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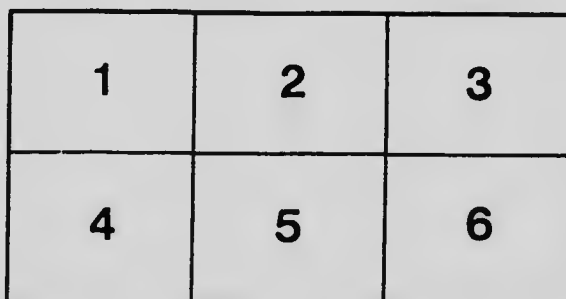
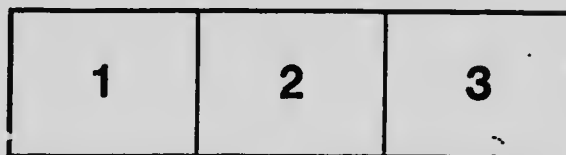
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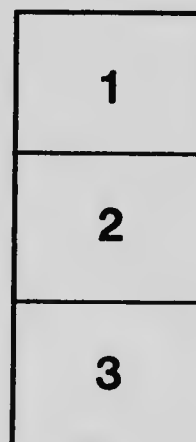
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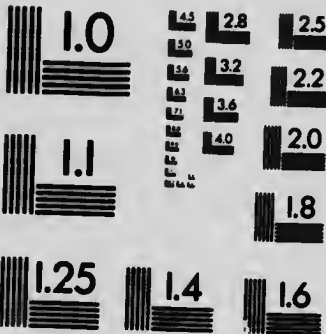
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C. GORDON HEWITT, DOMINION ENTOMOLOGIST.

LOCUST CONTROL APR 20 1920
IN
THE PRAIRIE PROVINCES

By
NORMAN CRIDDLE,
Entomologist in charge for Manitoba

With an account of the outbreak of locusts in Western Canada in 1919, by Norman Criddle (Manitoba); A. E. Cameron and M. P. Tullis (Saskatchewan); E. H. Strickland (Alberta); R. C. Treherne (British Columbia).

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CIRCULAR No. 13
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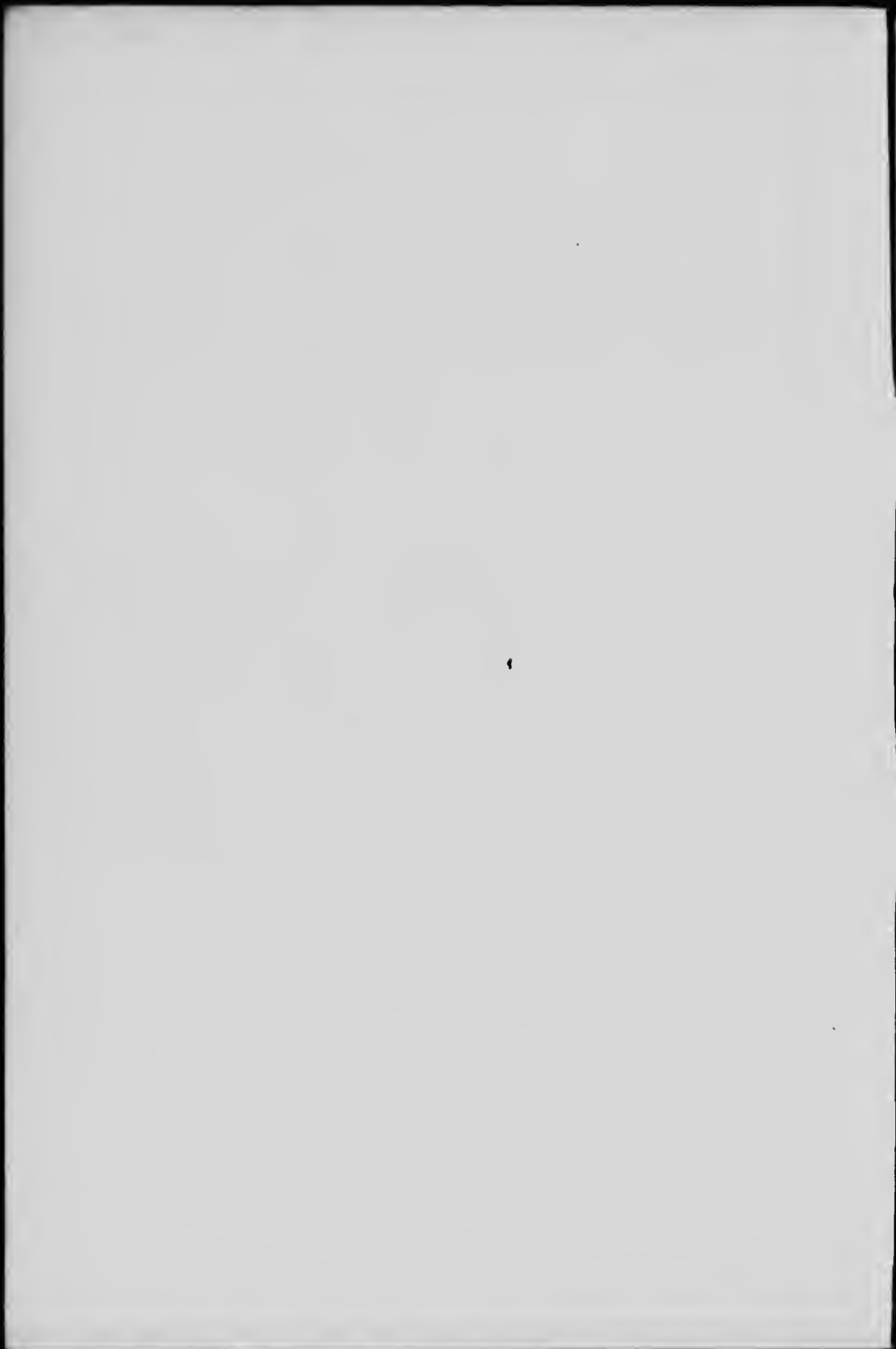
Published by direction of the Hon. S. F. Tolmie, Minister of Agriculture,
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OTTAWA, February 9, 1929.

To the Honourable
The Minister of Agriculture,
Ottawa.

SIR,—I have the honour to submit for your approval Entomological Circular No. 13, entitled "Locust Control in the Prairie Provinces".

In 1919 there occurred in the Prairie Provinces, and particularly in certain sections of southern Manitoba and Saskatchewan, the most serious outbreak of locusts that has been experienced since those regions were opened up to agriculture. Millions of dollars worth of grain were destroyed in spite of the combined efforts of our own and the Provincial Departments of Agriculture; the losses, however, would have been much greater had not control operations on a large scale been undertaken. An extensive migration of full-grown locusts took place at the end of the summer, and in consequence we anticipate a more serious outbreak during 1920, unless adverse climatic or other natural controlling factors affect the emergence of this season's brood of locusts. An account of the outbreak of locusts in western Canada in 1919, is included as an appendix.

This circular has therefore been prepared in order to supply to the farmers in the infested regions of the Prairie Provinces the necessary information in a concise form concerning the habits of the species of locusts involved and the methods of prevention and control.

Attention is specially directed to the importance of community action in dealing with insect pests of this character.

I have the honour to be, sir,
Your obedient servant,

C. GORDON HEWITT,
Dominion Entomologist.



LOCUST CONTROL IN THE PRAIRIE PROVINCES.

INTRODUCTION.

The first record of injury to crops by locusts in the Prairie Provinces of western Canada is that of an outbreak in 1818. Since then there have been irregularly-occurring infestations at intervals of about fifteen years which have usually lasted two or more seasons. The several outbreaks, however, did not necessarily occur uniformly throughout the same territory, but were more often many miles apart. Formerly, the chief offender was the well-known Migratory locust.¹ Of late years, however, that insect has been absent and we have in its place two native kinds known, respectively, as the Lesser Migratory² and the Pellucid locust.³ It was these two species that caused so much trouble to farmers in 1919, and it is to them that this circular particularly refers. (See fig. I).

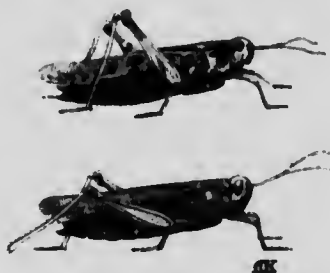


FIG. 1. The Pellucid locust, above; the Lesser Migratory locust, below. (Original.)

DISTINGUISHING FEATURES OF THE LESSER MIGRATORY AND THE PELLUCID LOCUSTS.

These two insects are somewhat alike in size and appearance but may be separated by the very much smaller eyes of the Pellucid locust, by the darker colour of the small hoppers of that insect, and by a well-marked sharp ridge on the back behind the head. This latter is indistinct in the Lesser Migratory locust. In addition, the wings of insects can be distinguished by the narrow row

¹*Melanoplus spretus* Uhler.

²*M. atlantis* Riley.

³*Camnula pellucida* Scudd.

of small spots along the centre of the wing-cover in the Lesser Migratory locust as compared with broad, dark blotches in the Pellucid locust. There are several other important but less-evident characters for separating the two species.

HABITS OF THE YOUNG OR HOPPERS.

The life of a hopper, as the young form is termed, commences when it emerges from an over-wintering egg-sac, in company with some twenty-five others. The time of its appearance is influenced by the nature of the season; an early spring is conducive to early hatching, while a late one produces a contrary effect. Generally speaking, however, we may expect the first hoppers to appear during the early part of May, and they will probably be sufficiently numerous to be a menace to the crops by the end of the month. The young hoppers are voracious feeders and, if food is not available in sufficient quantity where they have hatched, they quickly make their way to new feeding-grounds. With abundant food they develop quickly and, as they grow, cast off their skins from time to time, passing through five moults in all. After the last moult they are fully developed and have wings. The life of a hopper, as thus summarized, takes about forty-five days to complete. During this time its chief habits appear to be those of feeding and of sunning itself. In the early morning or on cool days, the hoppers may be observed in large masses indulging in the latter habit, while during the heat of the day their appetite appears to be unlimited. When still very young the hoppers generally seek some sort of shelter during the night. Here they will remain during the daytime if the weather be cold or wet. Grass lands such as road-sides, patches of broad-leaved weeds, or rough grain-fields all afford the desired protection, while fields with a smooth surface are always avoided. The fact that hoppers remain over-night where the land is rough or weedy accounts largely for the irregular outline at the margin of a field they are attacking, for the reason that they naturally congregate where they can secure shelter, and from such points make farther inroads into the growing crop next day.

HABITS OF THE ADULTS.

On attaining the winged state, the habits of locusts undergo a change. True, they are still voracious feeders but, in addition to this familiar habit, they have other habits such as those of flying and egg-laying. By the end of June flights are of general occurrence, and extensive migrations may be observed on every warm sunny day. It is under such climatic conditions that the insects rise in large numbers and drift along in such enormous swarms as to resemble a heavy snow-storm. These swarms may extend but a short distance or they may cover many miles, this depending largely on the governing weather factors. Warmth, sunshine, and a moderately strong breeze are the most favourable for long flights. In fact, the insects may be said to rise in sunshine and to drop in shadow, since a single cloud obscuring the sun is sufficient to bring them to earth. It is owing to these flights that many fields previously free, become infested, while others already attacked may be saved by the insects moving elsewhere. For this reason, too, various isolated areas often become centres for future infestation. These migrations continue intermittently for at least a month, but become less frequent during the egg-laying period. The Lesser Migratory locust flies at a much higher altitude than the Pellucid locust; the migratory flights of the former species may reach an altitude of several hundred feet, as we have learned by observation and by the report of an aviator at Carlyle, Sask.

EGG-LAYING HABITS.

All our injurious locusts deposit their eggs in masses and place them in the soil surrounded by a coating of frothy material which hardens into a protective covering known as a pod or sac. (See figs. 2 and 3.)



FIG. 2. Locust laying eggs. (After Gibson and Criddle.)

When preparing to oviposit, the locust forces her abdomen into the soil almost up to the base of the hind-legs; she then slowly places the eggs in position and encases them in the covering as she proceeds. When completed the egg masses reach almost to the surface of the ground and extend at their further extremity to a depth of about three-quarters of an inch into the soil. The number of eggs per pod varies according to the kind of grasshopper depositing them. Those of the *Pellucid* locust average 26; the *Lesser Migratory* locust generally produces 20. Each kind deposits two or more pods of eggs in a season, so that the total number of eggs laid by a single female often exceeds 50.



FIG. 3. Egg pods of locusts showing various shapes; pod at right open to show the closely packed eggs. (After Gibson and Criddle.)

BREEDING GROUNDS.

While the method of depositing eggs is the same for both insects discussed in this circular, it is important to know that there is a marked difference in the situations selected for that purpose. This has an important bearing on the control methods which are discussed later. For instance, the *Lesser Migratory* locust prefers the stubble-lands, old deserted weedy fields, or small bare openings amid sparse vegetation for egg-laying purposes; whereas the *Pellucid* locust selects the sodded land such as roadsides, grass fields, or pastures where she deposits her eggs chiefly in the clumps of grasses. It follows, therefore, that the greatest danger from the *Lesser Migratory* locust must be expected to come from stubble-fields or similar breeding areas, but that the *Pellucid*

locust will make its attack from sod-land. It is well to remember that as a general rule the Lesser Migratory locust is found on the more sandy land, while the Pellucid locust frequents the richer soils.

The eggs of all our common locusts are laid in late summer or early autumn. Commencing about July 10, the insects continue to lay until the cool nights of approaching winter finally destroy the few that remain.

THE CONTROL OF LOCUSTS.

Locust control is based upon a knowledge of the insects' habits and is, therefore, varied to conform with these habits at different seasons of the year.

BURNING.

As was pointed out above, the young hoppers require some sort of shelter in which to hide at night. Weedy patches in fields may afford such shelter, but a preference is usually given to dead grass such as that found on roadsides, where the hoppers frequently gather in enormous numbers. A knowledge of this habit enables us to take advantage of it by scattering straw near the places where the hoppers are feeding, or by spreading a small quantity among the grass to which they retire towards evening. This straw can then be burnt at night, preferably when there is a breeze blowing. Millions of hoppers may be destroyed by this method. Roadsides can also be burnt to great advantage when the hoppers first emerge there, and before they have had time to invade the grain-fields.

PLOUGHING.

There are several ways in which the plough can be utilized in fighting hoppers. A single deep furrow is sufficient to protect a crop for several days when the hoppers are still very small and, in combination with poisoned-bait scattered along it, is often of marked value as a means of killing the insects. A ploughed strip some 30 feet wide also acts as a barrier for a considerable time. Another use for the plough is to drive the hoppers gradually to a central strip by ploughing inwards on either side of a field. This practice can nearly always be followed at summer-fallowing time. When the remaining unploughed strip is some 40 feet wide, it can be left for a few days while poisoned-bait may be scattered over its surface. By this method most of the hoppers in the field will be killed.

POISONED-BAITS.

Of all the means employed in destroying locusts, no other can compare favourably with the poisoned-baits, the utility of which has been proved beyond all question. Their success, however, depends greatly upon correct application, while failure can nearly always be traced to some fault in mixing or applying the

baits. The following mixtures are of known merit and have been used with marked success both in the United States and in Canada :—

THE KANSAS BAIT.

Bran.....	50 pounds
Paris Green or White Arsenic.....	2 pounds
Molasses.....	4 quarts
Oranges or lemons.....	6 fruits
Water.....	5 to 6 gallons

Mix the bran and poison dry. Squeeze the fruit-juice into the water, to which add the pulp and peel after cutting them up finely. The molasses is then added to the water and the whole poured over the bran. The mixture is then thoroughly stirred until the bran is dampened and is of a crumbly nature.

Another poisoned-bait which has been found of value is the following :—

Bran.....	50 pounds
Paris Green or White Arsenic.....	2 pounds
Salt.....	1 pound
Water.....	5 to 7 gallons

A mixture similar to this, with the addition of molasses, has also been used successfully under field conditions. Sawdust, too, has been used in place of bran, or mixed with it, half and half.

Another bait with which the 1900-1905 outbreaks of locusts in Manitoba was largely controlled is known as the Criddle mixture, and is made as follows:—

Horse-droppings, preferably fresh.....	15 gallons by measure
Paris Green or White Arsenic.....	1 pound
Salt.....	1 pound

Add sufficient water to make a moderately wet mash, and mix thoroughly.

The practice of substituting white arsenic for Paris green, on account of its cheapness, is now largely followed, and in this connection Mr. G. E. Sanders, our officer in charge of insecticides, has informed us that the killing power of the arsenic is considerably increased by mixing it with equal parts of water-slacked lime.

THE APPLICATION OF BAITS.

All baits should be scattered as finely as possible so that there are no large lumps; for this purpose the hand may be used and the mixture thrown in a manner similar to that of sowing grain. Another way is to use a trowel or short paddle. In scattering the Criddle mixture a manure spreader has been utilized by several farmers with marked success. In applying any of these baits some sort of vehicle is necessary to carry them, such as a wagon or light rig, as it is only by this means that they can be spread quickly enough over large areas. The mixtures should be put out in the morning, if possible, so that the locusts may be attracted to them before appeasing their appetites on the growing crops. Probably two hours after sunrise would be the best time to begin operations, though effective results may be secured when they are put out any time before four o'clock in the afternoon. Under no circumstances should baits be applied on cold days with a temperature below 50° F. It is also unwise to apply them during cloudy weather or, of course, when it is raining. In conclusion, it is well to remember that one application only acts as a check, and that in the case of a severe outbreak applications may be required to be made at regular intervals of four or five days before the insects are finally brought under control.

HOPPERDOZERS.

For details relating to the construction of these machines, see fig. 4. When

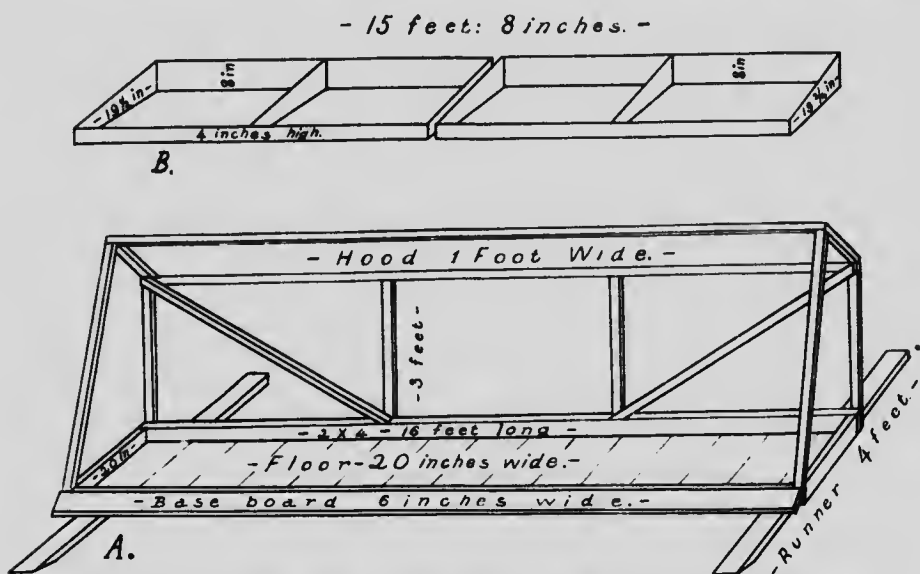


FIG. 4. A. Frame of hopperdozer to be lined inside with galvanized sheet iron or canvas.
B. Water-tight trays to fit into bottom of frame to hold the water and coal oil. (Original.)

in use the trays, fig. 4B, are filled with about an inch of water and one-half inch of coal oil, into which the locusts fall after striking the back or sides of the hopperdozer. The appliance is drawn by two horses, one on each end, see fig. 5. It is especially useful in pastures where there is some risk in using poisoned-baits.



FIG. 5. Hopperdozer in use. (Original.)

EGG DESTRUCTION.

The destruction of eggs is a very important part of the control of locusts, and were it possible to carry out fully the methods advocated below, the danger of an outbreak the following year would be greatly reduced. Two measures are suggested to attain this end; they are:—

1. Deep and well-turned ploughing in fall or spring, preferably during the former season. Such ploughing should be not less than six inches deep and the furrow turned so that the whole upper side is well covered, otherwise there will be an emergence of young hoppers along the furrow edge. Shallow or badly-turned ploughing is of little practical value. The ploughing of stubble land is a comparatively simple control method, since it constitutes part of the year's work. But, when it comes to treating the sodded areas in a similar way, the task becomes far more difficult. **When it is realized, however, that fully 90 per cent of the eggs of the Pellucid locust are placed in sod land such as fence-rows, roadsides, and other hard grassy places adjacent to cultivated land, the necessity of ploughing such areas will be seen to be of the utmost importance.**

2. When it is not practicable to plough infested land it should be disced or cultivated instead, preferably directly after harvest, so that the eggs are exposed to the hot sun. This will at least kill part of them, though the practice is not to be compared for efficiency with that of ploughing.

COMMUNITY ACTION.

United action when anything of a serious nature threatens a community is of vital importance. One may work independently under normal circumstances, but when danger threatens to involve the whole population of a district, it is to the interest of all that they should take an active share in such measures as may be deemed necessary for the public welfare. In this connection the threatened destruction of the crops of any district must, necessarily, involve the prosperity of the city-dwellers within the area. Consequently, it is to their interest to assist the farmers by every practical means.

Community action has already proved of extreme value as an aid to locust control in the United States and in eastern Canada. It has also been of much assistance in destroying gophers on the prairies. Perhaps a still better illustration may be recalled in that of the harvest-clubs during the war, when citizens, largely made up of women, did so much to assist the farmers in gathering in the crops.

In fighting locusts through community action several details must be taken into consideration. First, the community has to be organized and leaders provided. Next there is the procuring of materials and the mixing of baits. This should, of course, be done at some central point and under reliable supervision. Horses and vehicles are necessary for the carrying and spreading of the material. It is also important that the weather be fine, as well as warm, when the mixture is spread. The areas to be treated should be surveyed in advance and definite instructions issued to each driver as to the ground he is to cover. The social aspect of such community work is also an advantage that should not be lost sight of in rural communities. It is hardly necessary to add that the scheme presents many possibilities, and if carried out with the enthusiasm it deserves, should do much to save the crops involved, and so indirectly enrich the whole community.

NATURAL ENEMIES OF LOCUSTS.

The natural enemies of locusts are many and, under ordinary circumstances, can be relied upon to keep them more or less under control. The importance of such control, however, is one that only an expert can gauge successfully, and a farmer should not, therefore, place too much confidence on being freed from locust trouble through these agencies.

Among the more important enemies of locusts are the following:

The Locust flesh-fly (*Sarcophaga kellyi* Ald.); this fly is about the size of the common house-fly, but is greyer; it has three black stripes down the back and a reddish tip to the abdomen. The fly deposits its maggots upon both dead and living locusts, and has at least two generations in a year.

Blister Beetles—longish, black, grey, green, or reddish beetles commonly met with feeding upon caragana, potatoes, or wild peas. The young of these beetles live upon locust eggs.

The Locust Bee-fly (*Systachus oreas* O.S.) A hairy golden-coloured insect about the size of a deer-fly, commonly met with resting upon flowers. The maggots of this fly are much wrinkled, inactive objects of a creamy-white colour. They live upon locust eggs.

Red spider-like mites (*Trombidium* sp.) These are very commonly observed attached to the wings of locusts which, however, they seldom appear to kill. Later they are of value in destroying locust eggs.

Locust Fungus (*Empusa* sp.) This is the disease that is responsible for the dead locusts found attached to the tops of weeds, wild grasses and cereals. It depends upon favourable weather for its spread.

There are a number of other natural enemies of locusts some of which attack the mature insects, others the eggs or young. Birds also play an important part in this work of suppression, of which lake-gulls, terns, crows, black-birds, grouse and meadow-larks are worthy of special mention.

SUPPLEMENTARY NOTES.

OTHER INJURIOUS LOCUSTS.—Favourable locust years always increase various other kinds apart from those of most importance. The commonest of these are generally the Red-legged locust, *Melanoplus femur-rubrum*, DeG., and the Two-striped locust, *M. bivittatus* Say. The first named resembles the Lesser Migratory locust, but prefers moister situations, besides being later in hatching. The latter is much larger and can be distinguished by the two light stripes, one on each side of the back, and the black lines down the hind legs. The young of this insect are often green.

COLOURED-WINGED LOCUSTS.—There are several of these that hatch from eggs in the fall, and so give rise to the idea that the injurious kinds are appearing at the wrong time of year. These winter over as hoppers, and are quite large before the common kinds emerge from the eggs.

FACTS TO BEAR IN MIND.

Locusts eat actively on warm sunny days. They do very little or no feeding on cold, cloudy or wet days.

Adult locusts are as easily poisoned as are the young hoppers.

Locusts do not lay eggs upon clean summer-fallow or newly ploughed soil.

Burning grass lands or straw piles in the fall is a useless practice, as locust eggs are not killed by this. Straw and grass, however, are of decided value for burning the hoppers in spring.

Care should be exercised in mixing poisoned-bait owing to the fact that the poison may enter the pores of the skin and may also be inhaled by the mouth or nose. To guard against the latter contingency it is necessary to tie a handkerchief or cloth over the mouth and nose when handling large quantities of the poison.

Tubs or other vessels in which poisoned-bait has been mixed should not be left where live stock can reach them. The poison kills domestic animals as easily as it does locusts.

Keep cattle supplied with salt; they will then be less likely to eat poisoned-bait.

Farmers in locust-infested districts should organize in early spring so as to be fully prepared to cope with threatened outbreaks. It is especially important to arrange for the obtaining of supplies of poison, bran, and other materials long before the hoppers appear.

Watchfulness, quick action, and persistent effort are the attributes on which to rely for the control of insect outbreaks. Delay is often fatal.

THE OUTBREAK OF LOCUSTS IN WESTERN CANADA IN 1919.

INTRODUCTION

The outbreak of locusts which occurred in certain sections of Manitoba, Saskatchewan, Alberta and British Columbia in 1919, was the most important from an economic viewpoint that has been experienced since the west was developed as an agricultural region, although serious losses were confined to certain districts.

As soon as it was realised from the unusual emergence of young hoppers that the outbreak of locusts was likely to have serious effects, immediate steps were taken to warn farmers and to advise them as to control measures. The press willingly co-operated throughout the season's campaign in publicity work. The Dominion and Provincial Departments co-operated in the control work, which included determining the infested areas, holding meetings of farmers, demonstrating the use and value of the poisoned-baits, and later in the season the new areas in which eggs had been deposited were determined.

Anticipating possible outbreaks of this nature we had taken up with insecticide manufacturers in 1916 and 1917, the question of adequate supplies of standard insecticides such as Paris green, arsenate of lead and arsenate of lime, and as a result the output was greatly increased. At the same time we urged farmers and fruit growers, individually or co-operatively through their organizations, to provide themselves with adequate supplies of insecticides to meet possible contingencies; grain growers and other associations in the west were advised to stock insecticides.

The importance of manufacturing sufficient supplies of insecticides and of an adequate and strategic distribution of such munitions of insect war was impressed on all concerned. We have reason to believe that in spite of the shortage of insecticides which occurred in western Canada, this shortage would have been far more serious had not the previously aforementioned steps been taken. The difficulties of obtaining insecticides from eastern Canada where they are manufactured was increased by the Winnipeg strike in June and July and the embargo on freight and express shipments to that city. Through the hearty co-operation of the Canadian Pacific Railway, which we gratefully acknowledge, about seventeen tons of Paris green were transported by the regular passenger trains from Montreal to Winnipeg and Regina and this supply greatly helped the situation.

In Manitoba and Saskatchewan the Provincial Governments supplied the arsenicals to the farmers through the local authorities. In many cases the municipalities supplied the other ingredients of the poisoned-baits and mixed the same.

The difficulties of dealing with the situation were enhanced by the fact that the outbreaks were most severe in districts affected by the extreme drought. Consequently it was difficult to persuade many of the farmers who were discouraged by these losses to undertake control work. The demonstrated value of

the poisoned-bait, however, convinced the majority that the securing of a crop depended upon its use, and as the result of the widespread application of poisoned-bait and the use of hopperdozers thousands of acres of crop were saved.

Unless unfavourable weather conditions prevail during the coming spring and affect the emergence or growth of the young hoppers our investigations of the areas in which the migrating adults of last season deposited their eggs lead us to expect that the infestation of 1920 will cover about twice the area of that of 1919.

C. GORDON HEWITT,
Dominion Entomologist.

MANITOBA

By NORMAN CRIDDLE

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The 1919 outbreak of locusts in Manitoba was chiefly confined to the southwest corner of the province and the areas most affected were those in which the villages of Melita, Pearson, Lyleton and Waskada formed centres. In addition to this main area various other districts suffered locally to a small extent. These included Napinka, Deloraine, Pilot Mound, and Homewood in the south, Reston and Virden in the west; Sidney to Portage la Prairie on the C.P.R. main line and Gladstone to Longruth in the north. Most of these merely embraced incipient outbreaks which, however, may increase to serious proportions under favourable weather conditions another summer. Owing to the absence of reports from the affected districts, the previous year, we were quite unprepared for the serious outbreak that occurred and in consequence the insects had made considerable inroads into the crops before they could be checked. The lack of necessary supplies, to begin with, also greatly handicapped the work of control and on account of these considerations the losses were far in excess of what they would have been otherwise.

On being notified of the outbreak, the Dominion and provincial officials in Manitoba immediately visited the affected areas where instructions in control methods and demonstrations were given to the farmers concerned. The Extension Service of the Provincial Department of Agriculture also placed men in the field who, for a time, supervised the mixing of poisoned-baits and otherwise rendered assistance. As soon as it was recognized that the outbreak was of a serious nature the Manitoba Department of Agriculture promptly undertook the distribution of free poison and by this action undoubtedly did much towards saving the crop. The municipal authorities were also quick to take action in the matter and were soon supplying most of the bran and attractants used in baits, besides, in some instances, actually mixing the ingredients at a central point.

In the work of control we relied entirely upon poisoned-baits during the early portion of the season, but later a large number of hopperdozers were constructed and utilized as well. The total area infested by locusts in Manitoba was in excess of 500,000 acres of which by far the greatest proportion was situated in the southwest corner. Locusts were by no means evenly distributed over this territory, however, and it happened, therefore, that while some farms were severely infested others escaped entirely. Owing to drought, rust and other adverse factors losses cannot be estimated with even reasonable accuracy, and

in consequence, all we can state is that a number of fields were completely devastated while many others suffered to a lesser extent. For the reasons given above, it is also impossible to reasonably estimate the amount of crop saved, though this was undoubtedly considerable and certainly ran into thousands of dollars. At Waskada counts of poisoned locusts were made on a previously infested field and it was found that the dead insects approximated 226 bushels per acre, while on another field near Melita there were even a greater number of dead. Many locusts were also killed by means of hopperdozers, in some instances 14 bushels being collected by one machine in a day.

In conclusion it seems wise to draw attention to the fact that enormous numbers of eggs have been deposited, many of them in territory unaffected last year. These, under favourable weather conditions will develop into hoppers next spring thus threatening a far greater area than did the outbreak of 1919. The organization for fighting them, however, is much more perfect than formerly and with prompt action from all concerned there is no reason why the pest should not be kept within bounds.

SASKATCHEWAN

By A. E. CAMERON, D.Sc.

Entomologist in charge for Saskatchewan, Dominion Department of Agriculture.

AND

M. P. TULLIS

Weeds and Seed Commissioner, Saskatchewan Department of Agriculture.

The outbreak of locusts* which proved such a source of trouble to the grain growers of Saskatchewan last summer, might have been predicted had we been in possession of the necessary information regarding the abundance of these insects and the extent to which they laid eggs in 1918. Such information, however, was not in our possession and when the locusts began to emerge in large numbers in May, 1919, the serious nature of the outbreak was realised and steps were immediately taken to meet the situation. The failure on the part of some farmers to grasp the importance of the situation, rendered the work of control at first somewhat difficult. It will be readily seen, however, from the perusal of the brief statement that follows, that the Department of Agriculture of the Province of Saskatchewan accomplished, under the circumstances, excellent work in its endeavour to assist the farmers.

We would say that the figures hereinafter quoted have been drawn from the records of the Saskatchewan Department of Agriculture and have been mainly compiled by one of us (M.P.T.).

EXTENT OF INFESTATION.

An area of approximately one thousand five hundred square miles was more or less involved in the outbreak, extending from the Manitoba and United States boundaries in the south-eastern part of the province and following a north-westerly direction to the vicinity of Saskatoon. In this area the infestation

*The most prevalent species were as follows: *Camnula pellucida*, *Melanoplus atlantis*, *Melanoplus bivittatus* and *Melanoplus femur-rubrum*.

was by no means uniform in its intensity. In those municipalities where the soils were light, the locusts generally speaking caused greater damage than where the soils were heavy. Altogether, forty-two municipalities reported outbreaks, and within these municipalities 358,000 acres of growing wheat were overrun by the locusts. These municipalities were as follows:—1, 2, 3, 33, 63, 130, 223 and 284, in all of which the infestation was very heavy. In the remainder the infestation was less heavy than in those just enumerated. They were, 25, 31, 32, 34, 36, 38, 61, 64, 65, 66, 68, 91, 92, 98, 99, 100, 120, 162, 221, 222, 224, 250, 253, 254, 255, 283, 285, 314, 315, 343, 345.



Fig. 6. Locusts crossing a road in south-eastern Saskatchewan,

AMOUNT OF DAMAGE AND CROP SAVED.

About 75,000 acres of growing wheat were destroyed within the infested area, representing approximately 21 per cent of the crop-acreage in which the locusts were working. At the present price of wheat (\$2.50 per bushel*), locusts were thus responsible for a loss of \$1,600,000 to the farmers of the province, a figure which would be greatly increased if we were to reckon in currency the damage caused to other crops and pasture.

On account of the interference of other complicating factors, particularly drought, it has been difficult to furnish anything like an accurate estimate of the amount of crop saved in virtue of the campaign of control against the locust pest. We believe, however, that we are conservative in stating that about 100,000 acres of wheat yielding an average of eight bushels per acre were saved. Valuing wheat at \$2.50 per bushel, this represents \$2,000,000 worth of wheat which would have been actually lost in the absence of control measures.

*This represents the mid-winter price of No. 1 hard wheat. The price has increased lately.

AMOUNT OF POISONED-BAIT USED.

The poisoned-bait principally used in control was constituted as follows:—

Bran.....	20 pounds.
Paris green or White Arsenic.....	1 pound.
Molasses.....	2 quarts.
Oranges or lemons.....	3 fruits.
Water.....	2 to 2½ gallons.

The Criddle mixture composed of one pound of Paris green or white arsenic and one pound of salt mixed with 15 gallons by measure of fresh horse-droppings was employed in a few instances, but in that the results from its use did not compare with those of the former, its general adoption was not advised.

The campaign of control was greatly assisted by the Saskatchewan Government which furnished to the farmers through the medium of the various municipal councils 15,200 pounds of Paris green and white arsenic at a cost to the Government of \$7,260. In consideration of this assistance the municipalities undertook to supply to their ratepayers free-of-charge the remaining ingredients of the poisoned-bait, including the bran, molasses and fruit. Previous to the making of this arrangement, the municipalities themselves bought and used 10,000 pounds of Paris green costing approximately \$5,000. The total amount of poison used was thus 25,200 pounds at a cost of about \$12,260.

Altogether, this amount of poison served for the preparation of 226 tons of poisoned-bait at a total cost of about \$35,000.

OTHER EXPENDITURES INCIDENT TO THE CAMPAIGN.

In a few municipalities hopperdozers were extensively used at the outset of the campaign before the supplies for the preparation of poisoned-bait came to hand. Indeed, one of the most difficult problems with which the farmers were faced was the lamentable shortage of both Paris green and white arsenic in the province in the spring and early summer when these materials were in greatest demand. The railway freight-workers strike which occurred during the month of June, did not serve to improve matters, and it was only after serious delay that the required shipments of poison became available.

Some farmers who had endeavoured to stem the early ravages of the hoppers by the use of hopperdozers continued to use them even after stocks of poison were obtainable. Several, indeed, expressed a preference for the hopperdozer, and, undoubtedly, excellent results were obtained on some farms where they were regularly employed. Altogether about 175 hopperdozers were constructed at a cost of about \$10 each and used more or less regularly by the farmers on the western limits of the outbreak, in municipalities 223, 224 and 284. It would be difficult to estimate what was the exact cost of operating these hopperdozers for the part of the season during which they were effective, but we have furnished an approximate estimate in the summary that follows.

For the purposes of making demonstrations of the preparation and application of the poisoned-bait, as well as surveying the infested municipalities and organizing the farmers for the campaign of control, the provincial government placed seven district representatives in the field. The work of these men was directed by the authors. This phase of the campaign, including salaries and travelling expenses of both federal and provincial employees cost in the neighbourhood of \$3,500.

REQUEST FOR LEGISLATION.

It was amply demonstrated during the recent summer that the campaign of control was seriously handicapped owing to lack of authority in compelling farmers in affected districts to undertake the necessary control measures in fighting the locust pest. A desire on the part of individual farmers as well as municipalities was frequently and strongly expressed favouring the legislation of the work. Finally, on November 13, 1919, at a meeting of the municipal representatives attending a convention of the Hail Insurance Association in Regina, this desire took a practical shape with the result that the following resolution was adopted:—"That the Municipal Act be amended so as to confer upon the council of a municipality, in connection with the destruction of locusts, powers similar to those given in the Rural Municipalities Act in connection with destruction of gophers and to provide a penalty upon farmers who refuse or neglect to put out poison or employ other equally effective means to destroy locusts upon their land when ordered to do so."

The provincial legislature is now engaged upon the amending of the above-mentioned act with a view to covering the exigencies of future outbreaks.

SUMMARY OF EXPENDITURES

As an explanation of the figures that follow we would particularly wish to emphasize that they are merely approximate, but from the information at hand we believe that they are as accurate as can be obtained. In the case of the hopperdozers we have assumed that each one was operated for an average of five full working days. In some cases they were actually in use more days than this and in some cases less.

POISONED-BAIT.

(1) 226 tons including all ingredients as above.....	\$ 35,000 00
(2) Preparation and distribution of this amount of bait at 75 cents per 20 lbs.....	16,950 00
	<u>\$ 51,950 00</u>

HOPPERDOZERS AND OIL.

(3) 175 hopperdozers at \$10 each.....	1,750 00
(4) 4,375 gallons of kerosene (5 gallons per day per machine for five days) at 35 cents per gallon.....	1,531 25
(5) Labour of man and team at \$6 per day for five days per each machine.....	5,250 00
	<u>\$ 8,521 25</u>

SALARIES AND TRAVELLING EXPENSES.

(6) 10 assistants for organizing, provincial and federal	3,500 00
	<u>3,500 00</u>

The total of these expenditures amounts to \$63,981.25, and whilst some minor items may have been overlooked, we believe that the total outlay of the campaign in which \$2,000,000 worth of wheat was saved, did not cost the government and the farmers more than \$70,000.

ALBERTA

By E. H. STRICKLAND

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Locusts were unusually abundant over a district of approximately 2,500 square miles in southern Alberta, of which about 500 square miles is Indian reservation. The infested area is bounded on the north by a line running from Lundbreck to Diamond City, through MacLeod and Noble; on the east by a line running from north to south through Lethbridge, and on the south and west by the provincial boundaries.

The crops in this area were so completely destroyed by drought that no estimate of the loss due to locusts can be given. Some farmers who had no crop whatever, estimated that their fallow land would have yielded nine bushels per acre if it had been uninfested.

At the end of June the Lesser Migratory locust (*Melanoplus allanis*) predominated around Kipp, where the infestation was the most heavy, but by August both in the Kipp district and around Magrath the Pellucid locust (*Camnula pellucida*) was the most abundant species.

Little control work was practised. There was nothing to save. Experiments with the Kansas poisoned-bait indicated that Paris green killed more rapidly than did white arsenic.

Farmers were too disheartened with drought to take much interest in locusts and did not report their presence. The Secretary of the United Farmers' Association very kindly circulated a questionnaire to all of the local secretaries of the association. From the replies received the area infested was estimated.

BRITISH COLUMBIA

By R. C. TREHERNE

Entomologist in charge for British Columbia, Dominion Entomological Laboratory, Vernon, B.C.

During 1919, four widely separated outbreaks occurred in British Columbia: (1) in the Boundary country between Bridesville and Rock Creek; (2) on Shuswap lake at Celesta; (3) in the Chilcotin district, particularly on the Riske creek range; and (4) in the Lower Fraser valley at Huntington. The Pellucid locust (*Camnula pellucida*) was the most important injurious species in the Boundary and Chilcotin districts; the Lesser Migratory locust (*Melanoplus allanis*) on Shuswap lake; and the Red-legged locust (*Melanoplus femur-rubrum*) in the Fraser valley. There is little doubt, that taking the southern sections of the province as a whole, the numbers of locusts on range lands are on the increase, but at the four above-mentioned points they occurred in such numbers that definite outbreaks were recorded.

In the Boundary country approximately 5,000 acres, of which less than 1,000 were cultivated, were affected by locusts in 1919. It was not possible to estimate the amount of damage caused by locusts alone in this area for the reason that excessive drought conditions greatly interfered with the growth of the crops. There is no doubt that the losses due to locusts were very considerable.

At Celesta, 400 acres of land, of which about 150 acres were planted to grain, hay and roots, were completely destroyed. Apple trees were also defoliated in August.

In the Fraser valley an area of two and one-half miles long by one mile wide was attacked to such an extent that many growers considered it advisable to cut their grain crops in a green state. Owing to the vigorous vegetative growth that occurs in this area it is impossible to base a correct estimate of the influence of locusts.

In the Chilcotin-Riske creek range, the area invaded by locusts was very large indeed. Thousands of acres of cattle range were involved but the chief injury took place on the winter ranges. No effort has yet been made to form a correct estimate of the actual loss caused by locusts on range lands in the province of British Columbia, where their attacks are becoming increasingly serious to the live stock interests in the province. The problem involves studies of overstocking of winter ranges and the influence of biting flies on the summer ranges. Both these conditions together with unusual drought conditions are closely associated with the influence of locusts.

No poisoned-bait was distributed this year in British Columbia with the exception of approximately two tons which were sold to farmers in the Bridesville areas by United States authorities who were engaged, at the time, in a locust campaign just across the Canadian border in the Boundary country.

