include birds; wasps; pentatomids, mirids, anthocorids, neuropterous larvae, spiders, and mites.

Certain fungus and bacterial diseases cause a small but fairly consistent mortality in the field and these require further study. No evidence of a virus disease has yet been found.

Forestry Aspects

L. D. Nairn

Tamarack is one of the most widely distributed conifers in North America, extending from Newfoundland to Alaska and reaching as far south as West Virginia. It is a pioneer species and initiates forest succession on wet lands following the sedge mat-sphagnum or bog-shrub stage. It promotes a drier, better aerated and more mature soil and prepares the way for other forest species.

When competition does not eliminate it and where favourable moisture conditions permit germination and early survival, tamarack thrives on upland sites, where it is probably the fastest growing conifer in its range.

The recent outbreak of the larch sawfly, which began about 1940, covered most of the western range of tamarack by 1952. Stands of all ages have been subject to defoliation and loss of increment. Tree mortality began to occur in some of these stands in 1954.

Damage from oviposition is easily recognized by curling of the new shoots. Then the larvae feed from the extremities of the branches inwards. Complete stripping of the needles occurs first at the apex of the tree and around the periphery of the crown, because the upper crown has less foliage. Complete defoliation is common in years of severe infestations. Severe defoliation of a healthy tamarack by the sawfly promotes refoliation in the late summer of the same year that it is attacked, but continued severe defoliation causes a decline in the production of both foliage and shoots.

The deterioration of tamarack stands due to sawfly defoliation presents new problems in the study of potential populations and complicates the assessment of damage caused by the population of any one year. The death of branch tips, branches, and the tree itself, together with the production of adventitious shoots from the trunk and branches of severely weakened trees, are all factors that must be considered in study of larch sawfly abundance.

Indirect control of the insect through cultural practices offers many approaches to the problem. However, the inherent properties of the tree, its habitat, and the relatively small size and scattered distribution of the stands, reduce practical control solutions. Regulation of stand density appears to have little effect on larch sawfly populations. Open growing trees are just as severely attacked as those in dense stands. Regulation of stand composition is difficult as tamarack is a very intolerant species. Controlled flooding of stands during the postdiapause stage of the insect or soon after cocooning is an excellent control. But whether it is practical or not is another matter. The development of a sawfly resistant hybrid is a possibility but little progress has been made on this aspect.

The greatest loss of increment and mortality due to defoliation appears in the more mature stands. Considering our present knowledge of the problem, it appears that the best management plan for tamarack would be to progressively clear cut all of our existing merchantable stands. Just how long these cut over stands will take to regenerate and what type of stands will result is still in doubt. However, plans are presently being formulated to provide an answer to the question.

DISCUSSION

W. G. Ives

Mr. Nairn mentioned that the silvicultural practice of thinning does not appear to alter the susceptibility of tamarack to larch sawfly attack, and since stand density does not seem to affect sawfly populations, what factors do you consider important, Mr. Turnock?

W. J. Turnock

The only site character that seems to be of direct importance is the level of ground water. High water levels in the summer restrict the number of cocooning sites and larvae dropping from the trees may drown in surface pools. In the spring, postdiapause larvae in the cocoons may be killed by high water levels. There is a tendency for wet sites to support lower sawfly populations than drier sites.

T. V. Cole

Can larch sawfly be controlled by flooding?

L. D. Nairn

In theory, yes, but it is generally impractical in the bogs and is liable to cause injury to the trees or death.

W. G. Ives

Mr. Nairn has suggested a program of clear cutting all merchantable tamarack stands that have been heavily attacked. It is quite conceivable that this might bring about a change in moisture conditions. Mr. Muldrew, how would this affect the natural control factors operating in remnants of stands?

J. A. Muldrew

Little work has been done on the relation between parasitism and site conditions but there is some evidence that parasitism by Bessa is higher in the more open, drier sites.

Site changes are known to have an important influence on small mammal predation. In wet swamps shrews are more abundant than are mice and this appears to be a desirable condition as a shrew devours a great many more sawfly cocoons than a mouse. Among the shrews, Sorex cinereus, which has well developed powers of discrimination, prefers wetter swamps than does Sorex arcticus, which does not reject parasitized cocoons. In wet swamps the total amount of moss and humus available for larch sawfly cocooning is much smaller than in dry swamps, and the small mammals, although fewer per acre, have a smaller searching universe and may often destroy a greater proportion of the cocoons.

Fungus and perhaps bacterial diseases destroy a greater proportion of larvae under humid conditions.

It is still unknown whether heavy cutting of tamarack would make the site wetter, but on the assumption that this would happen, the considerations mentioned indicate that a greater percentage mortality would be caused by biotic factors.

W. G. Ives

Mr. Nairn, you mentioned that both foliage and shoot production decline during prolonged larch sawfly attack. What is their role in regulating sawfly populations? If tree vigor has declined to a point where either or both of these are effective, what is the chance of the tree making sufficient recovery to resume normal growth?

L. Nairn

The larch sawfly oviposits on the new shoots of tamarack and shoot production might seem to be a prime factor in regulating sawfly populations. Sampling data gathered during the past three years indicate that the utilization of shoots as oviposition sites during any one season rarely exceeds 50 per cent on any tree. However, the development of the insect is not completely synchronized with the development of the host tree and 50 per cent utilization of total shoots in a season may represent 100 per cent utilization of shoots suitable during oviposition.

A decline in foliage production is naturally accompanied by a decline in number of sawfly the tree can support. R. J. Heron has shown that overpopulation results in starvation of many larvae and a subsequent reduction in the adult reproductive capacity. Therefore foliage production is a prime factor in regulating sawfly populations, but there is still some doubt as to the role of shoot production.

Investigations of the recovery of trees following a severe infestation are still in a preliminary stage. Observations would indicate that mortality occurs more frequently in the older and denser stands. Recovery is more rapid in the younger and open growing stands.

A. J. Thorsteinson

What is the relationship between the abundance of oviposition sites and the larval population that a tree will support?

W. G. Ives

On healthy trees, about 30 per cent utilization of shoots as oviposition sites will produce sufficient larvae to completely defoliate the tree.

W. G. Ives

We have been discussing the role of shoot and foliage production in the control of larch sawfly. Presumably the trees are subjected to prolonged attack before either of these becomes effective. Mr. Muldrew, have you any evidence to indicate that the per cent parasitism increases during the course of an outbreak, and what happens to the parasite's effectiveness when the sawfly population starts to decline?

J. A. Muldrew

Cocoon collections have been made in certain areas in Manitoba and Saskatchewan for the last 5 to 10 years. Dissection of the larvae in cocoons indicate that during the early part of the outbreak, when the population was building up at high levels, parasitism by Bessa remained low or increased only slightly. In many areas the populations of sawfly larvae have gradually declined since 1950, partly as a result of the decrease in foliage production, but Bessa parasitism increased to approximately 50 per cent. These estimates of Bessa parasitism are on the low side, since they do not include the Bessa adults that emerge in the fall. This can be as high as 75 per cent of the total Bessa parasitism.

Mesoleius parasitism showed no obvious relation to changes in larch sawfly density. It has averaged about 3 per cent over a 10 year period except in the Prince Albert area, where it was about 8 per cent. Total parasitism by Mesoleius, including encapsulated eggs, has averaged roughly 10 per cent in most areas and 35 per cent at Prince Albert.

R. M. Prentice

Why doesn't Mesoleius die out if it only successfully parasitizes less than 10 per cent?

J. A. Muldrew

The evidence indicates that the searching ability and reproductive capacity of the Mesoleius females are great enough so that sufficient host larvae are parasitized each year to include a proportion of susceptibles. One would expect, however, if the immunity reaction is strictly under genetic control, that continued parasitization would gradually reduce the proportion of susceptibles to the point where there were so few that the parasite could no longer survive. Our present working hypothesis is that the susceptible strain of larch sawfly has superior survival power in the absence of Mesoleius and its proportion increases when the parasite is at a low density. The relationship between host and parasite being that of a self-regulating feedback system.

W. G. Ives

None of the biological control factors presently operating seem to offer much hope for controlling larch sawfly populations. Mr. Muldrew, is there any possibility that this method of control may be successfully applied in the future?

J. A. Muldrew

The outlook for an improvement of the Mesoleius situation is not too high. Mesoleius recently obtained from England have been tested against the resistant larch sawfly on a small scale and the response of the hosts to these parasites was not significantly different from their response to native Mesoleius. There is a possibility that a strain of native Mesoleius will arise that is able to resist the immunity reaction of the host.

With Bessa, possibly natural selection in the field will eventually eliminate the poor synchronization of the parasite and improve its efficiency. In limited instances mass releases of Bessa may be valuable.

The complex of natural enemies of the larch sawfly in America is comparatively restricted and a search for additional parasites, predators, and diseases is currently being carried out in England and Europe. There is always the hope that a virus disease, similar to the one that brought an end to the outbreak of the European spruce sawfly, may be found. There is a remote hope, that the Forest Pathology Laboratory, at Sault Ste. Marie may come up with a mutant form of a disease organism, highly pathogenic to the larch sawfly under field conditions.

W. A. Reeks

What are the prospects of aircraft spraying for control?

J. A. Muldrew and L. D. Nairn

Entomologists in Minnesota investigated aerial spraying with DDT and found that when the spray was applied approximately one week before the peak of larval feeding, population reduction was 60 to 70 per cent. This comparatively low mortality from spraying is primarily due to the extended period of adult emergence. Other objections to large-scale spraying are the small size, widely-scattered distribution, and low commercial value of tamarack stands.

A. J. Thorsteinson

Have the old tamarack stands conditioned the site for black spruce?

L. D. Nairn

Apparently so, black spruce is found in most stands containing merchantable tamarack.

A. J. Thorsteinson

What about draining sites for conditioning and what is the comparative value of tamarack versus black spruce?

W. J. Turnock and L. D. Nairn

Commercially, black spruce is preferable for newsprint manufacture, but they are of equal value for kraft paper. Black spruce is preferable because of its lack of insect pests. As sites for black spruce they would be improved by drainage, this is generally not economic.

W. A. Reeks

Comment on the difference between the so-called red and black tamarack.

L. D. Nairn

These are ecophenes. Fast-growing tamarack on good sites is called red; slow-growing, rot-resistant trees on wet sites are called black. Beginning about 1930, almost all the tamarack in Manitoba and Saskatchewan have shown an outstanding release of growth. This has caused confusion among farmers, who find that tamarack fence posts cut recently only last 3 to 4 years whereas slow-growing tamarack posts resisted rot for 15 to 20 years.

A. J. Thorsteinson

Mr. Nairn, what caused this release of tamarack?

L. D. Nairn

This is currently being investigated. I suspect a climatic change is responsible. It was co-incident with the "dry years" on the prairies. This release does not occur in black spruce.

W. R. Allen

Does flooding cause tamarack to go back to the same growth rate as before release?

L. D. Nairn

If the water levels are not high enough to cause tree mortality they would come back to the same growth rate.

A. J. Thorsteinson

Are the trees equally susceptible to larch sawfly before and after release?

L. D. Nairn

After release the trees are more vigorous and produce more foliage and shoots. They can therefore support a higher population of larch sawfly with less injury. However, sawfly outbreaks in the drier sites usually last longer because of reduced mortality in the larval and cocoon stages.

W. R. Allen

With regard to the problem of cocoon sampling and predation, have you tried exclusion studies?

W. G. Ives

Funnels and boxes excluding small mammals are currently being used to obtain estimates of initial cocoon population. This may later be adapted to give estimates of predation by small mammals.

W. R. Allen

What essential value does the life table have?

W. J. Turnock

The life table is a form of presentation that shows the changes in population between stages in a single generation and attempts to assign all mortality to definable factors. It emphasizes the comparative value of different control factors between life stages, in different years, and under different conditions.

A. G. Robinson

Do you not consider that 99.5 per cent mortality, as shown by the life table, is good population control?

W. J. Turnock

Not in the example given, because the surviving 0.5 per cent of the population was capable of laying enough eggs to give an increase in larval population the following year. The larger the initial population the higher the percentage mortality necessary to prevent an increase the following year.

AERIAL SPRAYING AGAINST THE SPRUCE BUDWORM IN NEW BRUNSWICK

W. A. Reeks
Forest Biology Laboratory
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By 1951 it was apparent that the spruce budworm outbreak in New Brunswick would equal that of 1909-1919, which wiped out the Miramachi Valley as an important wood-producing area for a period of about 40 years. Experience with this insect in other regions indicated that there was little hope of controlling the outbreak by biological methods and the area under attack in New Brunswick was so large that there was no possibility of effectively increasing presalvage operations. Considerable success in controlling a large budworm outbreak on Douglas fir had been reported from Washington and Oregon, so the forest authority of New Brunswick became interested in spraying spruce - fir forests to prevent extensive killing of trees from budworm attack. The forest authority was assured by responsible officers of the Division of Forest Biology that it could not guarantee that one application of spray would extend the life of severely infested trees by more than one year. Considering the market value of manufactured wood, it was felt that a spraying operation would be something more than a "calculated risk", and it was decided to spray in 1952.

The cost of the 1952 operation was shared by the Province of New Brunswick and the New Brunswick International Paper Company. This operation was considered successful, and similar operations were carried out from 1953 to 1955, with the Province, the Government of Canada, and pulp and paper companies sharing expenses. The total acreages sprayed in New Brunswick were: 0.3, 1.8, 1.1 and 1.1 million acres from 1952 to 1955 inclusive. Resprayed areas amounted to about 10 per cent in 1953 and 1954 and about 25 per cent in 1955, so the net acreage amounted to about 3,600,000 acres.

During these operations it was the practice to spray stands in the third or fourth year of severe attack, because beyond this point the trees can withstand very little additional defoliation. There were certain changes in objectives and techniques as the program continued. It was at first hoped by some that the spraying would by itself end the outbreak, but later it became increasingly clear to all that it is more realistic to measure the value of spraying in terms of "foliage protection" and percentage of budworm survival. In the initial operation DDT was applied at the rate of one lb. in one gallon of solvent per acre. Later it was decided that adequate "foliage protection" could be offered by reducing the dosage to 1/2 lb. DDT per acre, the formulation being 1 lb. of technical DDT in 1 gallon of Picco Hi-Solv 473. At first each aircraft was assigned to a spray block. Later it was found that greater safety could be assured by having the aircraft fly in pairs, 50 to 150 feet above the trees, at a lateral separation distance of 250 feet, and 150 feet between adjacent flights.

The operation in 1955 was completed in 20 days (June 7 to 26), and the fleet of aircraft consisted of 80 spray planes and 9 observation planes.

A large scale spraying program requires very careful planning and team-work between the various working groups. The responsibilities of the various groups as organized in New Brunswick are as follows.

<u>Operations Authority</u>

Although the Minister of the Department of Lands and Forests is considered the forest authority, one man can't always make wise decisions on the proper course of action without the aid of well-informed advisers. Consequently, a non-profit company (Forest Protection Ltd.) was organized, and the membership included officials of Government services and industry.

The Company makes decisions on matters of general policy, but a good deal of authority is vested in the Manager of the Company, who is in effect the Director of Operations. The Company makes decisions on matters of finance and administration, location and construction of air strips, contracting work and supplies, areas to be sprayed, scope of spray assessment, calibration of aircraft, and hiring of supporting staff (truckers, loaders, cooks, maintenance crews, spray assessment crews, radio crews, etc.). Technical advice is provided by officers of the Division of Forest Biology.

In addition, the Manager must also prepare maps of the "spray blocks", about 5000 acres in area, enclosed by natural features, such as streams, ridges, etc. Safety in the air is also of prime importance, in this the Manager is assisted by a representative of the Department of Transport.

The spray crew is directed by a chief pilot, who in turn is responsible to the Operations Manager.

Spray Assessment Crew

This crew works under the jurisdiction of Forest Protection Limited. The function of the crew (about 40 workers) is to appraise the spray coverage. They measure the amount of spray reaching the ground by means of a special paper impregnated with an oil soluble dye. The droplets of spray leave circular marks on the paper, and after spraying the paper sheets are classified by comparison with standard sheets of known deposit per acre. The sheets are placed at intervals across the line of flight in each spray block. The average deposit reaching the ground, as measured by this method, is about .36 gallons per acre, and only 3.9 per cent of the samples indicate a complete miss.

Biological Assessment Crew

This crew is made up of personnel of the Division of Forest Biology, with assistance from Forest Protection Ltd. This crew can determine when a spray block is ready for treatment by making periodic collections of foliage and larvae and an aerial reconnaissance. Spraying is commenced as soon as the balsam fir shoots are "opened" and larvae exposed.

After spraying the crew makes systematic collections and rearings and determines the percentage of budworm survival, the effect of spraying on parasites, and the amount of new foliage protected by the operation.

Survey Crew

Detailed surveys must be made from the air and ground to decide on the scope of the following year's spraying operation. An effective aerial survey party requires a co-ordinator, who must be responsible for organizing air crews, preparing flight maps, briefing the pilots, observers, and radio staff, and mapping results. The aerial survey party in 1955 included the co-ordinator, 5 pilots (5 aircraft), and 9 observers including substitutes, as well as radio operators and camp maintenance staff. The survey was carried out from July 1 to July 6, flying a total of 125 hours.

Prior to the aerial survey, a 5 mile to the inch plan of the northern half of the Province is divided into about 13 survey blocks. A 2-mile plan of each block is then prepared, and this shows the location of the proposed flight lines, which are numbered. Copies of the latter plan are given to each pilot-observer team at the beginning of the operation. The pilot notifies the observer at the beginning of each line and he records on a tally form the time-interval between observations, air speed, flight line number, and course. Also, at regular intervals (30 or 60 seconds) the observer tallies the degree of redness (light, moderate, or severe) a measure of current defoliation; the degree of old damage (appraised by extent of "grayness"); and foliage "recovery", detected as a tinge of green overlaying the "grayness". It is then a simple matter to plot these observations on a master plan showing "current defoliation","old damage", or "recovery".

The ground survey crew must be somewhat larger, consisting of 60 or more workers. The members collect and analyze samples of eggs obtained by the "branch method" of sampling, and make observations on current and old defoliation, and foliage recovery, at each sampling station. The relationship between each level of egg population and the anticipated defoliation the following year is fairly well established. For example, approximately 240 egg masses per 100 sq. ft. of balsam fir foliage is generally adequate to cause serious defoliation the following year.

The results of the aerial and ground surveys are combined in the form of a "harzard rating"map, which is the basis for planning the spraying program of the following year.

Discussion

When spraying was initiated it was feared by some that it might serve only to prolong the outbreak, by providing the larvae with an abundant supply of foliage, that otherwise wouldn't be available. As the earlier outbreak lasted about 10 years, it is not yet clear if the spraying will tend to extend the outbreak. It is reasonably certain, comparing sprayed with check areas, that most of the infested stands would now be dead if the spraying had not been undertaken. The operation has extended the salvage period by at least 3 years, and there is still hope that the spraying will contribute to the decline of the outbreak.

From the results of spraying in 1955 it has been concluded that the survival of the budworm was reduced about 83 per cent when all data from sprayed areas were compared with those from unsprayed areas. Also,an average of 70 per cent of the current foliage reamined in sprayed areas, a net saving of 40 per cent. In general, parasite populations were reduced by 54 per cent, indicating that they were not as seriously affected as the host.

Although the aerial spraying operation has been considered successful by most observers, its use should not be considered a substitute for control by silvicultural means. It should still be the aim of forest management to create forests resistant to insect attack.

International Great Plains Conference of
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Address - Neobiologos

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ZOOLOGY, the prolific mother of many lusty daughters--for as such I regard ENTOMOLOGY, HELMINTHOLOGY, LIMNOLOGY, ECOLOGY and many more. Zoology I say, and her daughters too,are on the way to becoming mere branches of Mathematics.

I am indeed reminded of a certain Spanish marquis de Morenas who, feeling that his physical and mental powers were on the wane, ordered his butler or major domo or whatever you call him, to put him, the marquis, through a meat grinder and mix the product with manure, and put the mixture in a tub until such time as the marquis would arise, revivified, re-invigorated.

Today many aspects of the zoological sciences are receiving similar treatment, the manure of course being mathematics, and the results are often no better.

It seems to me that the moment is opportune for those of us here, whether we be plain zoologists,or entomologists,or pestologists, those of us who were suckled at the bosom of that old harridan Classical Zoology, to stand back and consider the effect of this swing over to mathematics upon the methods and ideas in which we were trained.

As the spectators used to shout,in my native country of Lancashire in England, when we gathered round to watch a dog race, stand back chaps and let the dogs see the rabbit.

Now of course I am not so foolish as to think that the nature of the rabbit that modern zoology is pursuing can be in any way influenced by the reactionary yelps of mossbacks, or that such influence would be desirable.

But, de profundis, out of the depths to which classical zoology has sunk, let my quivering sob-choked voice be raised in hail and farewell to that great science that is passing away from us.

It is almost, today, a half century less three years when in innocent adolescence-that halcyon period between infantry and adultery, I proclaimed to an alarmed professor of zoology my considered threat to pursue zoology and even perhaps to overtake her.

My boyish ambition had germinated, I may say, not from the study of integral calculus but from the stealthy perusal, in the privacy of my bedroom, of that Victorian equivalent of the crime comics, Haeckels "Riddle of the Universe"--and had been inflamed by the discovery of a tattered copy of Buffons "Regne Animal", the Great Buffoon as a friend of mine waggishly remarked to an Edinburgh bookseller who forthwith conducted him to the shelf of George Bernard Shaw's works.

The comment of my chosen teacher was significant. He did not say to me, as I should have to say to such a brash young man today, no doubt you are familiar with methods of dispersion and skewness; I suppose, if I may mangle Milton, you have sported with Amaryllis in Tukeys Corner; you are clear I hope about the repulsive forces between closely saturated electronic shells; and of course you have grasped all the angles of the New Clear Physics.

No. He looked at me in somber silence and said simply -- can you handle a shotgun?

For in those days you see--the first decade of this century zoology was still a gentleman's occupation. A seditious and pernicious doctrine perhaps, that had robbed millions of souls of their hopes of salvation, but nevertheless the least useful and least commercially tainted of all the sciences; something far above those cads who merely studied sparks and stinks. As good Queen Victoria had remarked -- far too good for them -- but that was of another matter.

Entomology, first of zoology's daughters, was in Britain, merely a Saturday afternoon hobby for working stiffs and insect control was a matter for jobbing gardeners. Neither subject was tolerated in the ivory towers of most European and American universities. In Britain it is true, Robert Newstead, a self taught working man, had ridden into Liverpool University on the back of the housefly and in London the Colonial Office had been compelled to recall Maxwell Lefroy from his post as dominion entomologist in India to train working lads for posts as entomologists in tropical crown colonies.

The term Insect Control was unknown. I believe that I was one of the first to use it in Britain but I had been tainted by acting as assistant to Maxwell Lefroy. However the Gipsy Moth Committee in New England was arousing British zoologists to a more sinister aspect of the insect, than its aspect as a thing of artistic and cultural interest. Henri Fabre was being shouldered aside by Howard and Timberlake.

Nowadays when I sit down to a desk loaded with journals and reprints of zoological and entomological and helminthological research findings, most of which bear little resemblance to the zoology of my adolescence, being largely solutions of ten dollar problems with ten thousand dollar equipment. I say with a sigh in the words of the late Willie Shakespeare-- God bless thee Bottom thou art translated; on what rich meat doth this our Caesar feed. And I reverently drape a lab duster over the sardonic features of that bygone professor whose portrait hangs above my desk.

Today the zoological sciences are emphatically not occupations for the gentlemen for they themselves are no ladies--they are strip tease artists reverting rapidly to the pristine innocence of their childhood, and the grasping hands that are removing the veils are the hands of the mathematician.

There is today little Zoology, in the old sense of Faunal Zoology but rather a conglomeration of useful arts ranging from rat extermination to duck botulism. Here in Canada for example there is no Zoological Society, no journal devoted purely to zoology, no faunal marine laboratory, no zoological section of the Royal Society and at any important biological convention there will be few papers dealing with zoology in the old sense of the term.

The Zoology established by Thomas Henry Huxley and his disciples who cut slices of tissue with bread knifes and held them under microscopes with their thumbs,and shook the world with their findings, that zoology is dead.

Laboratory training is no longer a matter of blood, sweat and tears. The zoological laboratory of old, redolent of dogfish oil and formalin, its equipment mainly a few dissecting boards, a handful of 2 inch nails and a bungstarter--where with bated breaths we unveiled the beauties of the corpora cavernosa of the rabbit or the tortuodities of the opisthobranchiate nervous system or the musculature of Periplaneta americana is no more. In its place is the glittering enamelled sanctum of spinthariscopes, spectroscopes, cryoscopes, radioscopes, halitosigraphs, spectrographs, urinoscopes, polariscopes, piddleometers, burpometers and horoscopes.

The young man who comes for advice as to a research problem is no longer told to go soak his head in the stormy waters of evolutionary biology but is led reverently to the shelf of apparatus catalogues and told to pick his apparatus and then we will pick a problem to fit it.

For the hound of heaven that has pursued Zoology and her daughters down the arches of the years and finally brought them to bay is the new Physiology. Not the old Physiology that was driven from the zoological Eden by the flaming sword of that zoological archangel, Georges Cuvier; nor even that Physiology that has come to call itself Biochemistry; but the Physiology that is de facto Physics and ipse facto Mathematics.

Yet even in my salad days the writing was on the wall had we but looked. The taxonomist was retreating timidly to the shelter of the museum. That trio of animal lovers, the sportsman, gamekeeper and field naturalist, having de-faunized the worlds countrysides was taking to stamps and Ming Pottery. There was even something we called botanical mathematics; lies, damned lies, and statistics we said with hearty gusts of belly laughter little dreaming that this lusty infant, in years to come would, by shotgun wedding with Darwinism, produce that Messiah of evolutionary biology we call the Modern Synthesis.

The first crude advances of Mathematics into the zoological sciences we likened to --

...octopi and cuttlefishes
Those very sly and subtle fishes
Which do not own themselves defeated
But squirt a cloud of ink and beat it.
Imitating in their capers
The authors of mathematical papers.

The air still rumbled with the distant thunders of the Entwicklungs, mechanik controversies. Driesch and Haldane and Yves Delages were proclaiming the virtues of the Organism Theory. Daring souls were tentatively applying the startling new technique of hydrogen ion determination to loves old sweet song, and the entomologists were agog over the evolutionary significance of proturids.

But the zoology of Darwin, Romanes and Agazziz was dying on its feet. The first tinge of rust was gathering on scalpel and microtome, and although British zoologists at Lion Club dinners could still stand and wag their coat tails and roar and drink that time honoured toast-Here's to Zoology and may it never be any damned use to anybody, they were roaring past the graveyard.

For there was no zoological Churchill--except perhaps Edwin Ray Lankester--to announce that we will fight these mathematical invaders on the beaches, and in the Linnean Society, and in the Zoological Society and even on the floor of the Royal Society.

Now I am not here to bury this new Caesar even if I do not seem to praise him wholeheartedly. I would not have you think me an academic coelacanth. My teaching interests and my research interests are, and have always been, predominantly physiological; that is to say biochemical for to my lasting regret I scarcely understand enough mathematics to fill my income tax form correctly, and my interest in Physics was strangled at birth by studying its elements under a Nobel Laureate.

I do devoutly believe that the zoological sciences are in the hands of the mathematician. I know that J. S. Haldane used to proclaim fiercely that if ever Biology and Chemistry locked horns it would not be Biology that was swallowed, but mathematics has I fear a wider gullet.

I do wish however to point out that this New Deal, this Neobiologos, this Automation even, is only the tail and not the whole dog, and by biological concensus a caudum cannot wag a corpus. There are many mysteries of the organism that defy and will always defy the tagged particle and the electronic computer.

I feel uncomfortable that the wonderful tools and techniques of Zoomathematics are being wasted too often on trivialities.

The fundamental problems of Zoology are only two, the nature of living matter and the causes and mechanism of evolutionary change.

I am conversant with and appreciative of the contribution of zoomathematics to the elucidation of these fundamental phenomena; the contributions for example of Claude and his associates to an understanding of the nature of protoplasm; those of Muller, Klautz, Griswold, Jehle, Haurowitz and many more to the nature of the Van der Waals forces of intermolecular attraction; and the contributions of protein chemists towards the elucidation of genetic particles.

These men and many others are exposing the underpinnings of living matter in a way that the classical methods of Zoology could never do. But I am uncomfortably aware of a mass of so-called biophysical findings that are largely painstaking delineations of the obvious.

I am concerned too as a teacher with the impact of these mathematical approaches to the study of living matter upon the curricula of zoological sciences.

The teaching of structure, classification and distribution, narrow perhaps and with much irrelevant detail, did teach accuracy of observation and appreciation of variability. Today these subjects have been relegated in most zoological curricula to seats so far back in the bleachers that they might as well not be in the field at all.

Fifty years ago the zoological baccalaureate had his limitations but at least he could recognize at sight several thousands of his potential animal clients and he did not sink to his knees and knock his forehead on the floor when the apparatus salesman entered his office. Today I doubt whether he could recognize a couple of dozen species of animals--excluding salesmen.

If the prerequisite to a career in any biological science is to be that knowledge of a mathematics demanded, and rightly demanded, as a prerequisite to Chemistry and Physics if the symbol is to supersede the scalpel and the lens; then we shall see great progressive development of many existing zoological concepts but we shall shut the door to many a future Huxley and Darwin and Agazziz and such non mathematical duffers from who zoological concepts originate in the first place.

On the other hand, if a thorough and wide ranging knowledge of zoology and botany was a prerequisite to a career in Biochemistry and Biophysics we might see less of the fierce energy and clouds of symbols lavished by the biochemist and biophysist of today upon problems which are too often irrelevant to the elucidation of the fundamental phenomena of living matter.

The zoological mathematician today may be like
...the young man who said Damn
It is borne upon me that I am.
A being that moves
In predestined grooves
Not even a bus but a tram.

But he should be at least conversant with the structure and variety of trams and not be like the lady who, believing she had mysteriously lost the engine of her Volkswagen,proposed to borrow a spare one from the trunk of another Volkswagen owner.

Invitation paper:- THE CONTROL OF STORED GRAIN INSECTS

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Stored-Product Insects Section 1/
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Research on the conservation of grain in storage has received impetus in the United States during the past decade from three causes: The occurrence of large surplus stocks of grain, the enforcement of the Food, Drug and Cosmetic Act with respect to the contamination of grain and grain products by insects and rodents, and the discovery of the establishment of the khapra beetle in California, Arizona and New Mexico.

Large surpluses of grain have necessitated the use for storage of every available structure, including the holds of idle ships, unused airplane and blimp hangars, unused oil storage tanks, and warehouses of all types of construction. The handling of grain in these storages and the prevention of damage from insects, rodents and mold fungi have presented many problems.

The Food and Drug administration in its efforts to enforce the Food, Drug and Cosmetic Act has stated that as of July 1, 1956 wheat shipped in interstate commerce is subject to seizure if it is contaminated to the extent of 1 or more rodent pellets per pint of grain or contains 1 per cent or more by weight of insect-damaged kernels. This has increased the demand for information regarding the most effective methods of preventing insect and rodent contamination of wheat while stored on the farm or in country and terminal elevators, and for information regarding rapid methods for determining the filth load in grain offered for sale.

For many years it was believed that winter temperatures in the United States were too severe to permit the existence of active populations of the khapra beetle. In the autumn of 1953 heavy infestations of the beetle were found in Southern California. It was later discovered that this insect was already well established in Arizona also and had been introduced in several locations in New Mexico. In the effort to eradicate this insect from the United States many new techniques have been developed. The khapra beetle flourishes in hot, dry climates. It is doubtful whether it will be able to establish itself in Canada.

General Considerations

Insects are one of the most important hazards to the safe storage of wheat. Wheat at harvest time is relatively free from infestation by the insects that attack it during storage. Modern methods of control therefore, are largely based on preventing insect populations from developing in stored grain rather than in destroying them after they have done serious damage.

1/ This is one of the Sections of the Biological Sciences Branch, Marketing Research Division, Agricultural Marketing Service.

To preserve wheat from insect damage, precautions must be taken to prevent destructive outbreaks. Most of the insect pests of stored grain have short generations, a high rate of reproduction, and long-lived individuals--characteristics that cause great fluctuations in numbers. Under favorable conditions outbreaks are apt to occur suddenly. The immediate causes of such outbreaks are the factors that affect the rate of egg laying, the rate of development, the death rate and the longevity of the insect. The more important factors are, grain moisture, grain temperature, food supply, and human activities. We are unable, at this time,to do much about the weather or to change the existence of large supplies of food however, we can make grain less susceptible to insect attack by the use of efficient cleaning and drying equipment, the application of fumigants at the right time, and by good storage management.

Prevention and Control of Insect Infestation

Wheat that is dry, cool and free from dockage will keep for long periods without appreciable deterioration. For longtime storage a moisture content of 11 per cent or below is desirable. After prompt harvest, followed by drying when necessary, wheat should be stored in clean, insect-free, rodent-proof and weather-proof storage on premises from which nearby sources of insect infestation have been eliminated. Steel bins that are easy to clean and have been made tight by caulking are best.

Wooden bins should be thoroughly cleaned and the walls and floors treated with a residual spray before they are refilled. This will kill most of the insects that emerge from burrows and cracks in the woodwork. Steel bins should be thoroughly cleaned, and spray applied around the door frame where insects may be concealed. Wooden elevator bins should also be sprayed. A spray containing 2.5 per cent methoxychlor or 0.5 per cent of synergized pyrethrins can be applied at the rate of 2 gallons per 1000 square feet of surface area, or any other residual spray approved for this purpose.

With the exception of wheat stored in the northern border States we recommend treatment of farm stored grain with a synergized pyrethrum dust or spray as the wheat is binned, or fumigation within 6 weeks after binning. In the northern States fumigation may not be necessary, but would be a good precaution to take. Inspection every 4 weeks while grain is in storage will show whether additional fumigations are necessary. The finding of 1 or more live weevils or 5 or more bran beetles per quart sample of wheat indicates the need for refumigation.

It will usually pay to fumigate all wheat received for elevator storage or for flat or warehouse storage if it is to be held for a month or longer.

Wheat in farm storage that is in good condition in the autumn and free from serious insect infestation will cool down through the winter to levels where insects will not be troublesome until the following spring or summer. Reproduction does not occur at temperatures below 60° F. Elevator grain can be cooled to a satisfactory temperature by turning. Wheat in flat or warehouse storage can be cooled if the proper equipment for aeration is installed. Such systems are desirable and in many cases almost indispensible for fumigation as well as for aeration.

Grain Protectants

The use of dust and spray protectants has been one of the major advances in the control of stored grain insects in recent years. Experimental work is being conducted with a variety of materials, but synergized pyrethrum is the only material being recommended at this time.

Dust formulations: 1.1 per cent piperonyl butoxide and 0.08 per cent pyrethrins in a wheat dust carrier. Dosage: 75 pounds per 1000 bushels.

Spray formulations

Two types are available (1) an emulsifiable concentrate containing piperonyl butoxide and pyrethrins in the rates of 10 to 1 to be diluted with water; (2) piperonyl butoxide and pyrethrins in a solvent base ready to use.

Experimental work has shown that these sprays give satisfactory protection for one season when used at the rate of one ounce of pyrethrins per 1000 bushels of wheat or approximately 1 ppm by weight. If protection is desired for 2 seasons the dosages of pyrethrins should be increased by 50 per cent. Both dust and spray formulations should be applied to the grain before it becomes infested.

Fumigation

Farm bins:

Farm bins are so varied in size, shape, and tightness of construction that each bin is a separate problem. The fumigator must use his discretion in estimating the dosage required. There are many formulations available that will give satisfactory results. The materials most commonly used, and the dosages recommended per 1000 bushels under summer temperatures in steel bins are, the 4 to 1 mixture of carbon tetrachloride and carbon disulfide, 2 gallons; the 19 to 1 mixture of carbon tetrachloride and ethylene dibromide, 2 gallons; and the 3 to 1 mixture of ethylene dichloride and carbon tetrachloride, 3 gallons. Five per cent by volume of ethylene dibromide is often added by formulators to the 4 to 1 and the 3 to 1 mixtures. Dosages of 2 gallons per 1000 bushels of both formulations are satisfactory. In wooden bins dosages of all fumigants should be doubled. Grain that is cold or that is high in moisture content may require heavier dosages than those recommended.

Flat storage:

For wheat in flat storage the same fumigants can be used at dosages recommended for use in wooden bins. They are usually applied to the surface of the grain. Wherever provision is made for aerating grain in flat storage, the aeration equipment can be adapted for circulating fumigants through the grain mass. In such cases methyl bromide is recommended at a dosage of from 1 1/2 to 2 pounds per 1000 cubic feet of space.

If the building is too leaky for satisfactory use of recirculation, good results have been obtained by reversing the air flow and forcing the fumigant vapors from the bottom of the grain mass back to the surface. The blower or blowers are operated just long enough to give a satisfactory concentration of fumigant in the surface layer of grain. The density of the heavier-than-air fumigants causes the vapors to gravitate toward the floor of the grain storage so that normally the kill of insects in the surface grain is not always satisfactory when the fumigant is applied to the surface. This method will also do away with the necessity of a return duct.

Elevator storage:

For the treatment of elevator grain a number of fumigants and fumigant mistures are available. A number of them, with suggested dosages for use at different temperatures are given in Table 1.

Since it is most difficult to obtain a complete kill in the hopper and on the surface, extra fumigant should be added to the first and last lots of grain entering the bin. Dosages for wooden bins should be doubled.

Chloropicrin and calcium cyanide are applied continuously to the wheat stream as the bin is filled. Chloropicrin is usually applied as the wheat drops into the bin from the tripper. Calcium cyanide can be applied to the wheat stream at almost any point in its journey to the bin, -- on the belt, in a screw conveyor, on the up side of an elevator leg or in the wheat stream as it comes from the tripper. It should be used only in closed top bins with hopper bottoms. The other liquid fumigants are usually applied in aliquot doses to the last 100 bushels of each 1000-bushel draft entering the bin. This can be done by hand or with an automatic applicator. If necessary, surface application of these liquid fumigants can be made if grain temperatures are above 75° F.

When the elevator bin is equipped for aerating the wheat, the same system can be adapted for using methyl bromide by the forced draft circulation method. A dosage of 1 1/2 to 2 pounds of methyl bromide per 1000 bushels circulated for 30 minutes is recommended.

Recirculation Method

The forced circulation method of fumigating grain, which has been popular in Europe for so many years, has been thoroughly tested in the United States during the last 8 years and has been adapted for many types of grain storages. It has been found useful in deep silo-type elevator bins, warehouses, ships holds, oil storage tanks and railroad boxcars.

Table 1.

Dosages of Wheat Fumigants for use in Concrete or Steel Elevator Bins

Fumigant	80°F. or above	70° - 80°F.	Below 70° F.
Calcium cyanide	10 lbs.	10 lbs.	15 lbs.
Chloropicrin	2	2 1/2	3
Carbon disulfide-carbon tetrachloride (20-80)	2 gals.	2 1/2gals.	3 gals.
Carbon disulfide-carbon tetrachloride-sulfur dioxide (20-78-2)	2	2 1/2	3
Ethylene dichloride-carbon tetrachloride (75-25)	4	5	6
Ethylene dichloride-carbon disulfide-ethylene dibromide (76-19-5)	2	2 1/2	3
Carbon tetrachloride-trichloroethylene-benzene-sulfur dioxide (75-10-12-3)	2	2 1/2	3
Carbon tetrachloride-ethylene dichloride-ethylene dibromide (60-35-5)	2	2 1/2	3

In general, the system consists of a floor duct or ducts, or a series of perforated lateral ducts radiating from a central floor duct, connected to a blower or blowers capable of pulling or forcing the fumigant through the grain with an airflow, rate of approximately 0.1 cfm per bushel per minute, and a return duct or ducts from the blower to the overspace above the grain. The return duct can be located within the bin, warehouse or other structure, or on the outside. The pattern of the floor duct system and the return duct system can be arranged to fit the situation. The fumigant can be circulated by pulling it down through the grain or by forcing it upwards through the grain.

In railroad boxcars loaded with bulk grain the system may consist of a series of metal tubes with perforated tips thrust vertically down through the grain to the floor and connected above the grain by means of a manifold to a blower. The fumigant released in the overspace is circulated by being pulled down through the grain and returned to the overspace through the metal tubes. The metal tubes can be supplied individually with small blowers thus eliminating the manifold duct. The latter arrangement is employed to aid in the distribution of the fumigant through piles or bins of grain within buildings under fumigation in their entirety with methyl bromide. While the circulation method is not limited to the use of methyl bromide, more work has been done with this material than with other fumigants.

One advantage of the method is that at the end of the exposure period the free gas can be pumped out of doors.

Tarpaulin Fumigation

Gas-tight tarpaulins are being used more and more for the treatment of bagged grain in loosely constructed or oversize storage structures. Materials found satisfactory for covering stacks of bagged grain are: asphalt laminated fiber reinforced kraft paper, polyethylene sheeting, plastic-coated nylon, plastic coated canvas, rubberized fabrics, etc.

The tarpaulins are made tight at the base of the stacks by the use of sand snakes, bags or earth. Fumigants are introduced by means of a plastic tube into an air dome formed on the top of the stack. Methyl bromide or HCN have been found to be excellent fumigants for treating such stacks. Dosage of 1 to 1 1/2 pounds of either material per 1000 cubic feet give satisfactory results when grain temperatures are above 75° F.

In eradication work with the khapra beetle entire buildings are covered with tarpaulins and fumigated with methyl bromide.

Control of Surface Infestation of Moths

Surface infestations of the Indian meal moth are occasionally troublesome in grain storages of all types. Fumigation has not proved to be the answer, although in closed-top bins, fumigants can be atomized in the overspace to good advantage. Many grain dealers resort to pyrethrum sprays as moth preventions. We are conducting exerpiments with pyrethrum sprays at the present time to determine the proper concentrations that should be used and the frequency of application necessary. As a preventative measure we recommend a synergized pyrethrum spray applied as a coarse spray to the surface grain at the rate of 1 pint per 100 square feet of surface area. Spray formulation: 0.2 per cent pyrethrins, 2 per cent piperonyl butoxide, 97.8 per cent deodorized kerosene.

Detecting Internal Infestation in Wheat

The modern grain dealer in the United States frequently feels the need for a rapid method of determining the extent of internal insect infestation in wheat shipments offered for sale.

The cracking-flotation method was one of the first methods used. It is reasonably accurate, but slow and time consuming. Cleaned grain is coarsely ground to release the internal insect forms, and is either soaked in a water-alcohol mixture or in boiling water, and then mixed with gasoline or mineral oil. The insects or insect parts are floated off with the oil-layer in a Wildman trap flask, collected on a filter paper and counted.

A quicker and more accurate method consists of taking an X-ray photograph of a 100-gram sample of wheat and counting the internal forms. This method requires expensive equipment.

Recently a simple and inexpensive method was described by White (1956) whereby a mixture of two solutions of different specific gravity is used in making a rapid separation of infested and non-infested kernels in a sample of wheat.

The mixture consists of a solution of sodium silicate ($Na_2Si_3O_7$) in water with a specific gravity of 1.160 to which is added methyl chloroform adjusted to a specific gravity of 1.30 with deobase oil. When placed together a definite separation layer is formed between the two liquids. The lighter sodium silicate solution remains on top of the heavier methyl chloroform-oil solution. Kernels containing the later stages of weevil larvae float on top of the sodium silicate solution. Kernels containing early stages of weevil larvae and some non-infested light kernels are buoyed up to the separation level of the two liquids by the 1.30 specific gravity methyl chloroform-oil mixture. Non-infested normal weight kernels sink to the bottom. By placing a 1000-kernel sample of wheat in the receptacle containing the solutions and stirring to wet the kernels, a quick separation of the kernels occurs. If there are no kernels in the top layer the sample can be considered free from serious infestations. In the presence of floaters, the degree of infestation can be estimated by the relation between the number of floaters and the size of the sample.

Literature Cited

White, Gailen D. 1956. Studies on Separation of Weevil-Infested From Non-infested Wheat by Flotation. U.S.D.A. Circ. AMS-101-9 pp.

Summarized Discussions

SUMMARY OF INSECTS OF THE SEASON 1956

Field Crop Insects

Grasshopper populations have shown a general increase in the Great Central Plains area in 1956. Control measures were carried out on a fairly large scale on forage crops in Minnesota(Melanoplus femurrubrum) and North Dakota (M. mexicanus and differentialis), and on rangeland in Wyoming. Isolated infestations in Alberta and Saskatchewan required control. In Manitoba control measures were more extensive, particularly in alfalfa fields and pastures in light soil areas. In the Canadian provinces the main species were M. mexicanus, bivittatus, packardii, and Camnula pellucida.

The pale western cutworm threatened damage in Wyoming but this damage did not materialize. There was no damage in Alberta for the third successive year. In Saskatchewan the population was very low and no damage occurred. The army cutworm occurred in very light infestations and negligible damage was done in Alberta. In Manitoba the species was not observed. The red-backed cutworm caused little or no damage in the Great Central Plains area, but the insect was more abundant in Saskatchewan than for several years.

Wireworm damage in Saskatchewan was generally light with occasional moderate to severe thinning in summerfallow wheat. The most important species was Ctenicera aeripennis destructor (Brown). The following species were recovered from a field near Saskatoon: C. aeripennis destructor, Hypolithus nocturnus (Esch.), and Aeolus, Dalopius, and Limonius sp. In Alberta and Manitoba damage was very light. Limonius dubitans LeC. was recorded in Manitoba for the first time. In Wyoming and North Dakota infestations were isolated but damage was severe in some cases.

The corn leaf aphid caused some damage to barley in central Wyoming, and this species together with the English grain aphid and the green peach aphid were present in Alberta and Manitoba. Populations were low and no damage occurred. In Minnesota some control measures were required for the pea aphid on field peas. This insect was present in small numbers on alfalfa in Alberta.

Crickets increased generally in Alberta (Mormon), Manitoba (field), and Minnesota. In Minnesota there was damage to swathed grain, while in Manitoba binder twine was cut.

Wheat stem sawfly infestations were very light in Manitoba but severe in some of the northcentral and northwest counties of North Dakota. In Alberta this species was found for the first time in the Peace River area, and populations increased in some other areas. Parasitism by Bracon cephi appears to have increased in the Lethbridge area.

The European corn borer caused losses in Minnesota in 1955 estimated at $10,000,000. A survey in 1956 showed a 23 per cent mortality among overwintering borers. In North Dakota winter mortality was estimated at 80 per cent in the southeast. However, after the first generation borers hatched, 20 per cent of plants showed borer infestation. The insect was very scarce in Manitoba. The corn root webworm, according to a few reports, caused severe damage to corn in central and south central Minnesota, while the seed-corn maggot caused severe damage in sweet corn plantings in the south central district of Minnesota.

Armyworms were quite general in Minnesota, populations were higher in the west central area. Adults were taken in light traps in Manitoba and North Dakota but larval damage was light. There were heavy infestations of the bertha armyworm on rape and flax in south eastern and northeastern Saskatchewan and control measures were applied to about 15,000 acres.

Billbugs, Calendra spp., were found in many corn fields along the Minnesota River lowlands and there was 10 to 20 per cent damage.

The wheat midge was present in the northwestern corner of Minnesota; the majority of heads were infested in some fields. In eastern Manitoba some fields showed losses of 10 to 30 per cent. Scattered light infestations occurred in eastern Pembina County, North Dakota.

Blister beetle populations increased in Manitoba (Lytta nuttallii Say, Epicauta fabricii (Lec.), and E. subglabra (Fall), in Minnesota (E. pennsylvanica), and North Dakota, but damage was light. Epicauta sp. damaged one sugar beet field in southern Alberta.

In eastern Wyoming damage to sugar beets by the beet webworm was considerable, while in North Dakota soybeans and grain were damaged at several locations.It was present, up to 100 larvae per square yard, in flax and rape fields in Saskatchewan, but damage was light since the larvae fed mostly on weeds. In Alberta the population was lower than in 1955 and damage was light because of the low population and early control measures.

Wheat stem maggot infestations were lighter than for several years in North Dakota; in Manitoba its abundance was as usual.

Sweetclover weevil defoliation to seedling sweet clover was severe in some fields in northeastern North Dakota. In Minnesota injury was heaviest in the Grand Forks-Crookston area. Seedling clover was not damaged in Alberta, but there was damage to second-year stands grown under dry conditions. The weevil was found throughout the Peace River area in 1956. Populations were high in Manitoba but good growing conditions prevented serious losses.

The sweet clover aphid, Myzocallidium riehmi, appeared in northern Valley counties of North Dakota where 10 to 100 per cent of seedling plants were infested. There was some leaf yellowing in late June but good stands were obtained. Similarly, in the corresponding area of Minnesota infestations were severe. This insect was recorded for the first time in Manitoba.

The alfalfa weevil is a perennial problem in Wyoming, but sprayed fields were satisfactorily protected. In North Dakota, where it first occurred in 1955, it is present in low numbers in five southwestern counties. In Saskatchewan the weevil population and area infested have increased. The known infested area extends about 100 miles north of the International Boundary and from Alberta to within 65 miles of the Manitoba border. In Alberta it has become established in an area extending about 75 miles north of the border. Infestations are subeconomic in these provinces.

Plant bugs, Lygus sp., and the alfalfa plant bug, Adelphocoris lineolatus, damaged alfalfa in the Crookston and legume seed growing areas of Minnesota. In Manitoba A. lineolatus and A. rapidus were present in usual numbers but there was no visible damage. Plant bugs, Lygus unctuosus Kelton, L. borealis Kelton, Plagiognathus n. sp., and A. lineolatus were the most important pests of alfalfa in northern Saskatchewan.

The spotted alfalfa aphid has not been taken in Wyoming or Alberta.

Clover leaf weevil larvae damaged white dutch clover in a greenhouse at Lethbridge. This is believed to be a first occurrence record for Alberta.

The sugar-beet root maggot, Eurycephalomyia myopaeformis (Roed.), damaged sugar beets in the light soil areas at Taber and Cranford, Alberta, but damage was lighter than in 1955. About 3,000 acres of beets were treated at seeding. In Manitoba infestation occurred in the light soil areas at Steinbach southwest of Altona. Good growing conditions prevented serious losses. The sugar-beet aphid was present and populations were higher than in 1955 in most of southern Alberta. Reports were received of infestations of lettuce, swiss chard, spinach, and beets. The spinach carrion beetle, Silpha bituberosa Lec., caused little damage to sugar beets in Alberta.

Sunflower insects caused light damage in Manitoba despite a slight increase (1.7 to 2.5 per cent) in damage by Phalonia hospes (Wlshm.). Homoeosoma electellum (Hulst), which was present in 1954 and 1955, was not found. Rhynchites aeneus Boh. was found causing head drop.

Vegetable Insects

Colorado potato beetle infestations were light in Alberta and North Dakota but heavy in north central Wyoming. In Manitoba populations were heavier than for a number of years. Early season chemical control was required; neglected gardens were seriously defoliated. Potato leafhopper populations were high in North Dakota and "hopperburn" was apparent where chemical treatment was inadequate. In Manitoba populations were much lower than in 1955. Potato flea beetle infestations were heavier in Manitoba and North Dakota than for several years.

High populations of the stripped cucumber beetle damaged cucumbers, melons,and squash over a wide area in eastern North Dakota.

Imported cabbageworm adult populations were heavy about mid August in North Dakota, Manitoba, and Alberta, and control measures were required on susceptible crucifers. In Saskatchewan the insect was present in most rape fields but damage was insignificant. The diamondback moth damaged mustard in the Milk River area of Alberta and was abundant on cabbage and rutabaga. In Saskatchewan larvae were present on rape but damage was light.

Six-spotted leafhopper populations were not as high as in previous years in Manitoba and for the first time in several years market gardeners produced marketable head lettuce.

Stored Grain Insects

The rusty grain beetle was present in southern Alberta, a severe infestation occurred at Vulcan. The saw-toothed grain beetle was reported from Medicine Hat, Alberta. Several householders reported damage to cereals in the Winnipeg area. The granary weevil was present in stored grain at Medicine Hat and Wilson Siding, Alberta. The Mediterranean flour moth was found in salted peanuts in Winnipeg.

Forest, Shade Tree, and Ornamentals Insects

Forest tent caterpillar infestation remained at a low level in Minnesota with a small defoliated area in the east central and northeastern part of the State. Very little control work was carried out. In Alberta there was damage to poplar trees in the Lethbridge area.

The jack-pine budworm has been increasing in Minnesota since 1954, and this year defoliation occurred in seven north- and east-central counties.

The spruce budworm has been increasing throughout spruce-fir areas of northeastern Minnesota with moderate to heavy defoliation from International Falls to Basswood Lake along the Canadian border.

Fall cankerworm damage was severe on Manitoba maple in some areas in southern Alberta. There was light to moderate damage in Manitoba.

The cottonwood leaf beetle was present on poplar and willows along river banks and in many shelter-belts in southern Alberta.

Grape leafhopper, Erythroneura sp., severely damaged Virginia creeper in southern Alberta. Leafhoppers also damaged Manchurian elm in the Lethbridge area.

Heavy infestations of oystershell scale on cotoneaster occurred in many areas of North Dakota. Hedges were also damaged in the Lethbridge area.

Damage by larvae of the mourning-cloak butterfly was reported from Manitoba, Alberta, and North Dakota.

Blister beetles defoliated caragana hedges in many areas in North Dakota.

The fall webworm occurred in heavy infestations with severe defoliation in some areas in North Dakota. A few nests were observed in Manitoba.

The pear-slug was present on cotoneaster and mountain ash in the Lethbridge area. It was worse than usual in Manitoba on cotoneaster and plum in the Winnipeg area.

The linden borer, probably a first record for the Province, emerged from firewood in Fort Garry, Manitoba.

Insects Attacking Man and Animals

Infestations of the American dog tick were the heaviest for a number of years in southern Manitoba. They were very troublesome to humans and cattle. Black flies were unusually abundant in southwestern Manitoba and some chemical control was required in the Souris and Pembina Rivers. In Saskatchewan there were severe outbreaks of *S. arcticum* and *S. venustum*. Sixteen livestock fatalities occurred and milk yields were reduced in the northwest and central parts of the Province.

Stored Product Insects

Chairman: F. L. Watters

F. L. WATTERS

The most serious pest of stored grain in the Prairie Provinces is the rusty grain beetle. It infests grain stored on the farm and in country elevators; less frequently, grain in terminal elevators. The insect feeds on the germ and causes bulk grain to heat, often resulting in down-grading when it is sold.

Other beetles that often occur in stored grain in the Prairie Provinces are: fungus beetles, *Cryptophagus* spp. and *Enicmus* spp.; the yellow mealworm; hairy spider beetle; saw-toothed grain beetle; the foreign grain beetle, *Ahasverus advena* (Waltl.), and granary weevil.

The mites that commonly occur are *Acarus siro* L., *Glycyphagus cadaverum* Schr., and *Cheyletus eruditis* Schr.

Moths occur infrequently in stored grain on the Prairies. The Indian-meal moth and the meal moth occasionally infest stored grain.

Most stored grain infestations may be prevented by good hygiene combined with residual insecticides. The first step is to clean up grain residues in empty buildings and outside premises. Next, one of the following residual insecticides should be applied to the floor, inside walls, and ceiling at one gallon per 1000 square feet: 2 per cent methoxychlor, 1 per cent lindane, 3 per cent malathion, or 2.5 per cent piperonyl butoxide mixed with 0.25 per cent pyrethrins. The first two insecticides are used as wettable powders, the others as emulsions.

Two dust protectants are also available for use in stored grain, 0.25 per cent malathion and piperonyl butoxide - pyrethrins 1.10 and 0.08 per cent, respectively. Either formulation may be applied to grain at a dosage of one pound of powder to 10 bushels of grain. Laboratory experiments show that both insecticides continued to protect grain from insect attack eight months after application.

When preventative measures have not been applied grain often becomes infested. Infestations may sometimes be controlled by turning the grain. This method has often been successful in reducing the severity of infestations during cold winter weather. However, insect infestations in stored grain are generally controlled by fumigation. Fumigant mixtures containing carbon tetrachloride, ethylene dichloride, and ethylene dibromide have been used widely in the Prairie Provinces. We have experimented with different methods of applying fumigants with special emphasis on safety factors. Wherever possible, fumigants should be applied from the outside of the building. For application, a stirrup pump may be used to treat grain in 1000-bushel granaries, and a gear-pump powered with a 3.5 horsepower gasoline engine for grain in annexes or elevator bins.

A useful method of detecting insect infestations in stored grain utilizes a water-trap. Most stored product insects are readily attracted to water, and light infestations are more easily detected with a water-trap placed at the grain surface than by sampling grain from the surface or from various depths. Control measures are more effective when applied before insects become widespread throughout the grain bulk.

<u>W. LOBAY</u>

Infestations of rusty grain beetles are now considered to be widespread throughout the Province of Alberta. There are, however, more reports of infestations from the southern part of the Province, where most of our grain is stored. We have found that fungus beetles are often associated with the rusty grain beetle. We have also had reports of three infestations of the granary weevil. The Province of Alberta has undertaken to provide gas masks to farmers who wish to fumigate their grain. This service is provided through the District Agriculturists. However, the canisters have a life of only about 20 minutes when exposed to heavy concentrations and it costs considerable to replace them. I would like to hear some discussion on the proper use of respirators in connection with grain fumigation.

F. L. WATTERS

I believe some of these canisters would last longer if the operators applied the fumigant from outside the building instead of exposing themselves to heavy concentrations from within.

W. LOBAY

We record the exposure periods on the canisters whenever they are used and replace them after 20 minutes to be on the safe side. I would like to know if it is absolutely necessary to use a fresh canister in a respirator before undertaking fumigation. We have never used respirators in the past, and I would therefore like to know how you determine when the protective usefulness of a canister has expired. I might add that canisters are relatively expensive and that the total cost of changing canisters for each fumigation could be appreciable if one had to do many fumigations.

B. BERCK

You are quite right, Mr. Lobay, in pointing out that the cost of a canister is relatively high. We use the Mine Safety Appliance G.M.A. (black) canister which costs $4.75 per canister. The manufacturers state that they will give respiratory protection when the total concentration of fumigant vapors in the air does not exceed 2 per cent by volume. This is a relatively high figure, but it is entirely possible to obtain and even exceed such concentrations under certain conditions. Apart from that, while a canister should not be used more than 20 minutes for a 2 per cent concentration, the maximum usage should not exceed 40 minutes for a 1 per cent concentration.

I have been given to understand that these concentration-time relationships are on the safe side with a wide margin of safety. Nevertheless, it is well to keep within the bounds specified. I recognize that it is impossible to know the exact or even approximate concentration of fumigant in the air without the use of chemical analyses that are far more costly than a few new canisters. One could further rationalize the situation by considering that 20 minutes of protection from inhalation of fumigants is well worth $4.75; for such protection, costs should not be considered too closely.

An additional hazard is the absorption of fumgiant vapors through the skin of the operator. Although the small amount of information on this point is conflicting, I am inclined to believe that under conditions of high temperature and high humidity, when one wears light clothing and perspires profusely, absorption of gases such as methyl bromide or ethylene dibromide through the skin is possible. I have no proof, but I feel that exposure of the body should be minimized. The best method would be to apply the fumigant to the surface of a granary or annex with the operator wearing a respirator but standing outside the door.

W. LOBAY

Can you use G.M.A. black canisters for protection against chloropicrin?

F. L. WATTERS

No. Yellow canisters are necessary when chloropicrin is used.

W. G. MALAHER

I am interested to hear of your reports about infestations of the rusty grain beetle. Our company recently had an infestation report from as far north as Melfort, Saskatchewan.

F. L. WATTERS

In Saskatchewan our heaviest infestations have been in the areas south of Regina, and near Rosetown. We have also had one or two reports from the Prince Albert area.

D. McLEAN

We didn't appear to have a problem of stored grain insect infestations last summer until the quota opened. When farmers began checking their grain stocks, they suddenly discovered that they had insects. I venture to say that there are probably more infestations about the country than we anticipate. I would like to hear a few more remarks on this subject.

F. L. WATTERS

I understand that there is a penalty imposed by the Board of Grain Commissioners for shipping infested grain from country elevators to the terminals. I believe that this is sufficient to discourage elevator agents from shipping infested grain. The penalty has also served to make agents examine grain deliveries more carefully so that they do not purchase grain that might infest the entire elevator. In many cases elevator agents have turned away grain that contained insects. This action, although drastic from the farmer's point of view, emphasizes the need of preventive measures for protecting farm-stored grain.

B. BERCK

Fumigants vary not only in toxicity to insects but also in the degree to which they can penetrate to the bottom of a grain pile. Thus we might find that 12 to 16 hours after application to the surface of a 30-foot pile of grain, fumigant A, B or C might penetrate to different depths. Such facts form the basis for formulating fumigant mixtures for application to stored grain, the individual fumigants are blended to yield a balanced mixture capable of combatting infestations at all levels.

We investigated the distribution and persistence of fumigants applied to grain in elevator bins and country warehouses. Tests were conducted with methyl bromide (MB), ethylene dibromide (EB), and carbon tetrachloride (CT), applied both singly and in admixture. Tests were also made with two proprietary fumigant mixtures: (a) Dawson 73 consisting of EB:MB, 7:3 by weight; (b) Dowfume EB-5 consisting of EB:ethylene dichloride (EDC):CT, 7.2:29.2:63.6 by weight. Mixtures (a) and (b) were applied to the surface of grain at rates of 6 to 8 pounds and 60 to 80 lbs. per M bushels, respectively. A comparative study of Dawson 73 and Dowfume EB-5 was of particular interest, because both contained almost the same amounts of EB by weight in the dosage range mentioned. We determine the concentrations of MB,EB, and CT by the use of chemical methods that we developed. We found that addition of CT to EB significantly increase the amount of EB that penetrated to the bottom of a grain pile, producing mortalities among test insects greater than that given by CT alone. But there was a preferential sorption of EB at the surface with only minimal downward migration when EB was applied alone, combined with 30% MB or with 70% MB. We concluded that CT in a fumigant mixture containing EB increases the toxicity of the mixture when it is applied to stored grain because it brings down more EB to the lower levels. In this respect it is much more effective than a mixture consisting of EB + MB.

G. COOPER

I wonder if Mr. Berck would tell us something about the residues that were obtained, and whether there was any damage to the quality of wheat due to fumigation.

B. BERCK

We found that the milling and baking qualities of the wheat were unaffected by the experimental fumigations and the treatments had no effect on the naturally occurring thiamine (Vitamin B_1) of the wheat. There were no marked differences in germination between treated and untreated samples, except that some of the MB-treated kernels had thickened root tips and reduced root length.

We obtained highly variable results on residues that are difficult to interpret. In some fumigation drum experiments we obtained residues that ranged from 6 to 45 p.p.m. of bromide. When the wheat and flour were relatively dry, more of the bromide was found in samples taken from the bottom of the desiccator, whereas when the wheat and flour were comparatively moist, more of the bromide was distributed in samples taken from the top and middle areas. On the other hand, when we determined residues of bromide and chloride in wheat fractions milled from wheat sampled at the top and bottom of the test cylinder experiments, we obtained values that ranged all the way from 0 to 565 p.p.m.

As previously pointed out, wheat fumigated with ethylene dibromide shows strong sorptive tendencies for EB, particularly if the moisture content is high. We found that the rate of desorption from the wheat of volatile EB was relatively slow under conditions of aeration that apply in country annexes, while under laboratory conditions it might take as long as 3 weeks to reduce the bromide residue down to 25 p.p.m. or so. We intend to investigate this aspect more closely.

S. R. LOSCHIAVO

Insect distribution was the criterion used to assess the food preferences of certain flour mill insects. The apparatus used consisted of cylindrical chambers designed so that insects could express a choice of from 2 to 12 foods.

Flour mill insects appear to multiply at certain sites in the mill, but it is unknown whether they arrive at these sites by choice or simply as a result of the mechanical operation of the mill. A knowledge of insect food preferences would enable a mill operator to watch more closely the machinery carrying materials preferred by insects, in order to carry out a more effective program of insect control.

The effects of nutritive value, particle size, and the degree of rancidity on the food preferences of the confused flour beetle were demonstrated. The results indicate that nutritive value of the food was an important factor in attracting insects. In general those foods containing the largest amounts of wheat germ attracted the greatest number of insects. There was some evidence that given sufficient time, the insects gradually became conditioned to unattractive food. Fine bran attracted significantly more insects than coarse bran, and there was a positive correlation between the degree of its rancidity and attractiveness. The older the bran and the greater the rancidity, the less attractive it was to flour beetles. But although the bran was unattractive to adult flour beetles it was a suitable medium for normal development of larvae.

This food preference study indicated that flour beetles are often abundant in the feed end of mills because of the mechanics of mill operation.

Adults of the flat grain beetle, like the confused flour beetle, preferred foods high in wheat germ. Larvae of the cadelle showed no apparent food preferences. Yellow mealworm larvae consistently preferred bran from which fat had been extracted and second patent flour rather than any of the other 12 millstocks tested. They preferred finely ground to coarse bran. Foods low in fat were more attractive than those of relatively high fat content.

The effects of sublethal fumigant treatments on larvae of the confused flour beetle are being studied to determine whether or not low dosages, that may occur during spot fumigation, affect the susceptibility and reproduction of the adults. Median lethal concentrations of fumigant will be applied at certain intervals during development. The resistance of survivors that reach the adult stage will be tested and the rate of oviposition and viability of eggs will provide further criteria of sublethal effects.

Median lethal concentrations for larvae have not been definitely established. The dosage that killed approximately 50 per cent of larvae 0 to 2 days old was insufficient to kill 50 per cent of 21 day old larvae. Survivors of larvae exposed to high dosages of carben tetrachloride moulted more times than untreated larvae or those exposed to low dosages. This excessive moulting may indicate a detoxification mechanism or a stimulation of the moulting cycle by the fumigant. Larvae that survived exposure to high dosages of carbon tetrachloride were smaller in size at maturity than untreated larvae of the same age and they developed at a slow rate to produce small adults. Cessation of feeding during treatment and slow resumption of feeding after treatment are probably responsible for the reduction in size.

Field Crop Insects

Chairman: L. G. Putnam

R. E. PFADT

The Chairman asked me to say a few words about grasshopper research in the United States. Both federal and state entomologists carry on grasshopper research. The main laboratory of the federal government is located at Bozeman, Montana under Frank Cowan. They have done considerable testing of insecticides for grasshopper control, but a shift is now being made to more fundamental studies on ecology and nutrition. Richard Newton of this laboratory is working on grasshopper enemies, particularly internal parasites. Two entomologists are studying grasshopper feeding and damage to range vegetation at a branch laboratory in Arizona.

Two years ago Dr. Pepper of Montana State College, and his group, felt that the States should be doing more on grasshopper research. Their idea culminated in the establishment of a regional project to study the ecology and control of range grasshoppers in Montana, Wyoming, Colorado, Idaho, and California. In Wyoming we began very early to control our range grasshoppers with insecticides. Dr. Pepper feels that we should first learn more of the biology and ecology of the rangeland grasshopper before attempting chemical control. At present Montana and Wyoming are taking opposite courses and we shall follow the pattern of grasshopper infestations under these two conditions. However, there has been some insecticidal control in Montana, as Dr. Pepper does not feel that they should be left entirely uncontrolled.

Montana has attempted to measure the effect of range grasshoppers on vegetation, by treating about half a section and leaving half untreated during the growing season to measure the differences in amount of grass produced. We have also used this method and a cage method, but both have disadvantages. With the former method it is difficult to obtain distinct differences between two large areas because of the great variation in vegetation within the area. With the cage method the grasshoppers and vegetation are brought under abnormal conditions. I think a combination of both methods will give us some idea of what the grasshoppers are doing. But I'm not optimistic that we shall find out how small populations may decrease forage production, because many factors affect it.

D. L. GUNN

In the last two days Walter Romanow has given us some insight into your grasshopper problem, sufficient for me to be able to point a contrast.

In North America your grasshoppers live either in a crop and breed there or very close to the crop. The most striking feature is the difference between the literature and what people tell us here. In the literature we see references to grasshopper numbers, grasshopper infestation, but we find that in the field Romanow talked about '*M. mexicanus*', '*M. bivittatus*' or '*Camnula*'. That was a very pleasing thing to discover, because these species live entirely different lives, and whatever solutions or alternative solutions are found, they will be developed species by species and not for grasshoppers as a whole. You have a very biological attitude in the matter and this is a very hopeful sign for the future.

In Africa locusts breed far from their target crop, swarm, and migrate hundreds or thousands of miles in dense swarms weighing thousands of tons. However a very small proportion of Africa is cultivated and subject to serious damage. But if a swarm, weighing perhaps 20 thousand tons, lands on a farm and eats, as estimated, its own weight in vegetation each day, very little is left for the farmer. For the red and migratory locusts, organizations have been established that try to prevent the formation of swarms. The main breeding or formation of swarms takes place in restricted areas, probably about two thousand square miles, and the invasion area in something like 3 million square miles, so there is a strategic possibility that by preventing swarm formation in the outbreak areas a very much larger area can be protected. We have been using insecticides due to operational necessity but the cost is high. Presently we use BHC, which is reasonably inexpensive, effective, and can be handled and dispersed by casual labourers without the risks inherent in the use of such effective insecticides as parathion and dieldrin. But our main research is directed toward ecological control. We ask what are the habits of and numerical relationship between the species with which we are dealing? What are the effects of weather on them or how do the effects of weather interrelate with vegetation? Probably there are many causes for any effect, and while meterological factors do seem the most important in controlling grasshopper populations, they must be somehow interrelated with parasites, predators, and vegetational differences. We are looking at this sort of thing to see if we can control other agencies that will combine with uncontrollable weather factors to control outbreaks.

In Africa we are turning to cultural and ecological control methods. Land utilization in outbreak areas is negligible and we are going to flood one large area, foster the growth of trees in another, and turn one to cattle production. But ecological control is going to be more difficult in your country because you can't change cultural practices which obviously are extremely profitable and well managed. Fortunately, the cost of grasshopper control in your prairie provinces has never exceeded one per cent of the net agricultural profits. However, I am glad to see that investigations are going on so that information may be available for alternative methods of control should they be necessary.

R. E. PFADT

I just want to comment that the species have not been designated in North American literature generally as a matter of convenience, because our crop land may be infested by three important species along with five or six species of lesser importance, and on range land fifteen or more species may be present. However, everyone dealing with grasshopper research agrees that in ecology the species must be considered.

W. ROMANOW

Do you use bait in Africa?

D. L. GUNN

No, we don't use bait because the red locust seldom comes down on the ground. It grows up in the tall grass and the migrating bands of hoppers leap from stem to stem. So a stomach poison has to lodge on the grass. A dispersible powder used as a dust is more effective for the red and brown locusts than an ordinary dust. They are applied with simple inexpensive, bellows dusters, by our very casual laborers.

In the last two years we have used light aircraft, Piper Supercubs, for spraying large swarms. Dinitro-o-cresol solutions were used because this is a quick killing poison that knocks the locusts out of the air, providing them with a lethal dose. Damage to vegetation is of no concern in these areas.

R. C. RAINEY

For the desert locust in flight aldrin has given poor results, 8 or 16 ounces per gallon of oil is required. BHC bait is used for 'hoppers' but the big limitation is the cost of transportation. Locusts tend to breed in such awkward places that something like 50 per cent of the campaign cost is required for moving bait carrier. But dieldrin concentrates, applied to vegetation at ultra low volume may, provide a possible substitute for baiting.

H. E. WOOD

What do you mean by ultra low volume spraying?

R. C. RAINEY

One-half gallon per acre of swarm, perhaps even down to one-tenth gallon. A point important to us is that the target consists of wide open, sandy areas with sparse vegetation a few inches high, and we find that when a spray (Ca 50 Microns) is used, the deposit left on the vegetation is greater than the deposit left on the ground. These little bits of vegetation appear to act as a sort of an air cleaner which take up spray from the finely dispersed clouds. So even with one-tenth gallon per acre, deposits that kill are found on the vegetation.

H. E. WOOD

I wish to discuss the changes in grasshopper control brought about by the change from baits to sprays. The governments in Western Canada have been interested financially in the control of grasshoppers over a long period of years, some 55 years in Manitoba. Up until 1941, when baits were last used, the provincial government purchased the bait ingredients and the municipal government looked after mixing and distributing the bait to the farmers. When the new spray chemicals came into use in the late 40's and early 50's, the control plans devised proved totally unworkable. A new plan of campaign was started this past spring, which we think is workable.

The Manitoba government still wants to aid farmers in grasshopper control. We are leaving the processing, handling, and retailing of the insecticides entirely with the trade. When the farmer purchases less than $10.00 worth of insecticides, no reimbursement is made to him. When his cost for insecticide exceeds this figure, half the remainder is refundable to him by the municipality. The Municipal and Provincial governments divide this cost equally. So the control campaign is now pretty well resolved to a matter of bookkeeping between the municipal and provincial governments.

We feel that this procedure will avoid the waste of expensive chemicals that might occur if they were provided by the governments.

R. E. PFADT

In Wyoming the control of rangeland grasshoppers is organized by the Federal and State Entomologists. The cost is divided equally between Federal and State governments and the land owners. The work is completed by private aircraft spray contractors. Total cost is about 60 cents an acre. In the crop area the Federal government does not now provide direct financial assistance.

J. CALLENBACH

In North Dakota we also receive Federal assistance for grasshopper control on rangeland, but the farmer is responsible for control on crop land. However, some counties are still carrying some of the grasshopper control fund,an assessment permitted in the thirties, and material was bought this year and dispersed within certain county areas; the farmers contracted to apply the material.

But our State and local set-ups are not geared to the use of insecticide sprays, but baiting programs. We hope that at the next legislative session our present laws will be revised and appropriations made so that the State can participate in control campaigns.

T. L. AAMODT

In Minnesota it appears to us that we should not have to suffer the damage caused by the grasshopper outbreak of the 1930's. We now have a great deal of knowledge about control campaigns, good insecticides, and equipment for application. We now have thirty-six thousand power spray units on the farms in the State and we have organizations for ground or air spraying. I think we are at the point where the farmer will be able to take care of his own program and do it cheaply. We can help the farmer most by emphasizing the educational program and showing him the way.

B. A. HAWS

Infestations of sweetclover weevils were severe in certain areas of Minnesota this year. Some new seedings of sweet clover observed were almost completely defoliated or destroyed. Weevil infestations vary considerably in Minnesota during a given year, the presence or absence of old stands of sweet clover, sources of infestation, their location in relation to new seedings and other local circumstances appear to influence the great variation in weevil injury. Well-timed rains during the season seem to have saved injured seedings of sweet clover that might not have survived during a drought.

Sweetclover weevils have been seen eating sweet clover buds, flowers, green seed, and chewing off racemes. The extent of this kind of injury and losses of seed due to weevils have not been determined.

Tremendous numbers of sweetclover weevils have been observed in Minnesota when the new weevils emerge during the summer. In August as many as 1394 weevils per square foot were counted along the edge of a new seeding of sweet clover where the invading weevils first encountered the clover. The newly emerged weevils appeared to disperse very little at first but they stripped the sweet clover thoroughly as they moved into the field.

In 1956, as in the past several years, sweetclover weevils have injured old stands and new seedings of alfalfa. Injury to the old stands usually results along the margins of fields when weevils emerge from fields where sweet clover was ploughed down. A new seeding of alfalfa and a new seeding of sweet clover in such a location were injured severely by the weevils this year. Most of the alfalfa leaves were notched, but the new seedlings of sweet clover nearby were almost completely defoliated.

In trials by farmers and experiments by the University of Minnesota to protect new seedings from sweetclover weevils, granular insecticides were mixed with sweet clover seed and placed in or on the soil as the seed was planted. Early results indicate the clover was not protected adequately where weevil infestations were severe. Experiments have included application of granulàr insecticides by special ground equipment and by airplane.

All new seedings of sweet clover observed in northwestern Minnesota in 1956 were heavily infested with the yellow clover aphid (Myzocallidium riehmi Borner). Alate aphids were observed early in the season on old sweet clover plants and later they were seen flying in large numbers to the new seedings.Aphid populations increased rapidly (0 to 40 per leaf in a week). A few days after infestation the clover leaves showed a characteristic yellowing and in about a week the lower leaves of the new seedlings began to drop off. The aphids seemed to disappear almost as suddenly as they appeared. Severe rains may have influenced the sudden decrease. Predators and parasites were plentiful.

Sitona scissifrons Say is commonly present on alfalfa in Minnesota, sometimes in large numbers. We do not know much about this insect but the adults notch the alfalfa leaves and it seems possible this insect might become a pest of economic importance. Does anyone else here know this weevil and does it cause losses to alfalfa?

J. S. KELLEHER

This insect occurs on alfalfa in Manitoba but we have not observed any important damage.

Livestock Insects

Chairman: R. H. Painter

R. H. PAINTER

Horn flies have been abundant all over the southern prairies. Spraying, at about 3-week intervals, starting in June, with 0.5% DDT wettable powders is still giving satisfactory control. High pressure is not needed, 250 lb. satisfactory; only the backs of the animals are treated. Backrubbers, homemade and otherwise, are satisfactory for smaller herds of cattle. I feel that a survey is needed to determine the distribution of the horn fly because they are often confused with black flies in the northern areas.

There have been frequent complaints of black fly infestation from northern Saskatchewan, Alberta and Manitoba. Such information as I have would indicate the species may be S. venustum.

Tabanids have been troublesome and complaints have been received from the northern areas in particular; concerning both "bull dogs" and deer flies.We have no recommendations for adequate control.

Mosquitoes have been troublesome, particularly in northern areas but little can be done about controlling these pests on livestock.

Sheep keds are the only pest of any importance on our sheep. In general, the trend in control has been a change from dipping to spraying. In the larger sheep-raising areas in Saskatchewan and Alberta, the sheep are sprayed a week or two after shearing, when all cuts have healed. Lindane and toxaphene are most commonly used. Spraying is done in pens or alleyways, the sheep being packed in tightly and sprayed with 3-nozzle guns, using No. 4 discs, and 400 lb. pressure.

An unusual tick situation was reported from the Oxbow district of Saskatchewan, where horses were dying from tick infestations in the Souris River valley. One band of horses pastured on the river valley slopes, that provide poor graze, came through the hard winter in very poor condition. Ticks, according to reports, were fairly abundant on horses examined. Some twenty to forty yearlings and colts were reported dead. It is felt that the ticks were probably an added factor to malnutrition; the major cause of the die off. The ticks were first reported to be D. andersoni and recommendations were made for control. But later they were determined to be D. variabilis.

The mange on hogs is much more prevalent than is indicated by reports. The fact that hog louse control methods have cleared up some of the scurfy condition that could not be attributed to lice, may be an indication that mange was the cause. There should be a detailed survey in regard to the relative prevalence of the occurrence of mange on hogs.

Concerning lice and mange on cattle it might be interesting to mention that in the last year we have succeeded in making it compulsory to spray all animals coming to the major spring bull sales with lindane. This reduces the possibility of buyers taking home animals infested with lice and mange bites. This applies to the sales at Brandon, Saskatoon, Edmonton, Regina and Calgary. The barns are sprayed before the shows begin, and, weather permitting, the animals are sprayed as they come off the truck and before they are stalled. Special spray rooms have been constructed at Calgary, and at other sales spraying is carried out in the wash racks. It has been found that it takes about two and one-half minutes to spray an animal, but with good equipment and experienced operators the time can be reduced to one minute. The method was first demonstrated to the cattle breeders at Brandon. It was accepted by the breed associations by vote because mange had occurred at some of the major shows. So the regulations are of the breeders' own making and the Fair Board managements have been completely co-operative.

Lice have now moved into the first position as a major insect pest of cattle. In general, cattle lice were abundant during the winter. Feed supplies were not abundant, particularly in the northern areas of the prairies, and this, combined with cold weather and blizzards, appeared to increase the louse problem. Certainly the cattle were in poor condition by spring and reports of lice and of animals dying of malnutrition were more common than in past years.

This, however, may be due to the fact that farmers and cattlemen are becoming more familiar with the gross appearance of a louse infestation. We have encouraged the use of lindane 50% wettable powder in sprays for louse control, due to the fact that it is acceptable to the Health of Animals Branch for control of mange. Mange also is usually more common in the winter and spring, so our recommendation has been two sprayings in the fall with lindane at a concentration of .05% (approximately 1 lb. of 50% wettable powder in 100 gal. of water). In the last few years there has been a marked interest in louse control, and fall spraying is much more satisfactory than dusting individual animals in the winter when populations have increased to the point where the animals are losing condition. High pressure spraying at 400 lb. p.s.i. is recommended.

I believe sucking lice are much more common than biting lice, but no detailed surveys have been made to determine this point.

The warble problem is much the same as usual. A high percentage of hides are grubby during February, March, April, and May, and sometimes continuing into June. It is difficult to encourage control practices when there seems to be no discrimination on the part of the packers against grubby animals. The recommendations are still the same. There has been some question as to the efficiency of the present method but we have always known it was not perfect and that much depends on the farmer and rancher and the degree of community control. It has been left to the individual to decide for himself how often treatment should be carried out and we have only attempted to emphasize the ideal procedures for hand treatment or power spraying. Until such time as a better method of control has been demonstrated I feel we should increase our efforts to acquaint the farmer with his losses, in condition, milk yield and calf crop.

Back rubbers are used on various farms. They are strongly recommended by the manufacturers at prices ranging from $5.00 to $60.00. We have found them quite satisfactory for horn fly control in small herds of cattle in the open areas of the plains. But in general we doubt their usefulness in bush country where the animals naturally seek protection in the brush.

For louse control they apparently are not as satisfactory as spraying. Some careful studies in animal behaviour should be carried on to determine their usefulness. Undoubtedly the claims that one backrubber will service 75 head of cattle are exaggerated, and I seriously question the economics of purchasing the manufactured article. It has been our policy to suggest that the farmer make one from materials on hand, using the plan suggested by Rogoff of South Dakota.

Insects of Vegetables and Fruit

Chairmen: J. S. Kelleher and H. P. Richardson

J. S. KELLEHER

At Brandon the seasonal life-histories of root maggots on rutabagas and radish and their egg predators are being investigated. The relationship between the amount of maggot damage to rutabagas and seeding time is under study. Observations have been made on abundance of carabid egg predators and time of their seasonal occurrence in relation to the abundance of root maggot eggs.

J. A. CALLENBACH

Sugar-beet root maggot control has been based upon results obtained in 1955. This year about 5,000 acres of sugar beets in the northern part of the Red River Valley were treated with insecticide-fertilizer mixtures. Either aldrin or heptachlor at 1 pound per acre was mixed with a phosphate fertilizer (approximately 0-43-0) and drilled into the row with the seed at planting time.

In 1955 tests, yields were increased by an average of 2.34 tons per acre when the insecticide-fertilizer mixtures were used. Cost of treatment would be between $2.00 and $3.00 per acre. No extra equipment or operations are required and fertilizer is normally drilled in with the seed. The insecticide-fertilizer mixtures are being formulated by the fertilizer trade.

In 1955 tests indicated no benefit from seed treatments or sprays to control adult flies before oviposition. Tests in 1956 indicate that where seed is pelleted with a heavier dose of insecticide some benefits may be obtained.

Greenhouse and field tests conducted by Dr. Gojmerac show variable phytotoxicity from insecticides. Chlorinated hydrocarbons showed phytotoxicity of a minor order and it is believed the solvent used may be the actual phytotoxic agent. Organic phosphates varied in their effects. Hercules AC 528 stimulated growth, Dow ET-14 gave effects similar to 2,4-D damage, and thimet was severely phytotoxic.

A. M. HARPER

The sugar-beet root maggot was a serious pest on sugar beets in the sandy soil areas of southern Alberta in 1955 and 1956; it had been a pest from 1934 to 1936. In 1956 the Canadian Sugar Factory treated approximately 3,000 acres with aldrin at 1 pound per acre, applied in the fertilizer at the time of seeding.

In an experiment at Cranford, Alberta, aldrin, dieldrin, and heptachlor were applied at 2 pounds per acre. These insecticides were mixed with fertilizer and applied to the soil at the time of seeding. All insecticides lowered germination.

Nine, 1.0-square-yard, emergence cages were placed in a wheat field (wheat after beets) beside our experimental plots on June 4. The emergence varied from 31 to 99 and averaged 52. The period of emergence lasted from June 6 to August 16, but only four flies emerged after July 20. There were two peaks of emergence this year, one in mid June and one in mid July.

Oviposition was high in our plots, over 300 eggs being laid on many of the beets. The number of maggots per beet was quite low, indicating a high mortality between oviposition and establishment of the larvae.

A. G. ROBINSON

We were contacted by Mr. Schreiber of the Manitoba Sugar Company in 1953 about damage to sugar beets by the sugar-beet root maggot in the sandy soils at Steinbach. The Company tried a small test on controlling the maggots present on the roots; it gave no success. In succeeding years the only control measure was to avoid planting on the sandy soil at Steinbach. In 1956 Mr. Schreiber advised us that quite a large area between Altona and Gretna had large adult populations and that eggs were being laid in considerable numbers around the roots. Our only life-history study has demonstrated that this insect overwinters in the maggot stage in Manitoba, as elsewhere. There is probably only one generation per year.

I would like to make a few remarks on the six-spotted leaf hopper. For about five years the market gardeners in the Greater Winnipeg area have been unable to grow head lettuce except from early spring transplants, because of aster yellows, presumably carried by the leafhopper Macrosteles fascifrons (Stal.). This year Mr. Peter Lee set up a series of plots treated with six different insecticides, applied as foliage sprays, plus control plots covered containing leafhoppers, control plots covered excluding leafhoppers, and normal checks. Our criterion for success or failure was to harvest head lettuce as though it was to be marketed. We had three crops, transplants, early seeding, and late seeding. All the plots produced excellent head lettuce, so our work and expense produced no worthwhile data. Market gardeners also had good head lettuce this year for the first time for several years. Populations of the six-spotted leafhopper were present, but it appears as though the aster-yellows was delayed, rather than absent, from some unknown reason.

W. R. ALLEN

Head lettuce was treated with malathion, Hercules 528, and thimet at 1.5, 0.5 and 1.0 pounds per acre, respectively. The first insecticide was applied 9 times from June 4 to July 30, the others 3 times from June 4 to July 2. Treated plots showed 9 to 14 per cent disease August 2, controls 17 per cent. But on August 15, 83 to 96 per cent of the plants on all plots were diseased. Diseased plants were not readily determined when the lettuce was in head and ready for market, but were clearly recognized when the seed stalks developed. The insecticide treatments used were non-effective for disease control.

P. LEE

Host preference studies conducted during two summers with lettuce, parsley, aster, flax, and carrot show that the six-spotted leafhopper has a definite feeding preference for lettuce. Parsley, aster, carrot, and flax were chosen in that order of preference.

Succulence appears to be one of the key factors for such preference. The migration of hoppers from host to host occurs when the more favored hosts become less succulent. Weekly counts of adults and nymphs on these host plants showed that lettuce is also most favored for oviposition.

H. P. RICHARDSON

The two commercial fruit crops grown in Manitoba are strawberries and raspberries. Control methods have been established for the strawberry weevil and root weevil and tarnished plant bug, but we do not have a suitable control method for the cyclamen mite. Does anyone have information on this problem?

T. L. AAMODT

Hodson has been using endrin applied before bloom. Kelthane has been used and this will also control the two-spotted mite.

H. P. RICHARDSON

I've used Kelthane for mites on raspberry with good control and this may provide the answer for cyclamen mite because a safer material than endrin is preferable for back garden use.

J. W. BUTCHER

Hodson recommends a fall application of endrin and this apparently does a good job.

H. P. RICHARDSON

In Manitoba mites are the main problem on raspberries. Aramite and Ovotran are very effective and Kelthane is as effective and has low phytotoxicity. It kills the adults, in this respect Ovotran is less effective. Malathion is non-effective, on our malathion treated plots we had more mites than on the untreated plots. I believe we are interfering with the abundance of mite predators; we have about 23 species of these in Manitoba.

G. COOPER

I'm interested in your remarks on the use of malathion. Excellent results have been obtained on a number of raspberry plots sprayed in Alberta. In many areas a mixture of malathion and Ovotran is recommended, the former to kill adults, the latter as an ovicide.

H. P. RICHARDSON

I intend to stay with Ovotran for the simple reason that an early spring application provides a residue that outlasts the mites and there are no eggs laid. Two applications keep the plants mite free all season.

E. McCONNEL

One of our main problems in Minnesota is the difficulty of distinguishing virus disease symptoms from damage caused by mites and aphids.

T. L. AAMODT

In Minnesota the plum curculio and codling moth are serious pests of apple, the maggot appears each year on schedule about mid July, and leaf rollers are becoming more important. This year 8 spray applications were required in orchards. The codling moth is again increasing as a problem and the home orchards are generally infested by it or the apple maggot. It looks like we are in for a real battle.

J. B. WALLIS

I would like to know if the saskatoon borer has been found attacking the apple trees.

H. P. RICHARDSON

We have no record of it in Manitoba.

Recent Developments in Insecticides

Chairman: S. McDonald

S. McDONALD

In this discussion I should like to solicit information on the recent research developments in the Prairie Provinces and adjoining States, then have reports from the members from industry on recent production and development activities, and finally to have a discussion on the new or projected regulatory aspects of chemical control.

At Lethbridge, Alberta, our main project in insect toxicology concerns the quantitative and comparative laboratory evaluation of insecticides. We want to determine the comparative effectiveness of various insecticides under laboratory conditions and the formulations to be used for control of the economic species in southern Alberta.

Initial laboratory studies on the sugar-beet webworm and the army cut worm have been completed. The sugar-beet webworm is not being satisfactorily controlled by the recommended one pound of actual toxaphene per acre. Twice the recommended rate is required for the 5th and 6th instar larvae.

Laboratory tests have shown that endrin is more effective than heptachlor or toxaphene whereas DDT and malathion were discarded, being ineffective for satisfactory control. With 6th instar larvae the LD_{50} values obtained at 24 hours were 4 and 28 ounces actual per acre for endrin and toxaphene, respectively. The difference was not so striking with small larvae where endrin was only three times as effective as toxaphene. Field studies are required to determine the rate of breakdown of endrin residue on foliage, because it has a high order of mammalian toxicity and treated foliage may not be safely fed to cattle. This is a practice in southern Alberta.

R. PFADT

Did you do field or laboratory tests?

S. McDONALD

These were laboratory tests. At present we are using the spinning-disc technique. A spray of uniform droplet size is projected into a cabinet and the test insect or foliage is passed through a selected band of spray. The droplet size and the number of droplets per sq. cm. are determined for each run,and the amount of spray in pounds of actual chemical per acre calculated. With this technique we are able to replicate our results at any time with less than 5 per cent error.

The LD_{50} values for the army cutworm, determined at 24 hours, show that endrin is the most efficient insecticide either as a stomach or contact poison. Other insecticides had the following order of effectiveness: dieldrin, heptachlor, aldrin, and chlordane. The rate of endrin required is extremely low, about 2 ounces actual per acre for early 6th instar larvae, slightly less for smaller larvae. Mature 6th instar larvae, and especially those in the prepupal condition, are much harder to kill. These individuals stop feeding, become quiescent, and are less likely to come in contact with the insecticide. Preliminary tests on feeding 6th instar larvae measured doses of endrin, applied to small lettuce discs,show a straight line relationship between body weight and the amount of endrin required to kill. Other insecticides produced variable results. The time required for death may extend over a longer period, some mature larvae may be unable to pupate, and those that do may produce malformed pupae or adults. We do not know whether or not the adults that survive can produce viable eggs.

E. McCONNEL

Is this the black army cutworm?

S. McDONALD

No, the scientific name is Chorizagrotis auxiliaris.

QUESTION

How far east does this insect occur?

S. McDONALD

Southern Alberta and Saskatchewan. It's quite easy to mass rear this cutworm.

We are doing some work this summer on seed dressings for flea beetle control on sugar beets. They are a pest of seedling sugar beets in southern Alberta and it is believed that yields may be reduced by their damage to young plants. Work done in England on turnips has shown that an overdose seed-treatment of lindane causes it to be translocated temporarily to the foliage where it controlled flea beetles on small plants.

Gammasan (75 per cent lindane) was used to treat sugar beet seed at rates from 2 to 200 ounces actual per 100 pounds of seed. We found that all treatments reduced germination. The initial plant stand was slightly higher at the 2-ounce and lower at the 4-ounce rate than the check. Concentrations higher than 4 ounces caused a marked reduction in stand. There appeared to be no difference in flea damage between treatments. Plants that were slow to emerge in all treatments were not attacked.

Sugar beets are extremely sensitive to overtreatment with lindane but very little, if any, is translocated to the foliage.

QUESTION

What rate do you seed your beets, 5 pounds per acre?

S. McDONALD

I think 7 pounds is the usual rate.

W. R. ALLEN

A meeting of the American Committee (International Congress of Phytopharmacy 1952) on the standardization of bioassay procedure was attended during the Congress of Entomology. Opinion varied as to whether it is of more importance to establish general criteria for adequate bioassays or establish specific standardized procedure for limited objectives. The general uses of bioassay in entomology support cases for either of these viewpoints. Bioassays are used to screen new toxicants, synergists, formulations, or to test application methods;to establish the tolerance to insecticides of different species or strains of a species either before or after continued use; and to determine residual amounts of toxicant in formulations or deposits which may remain in soil, on or in plant or animal products.

Some organizations feel that standardization would be difficult because companies, in particular, must use species and methods best suited for the evaluation of the material being screened.Others have neglected standardization because of great differences in climate, insect behaviour, and farm practices that characterize different areas. There was considerable approval of the official or tentative methods established by the Chemical Specialties Manuf. Assoc.

Other parties feel that standardization is necessary so that the results of bioassays will be acceptable to governmental and legal authorities, so that the resistance of species in various regions may be quantitatively determined and results from various laboratories evaluated. It is evident that preliminary bioassay will be continually used by analysts because they can quickly discard samples containing no residues. They are necessary when chemical methods are not available. But it is recognized that because bioassay is not specific it should be supplemented with positive chemical separations and analysis when these are available. The emphasis placed on the necessity for rigid standardization of the test insects, testing procedures, and statistical evaluation of the results suggests that value would be derived from specific procedure for limited objectives.

J. A. CALLENBACH

For wireworm seed treatment lindane appears to be on the way out in North Dakota, it is being replaced by aldrin and heptachlor. All materials at recommended dosages were non-phytotoxic. Tests indicated several years ago that lindane applied as a dust was some what phytotoxic to wheat at 4.5 ounces per bushel or at 3 ounces when applied as a slurry. Differences are probably due to lesser amounts of dust that adhere to the seed. Rates showing phytotoxic effects are several times the recommended dosage.

The wireworm problem is still poorly understood in North Dakota. No estimates are possible on the acreages of small grains which should be protected by seed treatment or the acreages which are protected. We suspect there is considerable variation in rates of treatment used.

W. B. FOX

Seed treatment of cereal crops for wireworm control on the Prairies is extending out from the well known hot spots to marginal areas. About 4 million acres, or 10 per cent of the seeded acreage, is being treated annually. Lindane and aldrin are the principal insecticides used to date, although heptachlor is now acceptable. Dieldrin is not used on cereals largely because of cost. Fungicides such as mercury are generally combined with insecticides to provide a combination seed dressing. This slightly increases phytotoxicity over either straight fungicidal and insecticidal treatments.

In Manitoba and Alberta dry bean production is increasing and the seed-corn maggot is occasionally destructive. Various formulations of seed dressings are being tested. Aldrin and associated compounds appear to offer promise.

The wireworm problem is increasing in sugar beet producting areas. Lindane is somewhat phytotoxic and aldrin is being tested at 2 to 4 ounces per 100 pounds of seeds. As fungicides are also being incorporated, a problem arises in connection with sticking large amounts of seed dressing to the seed.

D. S. McDONALD

With regard to fertilizer mixtures, if you have a fixed rate of application of fertilizer for potatoes and want to combine it with insecticide for wireworm control, could it be used on sugar beet for maggot?

J. A. CALLENBACH

The only insecticide-fertilizer mixtures being used here are custom-mixed.

Wireworm damage is much higher on Early Gem (25 per cent) than on Pontiac (5 per cent) potatoes.

W. B. FOX

There is a problem regarding fertilizer-insecticide treatments, broadcast and band treatments. There seems to be dissatisfaction with some of these treatments. In some cases they are more feasible to use but not so effective. When you mix fertilizers and insecticides there are always difficulties in getting good application. Band treatments are difficult to apply. In Ontario it is felt that band treatments are not as effective, although more economical.

J. S. SKAPTASON, Chemagro Corporation

At Chemagro four insecticides are currently being worked on. We are pretty well finished with research on systox and ready for registration and approval on 17 crops, including quite a few edible ones. Under the Miller Bill, the tolerance is 7 p.p.m. It is quite extensively used now. Chlorothion is particularly good on aphids generally, to a lesser extent on mites, very good on mosquitoes (adults and larvae), flies, and roaches. It is not on the market yet, may not be before 1958. Dipterex is exceptionally good on flies. It gives rapid knockdown and no resistant strains have been encountered. Laboratory and greenhouse testing gave poor results on a variety of insects but in the field insects were quite readily controlled. It has a very low order of mammalian toxicity. There are not many insecticides like it that are completely soluble in water. It is disappointing for aphid control, but generally speaking good on Lepidoptera. Guthion is less toxic than parathion. We are working on toxicity studies and will know within a year where it stands. It has a broad use, excellent for most aphids, mites, and many insects.

D. S. McDONALD

Dipterex did not show up well in laboratory except on flies.

J. S. SKAPTASON

In 1955 limited field trials showed excellent promise.

G. S. COOPER, North American Cyanamid Ltd.

At the 10th International Congress it was reported from the Netherlands that flies resistant to several organic phosphates have been established by use of sublethal dosage. It is quite likely that in time resistance to the organic phosphates will have built up. Flies now appear to metabolize organic phosphates, but further studies will have to be carried out using sublethal dosages.

T. L. AAMODT

I'm interested in the toxic effect that chlorothion and parathion may have on mammals. On the west coast chlorothion is being widely used for mosquitoes.

H. P. RICHARDSON

Excellent control of fowl mite was obtained at Morden with malathion in all houses but one, where there was some slight hemorranging. Would this be caused by malathion?

G. S. COOPER

No. I understand that Dr. Slingers of the O.A.C. said at a recent poultry conference that he had experienced no toxicity or damage to either day-old chicks or hens. Dr. D. Clendinin of the University of Alberta also reported no toxicity to birds with malathion.

W. B. FOX

Dieldrin has been tested this season in Manitoba for sheep ked control. It appears satisfactory, with no ill-effects upon the sheep.

A number of growers complained of lack of control with the usual slug control preparations,and 2% dieldrin dust was recommended. Results were satisfactory.

S. McDONALD

Don't the slugs slough it off in the slime?

ANOTHER SPEAKER

We got no results with granular dieldrin.

W. B. FOX

A dust is probably more effective.

A number of new insecticides and treatments not mentioned at this meeting have recently become available. Diazinon, R1303 and Chlorobenzilate are producing very satisfactory results. Chlorobenzilate appears to give effective mite control and Diazinon and R1303 are effective on a wide range of insects.

It should be noted that endrin appears promising for potato insect control, especially in the areas of the Red River Valley where the Colorado potato beetle has become resistant to DDT.

G. S. COOPER

At an informal meeting at the 10th International Congress, representatives of industry and interested entomologists discussed mass spraying for spruce budworm. The biological control people and leaders from industry brought out points that are important from the standpoint of chemical and biological control. It was agreed that a complete chemical program can lead to insurmountable difficulties. A complete biological program in many cases could not be tolerated, the amount of loss (10 per cent annually) which a fruit farmer, for instance, would have to sustain is too much. It was felt that more detailed studies must be done on the effect of our entire spray program. The insecticide being used may not be doing as much damage as some of the fungicidal and dormant oil sprays, which are not thought detrimental to the natural parasites and predators. There is a trend towards getting the two groups closer together to evaluate every spray being used. In Nova Scotia some of the damage in the past may have been caused by dormant oil sprays and not entirely by the insecticides. I would like to see a program on both insecticide and fungicide sprays, for some of the latter may be acting as ovicides. By determining the actual results of the various sprays on predators and parasites we may be able to work out a program where we can live together.

Dr. J. M. WAY, Rothamsted Experimental Station,
Harpenden, Herts., England

I will discuss the more serious pests attacking cereals, sugar beets, and potatoes in Britain. They are wireworms in cereals and wheat bulb fly, a pest of winter wheat limited to Europe. Concerning wireworms, one or two points might be added. We have found that BHC or lindane as seed dressing, 2 ounces of 20 per cent material per bushel, gave very good control. By control, I mean protection from attack early in the season. Phytotoxicity may partly be due to grain being moist. Furthermore, seed merchants are not always efficient in dressing seed and the dose is likely to be uneven. Comparing BHC seed dressing with broadcast treatments and combine drill treatments of BHC and aldrin, protection and yields are similar in the current season. However, BHC seed dressing did not kill wireworms, but just deterred them; they are still there the next year. In Britain we often follow wheat with a potato crop, which can be heavily attacked.

W. B. FOX

Have you compared aldrin with lindane?

J. M. WAY

We have used aldrin on broadcast soil; also BHC. These actually kill wireworms, but seed dressing doesn't. We haven't compared aldrin and dieldrin and BHC seed dressings.

One of our problems is the control of aphids on potatoes and sugar beets. We are attempting to control virus by killing aphid vectors. We now get fresh potato seed from Scotland every year, they have virus-free stocks. But we are trying to grow seed potatoes in southern England so that farmers can use their own seed several years in succession. We have compared DDT, endrin, systox, and metasystox for aphid control applied at different intervals during the season, down to 10 days. Metasystox with a low mammalian toxicity, is much more effective than parathion, malathion, and chlorothion. It hasn't been cleared for use on potatoes and sugar beets; when it is, it will be recommended for this work. DDT in a damp summer gives good aphid control and it is being used for virus work because of low toxicity and because metasystox is not yet available. In a dry summer DDT will not work, whereas metasystox continues to work well.

We are working on the timing of application. For aphids, spray should be applied when the infestation is just beginning. This will not only prevent virus spread but also prevents mechanical damage to the potatoes. We are trying to tie in the spraying program with the seasonal behaviour of aphids.

Laboratory experiments with DDT on cutworms have shown that the resistance to stomach and contact poison increases with size, but not proportionately. If you double the size of the insect, its resistance goes up by about x10 with DDT. Hence young larvae (tomato moth) were as susceptible to DDT as parathion but older larvae were very resistant to DDT but still highly susceptible to parathion. Resistance is related to body weight in the case of parathion but not with DDT.

ANOTHER SPEAKER

What about flea beetle control with lindane seed dressing?

J. M. WAY

We are not working on this, but no doubt it is effective for controlling underground attack.

With the wheat bulb fly we find that BHC is taken up by the plant and does not kill the insects but repels them. There is some evidence that aldrin has the same repellent effect.

W. B. FOX

Were you talking about technical BHC or lindane?

J. M. WAY

I am referring each time to lindane, the purified gamma isomer.

G. S. COOPER

We should look at the proposed Canadian law, which will be a counterpart of the Miller Bill, and the part entomologists will have to play. In the United States those responsible for spray calendars are very neatly ducking the issue by adding a phrase to the effect that they are not responsible for residue resulting from their recommendations. The onus is thrown on the chemical companies and the farmers, this can only be partially accepted. The extension entomologist will have to accept some onus. In Canada there are too few extension entomologists, but they will become more important in this new program. His position will have to be upgraded because he will have to accept responsibility for informing the grower about safe rates and dates of application. The research entomologist will have to supply him with more detailed, up-to-date information. But the extension entomologist must give recommendations that under specified conditions will stay within the tolerances set.

Further discussions on this proposed bill will be held in November or early in January. But one thing is sure, such new regulations have increased the cost of insecticides tremendously. We now estimate from the time we start research to the time we are ready to market, the cost of each chemical is about one and a half million dollars. This is one reason why we cannot lower costs of the newer chemicals.

When this law goes into force the entomologists should look back and review many of the insecticides that they have discarded. For example, DDT has been discarded in many cases before it should have been. Dr. Marshall in British Columbia has shown that by using non-ionic surfactants the efficiency of DDT can be increased. But safety and efficiency must be considered. DDT, for example, combined safety with a wide range of usage, malathion has taken its place in many instances but is seriously limited because of the lack of accepted label claims. In the years ahead many new insecticides will be held up longer than in the past and we will not get the flood of new materials we have had in the past few years, because chronic toxicity feeding studies must now be carried on for two full years before acceptable evidence is presented and more and more toxicological data are being required. For example, the data presented for direct application of malathion to cattle were acceptable but more were needed on the residual in bone marrow, in spinal fluid, and in hair, before we can expect final acceptance.

In regard to labelling products there is still confusion among the labelling committees, Food and Drug people, and the Provincial Health Departments. A label or P.C.P. number does not mean a product can be sold indiscriminately, the regulations of the Food and Drug or Provincial Acts may not permit this. For instance, in Ontario it is a criminal offence to have some materials on the premises unless they are in the hands of P.C. operators.

Report of the Resolutions Committee
I.G.P.C.E. Meeting, August 31, 1956

WHEREAS the 1956 meeting of the I.G.P.C.E. met jointly with the Entomological Society of Manitoba,

AND WHEREAS members of the two organizations were hosts to a group of visiting entomologists who had participated in the 10th International Congress of Entomology,

AND WHEREAS the I.G.P.C.E. meeting provided a free exchange of opinions during the business and social events,

BE IT RESOLVED that the Chairman of the I.G.P.C.E. thank the following individuals or organizations for services, facilities, or financial aid that contributed to the success of the meeting:

Dean Weir, Faculty of Agriculture, University of Manitoba
The Executive, Program Committee, and Entertainment Committee of the Entomological Society of Manitoba
Miss Betty Hart and Miss Mamie McGowan for stenographic assistance in recording the proceedings
Hon. C. L. Shuttleworth, Minister, Manitoba Department of Agriculture
Dr. A. J. Thorsteinson, Chairman, Department of Entomology, University of Manitoba
Drewry's Limited
Sonaphone Corporation of Canada
Ogilvie Flour Mills Co. Limited
Line Elevator Farm Service
Manitoba Sugar Co. Limited
Chipman Chemicals Limited
Green Cross Products (Sherwin-Williams Co.)
Dow Chemical Company
Lindenberg Bros., Brandon, Manitoba
Shell Oil Co. of Canada Limited
North American Cyanamid Limited
Harrisons and Crosfield (Canada) Limited
Velsicol Corporation, Chicago
Chemagro Limited

AND BE IT FURTHER RESOLVED that Dr. R. T. Cotton be thanked for his informative dissertation on stored product insects.

Resolutions Committee

W. C. Stehr
W. R. Allen
W. A. Reeks

MANITOBA ENTOMOLOGICAL SOCIETY EXECUTIVE 1956-57

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President	W. A. Reeks
Vice President	R. M. Prentice
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I.G.P.C.E. attendance indicated (*)

1) Allen, Dr. W. R.*
1) Askew, W. L.*
1) Barrett, C. F.*
2) Berck, B.*
1) Bird, Dr. R. D.*
3) Birt, F.*
4) Bradley, G. A.*
5) Brooks, A. R.
4) Buckner, C. H.
1) Cole, T. V.*
6) Eastwood, J. P.*
3) Fox, W. B.*
5) Fredeen, F. J. H.
7) Furgala, Basil
8) Greaney, Dr. F. J.*
9) Gurney, Dr. Ashley B.
10) Handford, Dr. R. H.
11) Hanec, W.
4) Heron, R. J.*
12) Howden, J. S.
4) Ives, W. G. H.
1) Kelleher, J. S.*
13) Krivda, Walter
2) Loschiavo, S. R.*
14) McLeod, Dr. J. A.*
15) Mitchener, Prof. A. V.*
4) Muldrew, J. A.
4) Nairn, L. D.
16) Petty, D. J.
4) Prentice, R. M.*
3) Pugh, S.*
4) Reeks, W. A.*
17) Richardson, H. P.*
18) Robertson, D. R.
19) Robinson, Prof. A. G.*
1) Romanow, W.*
20) Stansfield, E. J.
21) Sutherland, J. R. G.
19) Thorsteinson, Dr. A. J.*
4) Turnock, W. J.*
22) Wallis, J. B.*
4) Warren, G. L.
2) Watters, F. L.*
1) Westdal, P. H.*
4) Wong, H. R.*

List of Members (excluding Ent. Soc. Manitoba members)
and Visitors to I.G.P.C.E.

23) Aamodt, T. L.
23) Butcher, Dr. J.
24) Callenbach, Dr. J. A.
25) Cooper, Dr. G. S.
26) Cotton, Dr. R. T.
2) Cox, G.
27) Eva, W. J.
28) Farstad, Dr. C. W.
23) Flasherd, R. C.
23) Graeber, H.
29) Gunn, Dr. D. L.
30) Hall, J. W.
28) Harper, A. M.
7) Haws, B. A.
21) Hellen, R.
23) McConnel, E.
28) McDonald, S.
4) Melvin, J. C.
35) Neuman, N.
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36) Painter, R. H.
29) Pesson, Prof. P.
37) Pfadt, Dr. R. E.
19) Proctor, J.
5) Putnam, L. G.
29) Rainey, Dr. R. C.
38) Ritchie, T. M.
39) Ruston, F. W.
40) Skaptason, J. L.
41) Stehr, F. W.

31) Hitchon, J. L.
32) Hocking, B.
29) Kalmus, Dr. H.
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29) Lepesme, Dr. P.
28) Lilly, C. E.
33) Lobay, W.
34) Malaher, W. G.
8) Mather, H. J.
41) Stehr, Dr. W. C.
42) Stephen, Dr. W. P.
19) Tauber, M.
5) Taylor, M. E.
43) Volkers, B.
29) Way, Dr. J. M.
16) Whiteway, W. M.
44) Wood, H. E.

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Winnipeg, Manitoba

Business Sessions Entomological Society of Manitoba

Spring Meeting

A business meeting of the spring session of the Entomological Society of Manitoba was held in the Field Crop Insect Laboratory, Brandon, Manitoba, April 14, 1956. Mr. F. L. Watters presided.

The minutes of the fall meeting held in Winnipeg in November were read and adopted on a motion by R. M. Prentice and W. A. Reeks.

Business Arising from the Minutes

W. R. Allen moved that the constitution be adjusted to the extent that the offices of Past President, President and Vice President be held for only one year. The motion was seconded by W. G. H. Ives. Carried.

A letter from R. H. Wigmore, National Secretary, urging affiliation of the Manitoba Society with the incorporated National Society was read. W. Turnock moved affiliation with the incorporated society, seconded by A. J. Thorsteinson. Carried.

F. L. Watters informed the Society that the Provincial government had refused financial support of the Tenth International Congress. W. A. Reeks moved that the Entomological Society of Manitoba make a grant of $50.00 to the International Congress. Seconded by A. G. Robinson. Carried.

It was moved by W. A. Reeks that suitable gifts of appreciation be given stenographers and other personnel who assisted with the annual proceedings. Seconded by W. R. Allen. Carried.

The Treasurer's report was read by T. V. Cole. The Society was reported as having a bank balance of $116.00. He reported four new members had joined the Society; four cancelled memberships of four unpaid annual fees.

The Report of the Common Names Committee was given by W. Turnock. Five names had been submitted for approval. The validity of common names was discussed by the membership as a whole.

W. A. Reeks commented on the successful spring meeting and thanked the Brandon Laboratory for the hospitality extended to the Society.

The meeting adjourned at 12:15 on a motion by W. J. Turnock and W. Ives.

Fall Meeting

The business meeting of the fall session of the Entomological Society of Manitoba was held at the Department of Entomology, University of Manitoba, August 31, 1956. F. L. Watters presided.

The minutes of the business session of the spring meeting held at the Field Crop Insect Laboratory, Brandon, Manitoba, April 14th were read and adopted on a motion by R. M. Prentice and W. A. Reeks.

Report of the Common Names Committee

W. A. Reeks gave a brief summary of the meeting of the Common Names Committee of the National Society. He reported that A. V. Mitchener had been re-appointed chairman of the National Committee. W. R. Allen moved that the Common Names Committee of the Entomological Society of Manitoba be appointed and jurisdicted by the Executive.. Seconded by A. G. Robinson. Carried.

Report of the Nominating Committee

Prof. Mitchener reporting for the Nominating Committee, reported the following slate of officers for 1956 - 57:

Past President	F. L. Watters
President	W. A. Reeks
Vice President	R. M. Prentice
Secretary	H. P. Richardson
Treasurer	T. V. Cole
Editor-Librarian	W. R. Allen

Prof. Mitchener moved adoption of the report. Seconded by A. G. Robinson. Carried.

Other Business

On behalf of the Society, Prof. Mitchener expressed thanks to the Executive for the successful I.G.P.C.E. meeting.

F. L. Watters moved a special vote of thanks to S. Loschiavo and R. J. Heron who co-operated with the Executive.

W. R. Allen moved that honoraria be given to Misses B. Hart, L. Veltri, M. McGowan and Mr. B. Snead for assistance with stenographic work and printing of past proceedings of the Society. Carried.

W. A. Reeks accepted the chairmanship of the Society and moved adjournment of the meeting. Seconded by T. V. Cole.

ENTOMOLOGICAL SOCIETY OF MANITOBA
Financial Statement for Year Ending December 31, 1956

Receipts			
Balance in Bank, Dec. 31, 1955		$100.60	
Members' dues, 1956		104.20	
Members' dues, 1957		113.30	
Registration for 1956 spring meeting	$11.00		
Spring Banquet	20.22	31.22	
Refund of expenses of Western Tour of International Congress		57.80	$407.12
Expenditures			
Subscriptions to Ent. Soc. of Canada		152.00	
Banquet expenses		33.00	
Bank exchange		1.80	
Postage		5.00	
International Congress Donation		50.00	
Balance on hand Dec. 31, 1956		107.52	
Reimbursement of refund of expenses of Western Tour of International Congress to I.G.P.C.E. account		57.80	$407.12

APPENDIX

Additions to the Library of the Entomological Society of Manitoba

The following list contains the names of publications received in exchange for the Proceedings since the list published as Appendix II to Volume 11 of the Proceedings for 1955.

1. Proceedings of the Entomological Society of British Columbia, June, 1955. Index to Volumes 1 to 10 (Old Series) and 1 to 50 (New Series). Compiled by C. V. G. Morgan and M. D. Proverbs.

2. Zastita bilja (Plant Protection). Vols. 30, 31, 32, 33, 34, and Index to Vols. 21-26. Published by the Institute for Plant Protection. Beograd-Topcider. Narodna Republika Srbija. (Jugoslavija) 1955.

3. Proceedings of the Entomological Society of British Columbia. Vol. 52. Issued April 30th., 1956.

4. H. H. Schwardt, 1956. - Weevil Control in Farm-stored Wheat. Cornell Extension Bulletin 967. From Albert R. Mann Library, N. Y. State Colleges of Agriculture and Home Economics.

5. Hatch, Melville H. 1953. The Beetles of the Pacific Northwest, Part I. Introduction and Adephaga. Exchange from University of Washington.

6. "Redia" Journal of Entomology, published by Dalla Stazione Di Entomologia Agraria, in Firenze - Vol. XL, 1955.