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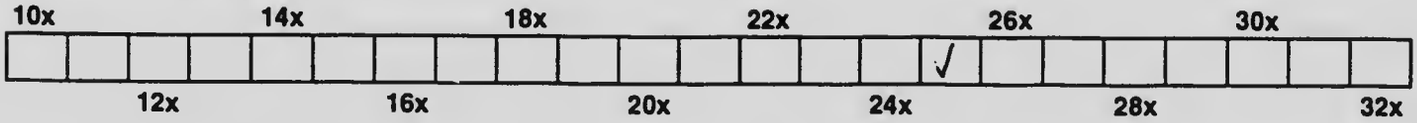

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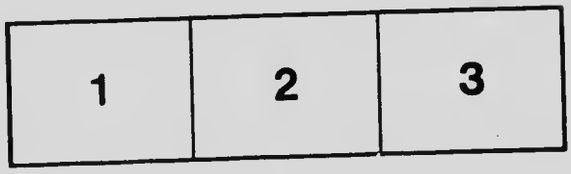

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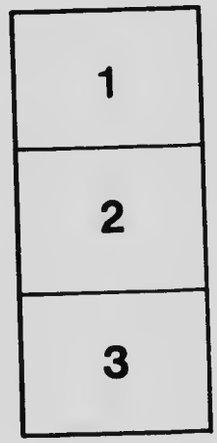

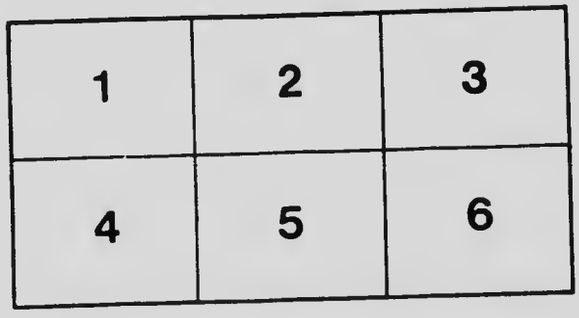

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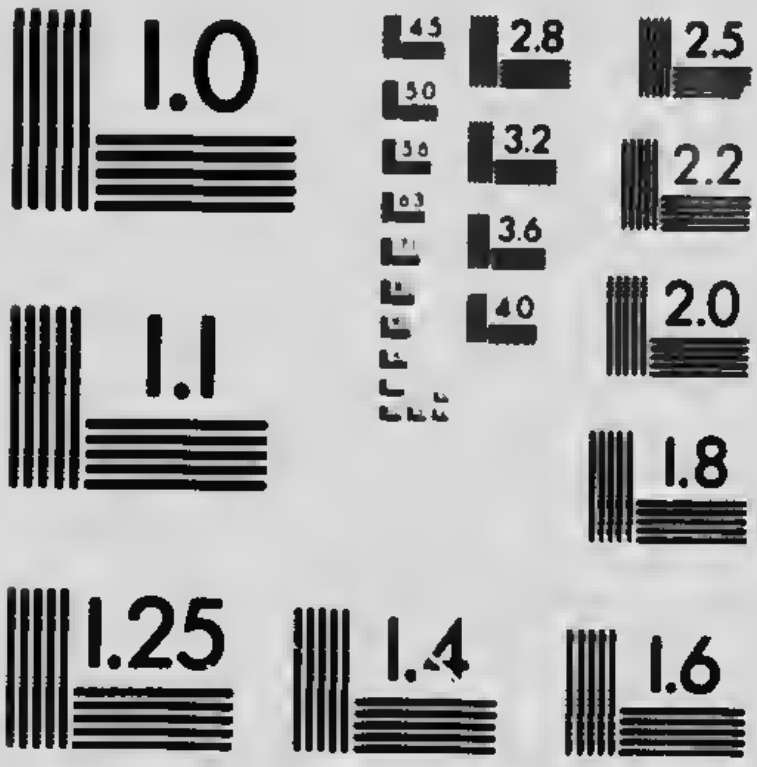

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DEPARTMENT OF AGRICULTURE
CENTRAL EXPERIMENTAL FARM
OTTAWA, CANADA

INSECTS

INJURIOUS TO GRAIN AND FODDER CROPS, ROOT CROPS AND VEGETABLES

BY

JAMES FLETCHER, LL.D., F.R.S.C., F.L.S.

Entomologist and Botanist to the Dominion Experimental Farms.

BULLETIN No. 52

JUNE, 1905

Published by direction of the Hon. SYDNEY A. FISHER, Minister of Agriculture, Ottawa, Ont.

To the Honourable

The Minister of Agriculture.

SIR,—I have the honour to submit herewith for your approval Bulletin No. 52 of the Experimental Farm series, which has been prepared under my direction by Dr. James Fletcher, Entomologist and Botanist of the Dominion Experimental Farms. This bulletin treats of insects injurious to grain and fodder crops, root crops and vegetables.

The injuries annually caused by insects to farm crops seriously reduce the profits arising from the labour of the farmer. Much of this loss is preventable and the object of this bulletin is to supply that practical information which will enable the reader to deal with these several pests in the most effective manner and at the least cost. The concise accounts given of the life history and habits of the injurious species treated of, together with the illustrations, will provide the means whereby they may be readily distinguished. The remedies suggested for the destruction of these pests are as a rule of easy application and at the same time are very effective.

It is hoped that farmers generally will put into practice the useful [illegible]on here given and, whenever occasion arises, promptly apply the remedies named, and thus much loss may be prevented.

I have the honour to be, Sir,

Your obedient servant,

WM. SAUNDERS,

Director of Experimental Farms.

OTTAWA, June 30, 1905.

INSECTS INJURIOUS TO GRAIN AND FODDER CROPS,
ROOT CROPS AND VEGETABLES

By James Fletcher, LL.D., F.R.S.C., F.L.S.
Entomologist and Botanist to the Dominion Experimental Farms.

Every crop grown by the farmer and gardener is liable to be attacked and reduced in value by various insect enemies, from the time the seed is sown until it is harvested. Frequent inquiries concerning even the commonest and most injurious pests make it advisable to issue in concise form for reference, an account of some of the more important of these, together with the latest approved remedies, and the most convenient methods of applying them.

The present bulletin treats of those insects which are injurious to grain and fodder crops, roots and vegetables; and it is the intention to treat of other classes of injurious insects in subsequent bulletins.

It must be acknowledged by all observant people that the losses due to the attacks of insects are every year enormous; and it should be more widely known that there are practical—that is effective, cheap and easily applied—remedies for most of those kinds which year by year levy such a heavy tax on all crops. For the effective use of remedies against injurious insects, a certain amount of knowledge as to the habits and structure of the latter is very useful, so that the most appropriate remedy may be made use of, and this at the time when it will be most effective.

LIVES OF INSECTS.

The lives of insects are divided into four well marked stages. These are: (1) the egg; (2) the larva (caterpillar, grub or maggot), during which, as a rule, they are most injurious; (3) the pupa or chrysalis, in which, except in a few orders, they do not feed, and are, as a rule, without the power of locomotion; and (4) the perfect insect. Although most insects are injurious in one or two stages, only some are destructive in all three of their active stages. It therefore becomes important to learn their appearance and habits from the time the eggs are laid until the whole life history is completed, so that no opportunity of destroying them may be lost.

Biting and Sucking Insects.—All insects may be divided into two large classes, by the nature of their mouth parts. In the first or large division, Biting Insects, they are furnished with mandibles or biting jaws, by means of which they consume the substance of their food, as in the case of caterpillars, grasshoppers, &c. In the second class, Sucking Insects, they have, instead of mandibles, a beak or tube by means of which they suck up their food from beneath the surface, as in the case of the true bugs, plant-lice, mosquitoes, &c.

PART I.

REMEDIAL MEASURES.

NATURE OF ATTACK.

When insects are observed to be injuring a crop, an examination should at once be made to discover the nature of the injury, so as to decide upon the proper remedy. It is plain that with Biting Insects, which bite off and swallow parts of the plant attacked, all that is necessary is to place upon the food plant some poisonous substance which will not injure the plant, but which being eaten by the insects attacking it, will kill them. With Sucking Insects, however, this treatment would be useless, for they would push their beaks through the poisonous covering on the outside of the food plant, and would with impunity suck up the sap upon which they live, from beneath the surface. For Sucking Insects, therefore, some substance must be used which will kill by mere contact with their bodies, or by suffocating them.

For nearly all the kinds of injurious insects which attack our staple crops, we have now good practical remedies; and all that is necessary for a farmer or gardener who sees that his crops are being injured by insects is to write a letter to the Division of Entomology, at the Central Experimental Farm, Ottawa, stating plainly what the trouble is, and, whenever possible, sending specimens for examination. In most cases, useful advice can be sent back at once, by which much loss will be prevented, because those insects which are most injurious to crops are naturally common species, and the life histories of nearly all of these have been worked out, and already practical remedies have been discovered.

There is at the present time in North America a large and earnest body of students working at problems connected with the discovery of new remedies or the improvement of old ones, by means of which insects which injure crops may be controlled. Something new is being learnt every day as to the means of either making or applying remedies, and day by day new facts are being learnt concerning the life histories and habits of the insects which are the causes of loss. In the present bulletin an effort has been made to supply Canadian farmers with the best remedies and the latest developments in methods of applying them. So much is written nowadays in magazines, newspapers, &c., concerning insect injuries and the best ways of preventing them that a great many experiments have been necessary to find out how reliable some of the proposed remedies were, and the present bulletin gives only the best results of such experiments as have been actually tried by officers of the Division of Entomology.

APPARATUS.

Nearly all insecticides may be used both as dry powders or in liquid. In the case of the useful arsenical poisons, it is necessary to mix them with some other substance as a diluent, on account of their caustic action upon tender vegetation, and also for convenience of distribution and to economize the material. For dry applications, suitable diluents will be found in flour, land-plaster, air-slaked lime, finely sifted ashes, or even road dust. The important point is that the powder shall be perfectly dry and in a very fine state of division, so as to mix thoroughly with the insecticide and thus insure even distribution. There are several implements for distributing dry insecticides such as bellows, insect guns, dusting boxes, &c., many of which will be found mentioned in the catalogues of our leading seedsmen. A convenient method for distributing dry poisons is to place the powder in a small bag of very fine muslin, then tie this to the end of a short stick so that it swings freely. If the bag is tapped lightly

with another stick held in the other hand, the operator can walk erect and do much better work than by stooping along over his crop with an aching back. Dry mixtures should be applied in still weather and, if possible, when the plants are wet with dew. It is found by experience, however, that during the spring months when insecticides are most needed, there are often periods of several days when these conditions do not occur. It therefore becomes necessary to apply the poison in some other way, so that the material may be evenly distributed over the plant to be protected, and not blown away by the wind. For this purpose mixing with water and then applying with a spraying pump is the most convenient plan.

I have no doubt that it will repay anyone who has to apply insecticides, even in a small garden, to go to the expense of procuring a pair of proper bellows for dry mixtures and a force pump with a spraying nozzle for liquid applications. Makeshift contrivances, such as watering cans, whisks, and even bunches of leaves, which are frequently used, actually cost far more in wasted time and materials than would pay for the best special implements, in addition to which, when the work is done, it is neither satisfactory nor effective. There are a great many kinds of implements for distributing both dry and liquid insecticides, many of which are advertised in the agricultural and horticultural papers.

Pumps.—Before deciding on what kind to use, it is advisable for one who has not used these implements to consult his neighbours who have done so, and then write for catalogues to the best known makers; and when buying make it a general principle always to procure the most suitable and the best of its kind. The difference in the initial cost between a poor, cheap implement and a thoroughly good one is small, compared with the subsequent loss and inconvenience from using a cheap pump or a poor nozzle. Spraying pumps are made in four sizes: (1) hand pumps, suitable for small gardens, which can be procured at prices ranging from $2 to $5; (2) larger pumps mounted on wheels or suitable for loading on a stone-boat, and consisting of an ordinary 40-gallon barrel, with a strong force pump to be worked by hand, which will cost about $20, and will be all that is required in an orchard of from fifty to a hundred trees, or in a large garden; (3) knapsack sprayers, which are useful machines, consisting of a tank of about four gallons' capacity, to be carried on the back, and useful when treating outbreaks of cutworms, turnip aphis, &c., in field practice; (4) power machines; these are of various kinds, and are for use in large plantations, or for spraying street trees where great power is required to elevate the spray. These are worked by steam, by being geared to the wheels of the vehicle on which the tank is drawn, or by the escape of carbonic acid gas. The cost of these will vary very much according to the make and size of the machines.

Spraying nozzles.—Of equal importance with a proper force pump in distributing liquid poisonous applications is a suitable nozzle, by means of which the liquid can be distributed evenly. The late Professor Riley, who did much in the development of spraying machines, said: 'The desiderata in a spraying nozzle are: the ready regulation of the volume to be thrown, the greatest atomizing power with the least tendency to clog, facility of cleansing or separation of its component parts, cheapness, simplicity and adjustability to any angle.'

Almost every maker of spraying nozzles has some special make which he recommends; but many kinds now in the market have not the qualities necessary for spraying crops for injurious insects in the best way. All that can be said here, is that some of these nozzles are far better than others and that great care is necessary in choosing one which will come up to Dr. Riley's requirements, as mentioned above. The experience of others is a valuable guide in this work; and, both at the Dominion Experimental Farms and at the similar provincial institutions, spraying work is carried on every year, which can be witnessed by all who wish to do so, and advice will be freely given by the officers in charge.

The operation of 'spraying' consists of applying liquids by means of a force pump and spraying nozzle with such force as to break up the liquid so thoroughly that

it falls upon the plants treated as an actual mist or spray. Such terms as *sprinkling* o *showering* are inaccurate for the operation here intended. Unfortunately, much of the so-called spraying as usually carried out could more accurately be designated by these terms, which describe a much less careful and less even distribution of liquids.

REMEDIES.

Remedies are either Preventive or Active, and must be applied in accordance with the circumstances of the case and the habits of the attacking insects. *Preventive remedies* are either agricultural or deterrent. The former of these consist chiefly of such methods as special rotation of crops, high culture, so as to stimulate a healthy growth of the crop and keep the land free of weeds and rubbish; early and late seeding, so as to present a crop to its insect enemies when they appear, in such condition that they cannot injure it, and rotation of crops, by which insects attracted to a locality by a crop will not have in that place the same crop to feed upon the following year. Deterrent preventive remedies consist of the application of mechanical contrivances, such as bands of paper or tin placed round plants to prevent cutworms getting at them, or the destroying or masking of the natural odours of some plants by scattering amongst them substances possessed of a stronger or a disagreeable odour, like gas-lime, carbolic acid, &c. *Active remedies* include such methods as hand-picking and the application of various poisonous substances to the plants to be protected.

For convenience of reference in the latter part of this bulletin, I append a short statement concerning each of the best known remedies, which will be referred to by the numbers which precede them:—

I. *Arsenites.*—The best known of these are Paris green, Arsenate of lead, the Arsenite of lime with soda, which has lately come into very much more general use, and Green Arsenoid.

In all of these poisons, arsenic is the essential ingredient, and other chemicals are mixed with the arsenic for the purpose of preventing it from injuring vegetation. There are many spraying compounds which contain arsenic, some of which are sold ready-made, and many others are made at home by combining the necessary ingredients.

Paris Green.—Undoubtedly the best known, and in many respects the safest poison to use is Paris green. It has passed through many years of trial, is well known, has a distinctive colour, and is a definite chemical compound containing 58·65 per cent of arsenious oxide, 31·29 per cent of copper oxide, and 10·06 per cent of acetic acid. It is, therefore, an aceto-arsenite of copper. It is soluble in ammonia. Paris green, if demanded, is now obtainable pure in all parts of Canada; but, as there is sometimes an adulterated article found in the market, it is wisest always to add an equal amount, with the Paris green, of freshly slaked lime, when the free arsenic will combine with the lime, and it can then be used safely at the rate of one pound of Paris green in 160 gallons of water on all vegetation, and, for a dry application, 1 pound Paris green in 50 pounds flour, land-plaster, slaked lime or some other perfectly dry powder.

As a general principle, lime should be always used with Paris green whenever it is applied in a liquid insecticide. Paris green is very heavy, and the particles quickly sink to the bottom of any liquid with which it is mixed. This makes constant stirring necessary. Paris green does not dissolve in water, and is merely mixed with water to facilitate its even distribution on vegetation in the very small quantities that are necessary to destroy insects. The finer the poison is ground, the quicker its effect on the insects which eat it, because the minute crystals are more rapidly dissolved by the digestive juices in the stomachs of the insects. The finer it is ground, the better also it will remain suspended in a liquid application. For most insects, one ounce of Paris green in 10 gallons of water is the standard strength; but some plants with coarse foliage, such as the potato, will stand double that strength.

Arsenate of Lead.—A poison which has come into much notice since the work of the Massachusetts Gypsy Moth Commission is Arsenate of Lead, which has been placed on the market in a very convenient form under the name of Bowker's Disparene and Swift's Arsenate of Lead. The chief advantages of Arsenate of Lead are that it can be applied to all kinds of foliage with less danger of injury than is the case with Paris green; and, on account of its fine state of division, it lasts longer on the foliage, because it does not wash off so easily. The cost of using it is about the same as that of Paris green, because, although cheaper, pound for pound, it is necessary to use three times the amount of it to get the same results. Arsenate of Lead may be made at home. Formulæ for its preparation vary slightly; but in the United States Division of Entomology, Bulletin No. 41, the following instructions are given for making the Arsenate of Lead wash ready for use:—

Arsenate of soda	10 ounces.
Acetate of lead	24 "
Water	150 to 200 gallons.

The arsenate of soda and acetate of lead should be dissolved separately and then poured into a tank containing the required amount of water. These chemicals unite readily, forming a white flocculent precipitate of lead arsenate, which is easily kept in suspension and can be used in excessive strengths on delicate plants without the addition of lime. When sprayed upon the foliage, it forms a filmy adhering coat, which is but little affected by ordinary rains.

Another formula for making Arsenate of Lead is that recommended by Prof. H. T. Fernald, and is :

Arsenate of soda, 50 per cent strength	4 ounces.
Acetate of lead	11 "
Water	150 gallons.

Put the arsenate of soda in two quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another wooden pail. When both are dissolved, mix with the rest of the water. Warm water in the pails will hasten the process. Prof. Fernald recommends that in mixing this with Bordeaux mixture one gallon of the above should be mixed with fifty gallons of the mixture.

'*Arsenite of Lime with Soda:*—

White arsenic	1 pound.
Sal soda (crystal)	4 pounds.
Water	1 gallon.

'The ingredients are boiled in the required amount of water until dissolved, which will take place in a comparatively few minutes, after which the water lost by evaporation is replaced. To every 40 or 50 gallons of water a pint of this stock solution and from 2 to 4 pounds of fresh slaked lime are added. The chemical compound derived from the combination of the sal soda and the white arsenic is arsenite of soda. In the presence of lime this breaks down and arsenite of lime is formed. It requires 4·4 pounds of crystal sal soda, or 1·6 pounds of dry sal soda to combine with one pound of arsenic, and 2 pounds of freshly slaked lime to combine with one pound of arsenic to form arsenite of lime. It is always desirable to have an excess of lime present, in order to prevent all danger of burning; furthermore, this excess is a convenience to fruit growers, because they can see by the distribution and amount of lime on the foliage how well the spraying has been done. The formula, which is the Kedzie formula with a few minor changes, has been used in many different sections of the country with unvarying success. In all of the practical tests under the advice of the writer, this solution is used and is found to be, not only as efficient as other solutions, but far cheaper.

'When it is desired to use Bordeaux mixture with this solution, it is added to the Bordeaux mixture in the same proportion as to a similar quantity of water.'—*(C. B. Simpson, Bull. 41, U. S. Div. Ent.)*

The above combination of Arsenite of Lime with Soda is preferable to arsenite of lime on account of the difficulty in making this latter combination perfectly, and, when this is not the case, the free arsenic is very destructive to foliage.

London Purple, which is an impure arsenite of lime, is now very seldom used, for the same reason. As it is a waste product in the manufacture of aniline dyes, it is very variable in composition, and therefore unsafe to use.

Green Arsenoid.—This is a convenient poison to use, being practically Paris green not crystallized, and is in some ways better; being a very fine powder, it remains in suspension longer and adheres better to foliage. Its chief disadvantage is it has a rather larger percentage of soluble arsenic, and, unless mixed with fresh lime, as suggested for Paris green, there is danger of it injuring foliage. It may be used in the same proportion as Paris green, viz., one ounce to ten gallons of water.

II. *Kerosene Emulsions.*—Next in importance to the arsenites are the emulsions of kerosene. These are particularly valuable against such insects as plant-lice, scale insects, and animal parasites. The best formula is:—

Kerosene (coal oil)	2 gallons.
Rain water	1 gallon.
Soap	½ pound.

Boil the soap in the water till all is dissolved; then, while boiling hot, turn it into the kerosene, and churn the mixture constantly and forcibly with a syringe or force pump for five minutes, when it will be of a smooth, creamy nature. If the emulsion is perfect, it will adhere to the surface of glass without oiliness. As it cools, it thickens into a jelly-like mass. This gives the stock emulsion, which must be diluted with nine times its measure of warm water before using on vegetation. The above quantity of 3 gallons of emulsion will make 30 gallons of wash. Insects breathe through small openings along their sides. The effect of kerosene emulsion is to suffocate them, by stopping up these breathing pores.

Kerosene emulsions may also be made conveniently by using an equal amount of sour milk instead of soap and water in the above formula, and churning for the same time to get the stock emulsion. Recently another method has been suggested by Mr. F. T. Shutt and Mr. W. T. Macoun, of mixing kerosene first of all with flour and afterwards with water by churning the two together. This convenient plan is a modification of a method proposed by Prof. Close, of the Delaware Experiment Station, in which it was shown that lime has the power of holding kerosene in suspension and forming an emulsion which does not separate for a long time. Lime is not conveniently obtainable in all parts of Canada, and Mr. Shutt made the valuable discovery that flour, which is to be had everywhere, may be used with equally good results if the emulsion is to be used at once. This gives us, then, by far the most convenient kerosene emulsion, when small quantities are required for immediate use. Instructions for making this new flour kerosene emulsion are given in the May and June, 1905, issues of the 'Canadian Horticulturist.'

The preparation is simple. The requisite amount of kerosene is placed in a dry vessel and flour added in the proportion of eight ounces to one quart of kerosene. It is then thoroughly stirred and two gallons of water are added for every quart of kerosene; the whole is then vigorously churned for from two to four minutes, and the emulsion is ready for use. When required for immediate use, two ounces of flour will emulsify one quart of kerosene; but, on standing a few hours, the kerosene will separate. However, it has been further found by Mr. Shutt that, by scalding the flour before adding the kerosene, an excellent emulsion which does not separate in the least after one week, can be prepared with two ounces of flour, by mixing the resulting paste with one quart of kerosene and emulsifying with two gallons of water.

III. *White Hellebore.*—This is a vegetable poison, being the finely powdered roots of *Veratrum album*. It is useful for leaf-eating insects and root maggots. Although very poisonous to insects, owing to the poisonous principles being soluble, it can be safely used where the arsenites would be dangerous. It can be applied as a dry powder or as a liquid mixture, using one ounce to two gallons of warm water.

IV. *Insect Powder (Pyrethrum, Buhach).*—This is another vegetable insecticide of special value, from the fact that, although it is extremely active in its effects upon nearly all insects, it is practically harmless to human beings and the higher animals. It is the pulverised flowers of some plants belonging to the genus *Pyrethrum*. It is useful for many household pests, as flies, mosquitoes and wasps, all of which are quickly affected, either by having a small quantity thrown into the air of a room by means of an insect-gun or small bellows, or by a small quantity (a teaspoonful) being ignited and allowed to smoulder. It seems to have a marked effect upon the breathing organs of insects. Where practicable, a dry application gives the best results. If mixed with four times its weight of common flour, and then kept in a tightly closed vessel for twenty-four hours, the mixture will kill nearly all caterpillars it is applied to, and in this strength becomes the best remedy for the caterpillar of the Imported Cabbage Butterfly. It can also be used mixed with water, 1 oz. to 2 gallons of water.

V. *Soap Washes.*—The most effective soap wash is made with whale-oil soap, one pound to from four to six gallons of water. The term whale-oil soap is merely a trade name for a fish-oil soap, made with either potash or soda. The potash soaps, which are the best, because even strong solutions remain liquid when they cool, are soft soaps. The soda soaps are hard. Of the two, the potash soaps are considered the best to use on vegetation, as well as being more convenient. Both kinds should always be dissolved in hot water.

When bought at retail prices, these soaps cost from 15 to 20 cents per pound, according to the locality, but if obtained in large quantities, can be got at from 3 to 5 cents per pound. Fifty-pound kegs are supplied at 5 cents per pound. Two well known brands of potash soft soaps which have been much used in Canada, and have given good satisfaction, are those made by W. H. Owen, of Port Clinton, Ohio, and by Good & Co., of Philadelphia, Pa. If thought desirable, these soaps can be made at home; but it is very unpleasant and dirty work, and it is besides doubtful whether such good or cheap results can be secured as by buying from firms which make a special business of manufacturing soaps with only the required amount of moisture and the proper grade and amount of potash. It has been found in experiments carried on at Washington that what is required for spraying purposes is a caustic potash and fish-oil soap, made with a fairly good quality of fish-oil, and from which water has been eliminated by boiling, so that it does not exceed 25 or 30 per cent of the weight of the soap. Soaps made with caustic soda instead of caustic potash are unsuitable for spraying purposes. Dr. J. B. Smith, in his circular No. 5, 'Whale Oil Soap and its Uses,' says: 'Whale-oil, or fish-oil, soap is one of the most reliable materials for use against plant-lice, and generally against sucking insects which can be killed by contact insecticides. It kills by clogging the spiracles, or breathing pores, of the insects and also to some extent by its corrosive action. The advantages of fish-oil over ordinary laundry soap lie in the greater penetrating power, in the fact that it remains liquid when cold, at much greater strengths, and that fish-oil itself seems to be more fatal to insect life than other animal fats. A good soap can be made as follows:—

Concentrated potash lye	3½ lbs.
Water	7½ gallons.
Fish-oil	1 gallon.

Dissolve the lye in boiling water, and to the boiling solution add the fish-oil; continue to boil for two hours, and then allow to cool. Any grade of fish-oil will answer.'

Whale-oil soap may be applied in the strength of one pound in four gallons of water for brown or black plant-lice, and one pound in six gallons for green plant-lice; warm water should always be used when dissolving it.

Soaps of all kinds are very useful in adding adhesiveness to liquid mixtures when it is necessary to apply these to such vegetation as cabbages, turnips, peas, &c., which have their leaves covered with a waxy secretion which prevents water from lying upon them. Any kind of soap will answer for this purpose, and it may be remembered that one quart of soft soap is about equal to one pound of hard soap.

VI. *Carbolic Acid.*—This fluid is very valuable as a preventive remedy, owing to its permanent and characteristic odour, which is found to be distasteful to many insects. A convenient form of using it is the Cook wash, which is so effective against root maggots. This consists of boiling up one quart of soft soap, or one pound of hard soap, in a gallon of water. When boiling, add half a pint of crude carbolic acid. Boil for a few minutes and stir thoroughly. The mixture is then ready to be stored away for future use. When required, take one part of this mixture by measure to fifty of water, and sprinkle or spray directly upon the growing plants once a week from the time they appear above ground.

Carbolized Plaster, Sand, Ashes or Sawdust.—This is simply one pint of crude carbolic acid, well mixed with fifty pounds of land plaster or some other diluent. It is used dry by sprinkling it among plants to be protected, and is said to be very efficient against flea-beetles, Striped Cucumber Beetle, &c.

VII. *Poisoned Bordeaux Mixture.*—The discovery of the great value of Bordeaux mixture as a destroyer of fungous diseases was soon followed by the equally important one that various poisons could be mixed with it and form a joint mixture destructive at the same time of fungous diseases and insect pests. All of the arsenical poisons can be mixed with the lime Bordeaux mixture, and this practice is now a general one, when it is necessary to protect crops against fungous diseases and at the same time to destroy insect enemies. A useful formula for making the Poisoned Bordeaux Mixture for fungi and leaf-eating insects is the following:—

POISONED BORDEAUX MIXTURE.

For Fungi and Leaf-eating Insects.

Copper sulphate (Bluestone)	4 lbs.
Unslaked lime	4 lbs.
Paris green	4 oz.
Water (1 barrel)	40 gallons.

Dissolve the copper sulphate (by suspending it inside a wooden or earthen vessel containing 4 or 5 or more gallons of water.) Slake the lime in another vessel. If the lime, when slaked, is lumpy or granular, it should be strained through coarse sacking or a fine sieve. Pour the copper sulphate solution into a barrel, or it may be dissolved in this in the first place; half fill the barrel with water; dilute the slaked lime to half a barrel of water, and pour into the diluted copper sulphate solution; make the Paris green into a paste by adding a little warm water and then pour it into the barrel and stir thoroughly. The mixture is then ready for use. (Never mix concentrated milk of lime and copper solution.)

A stock solution of copper sulphate and milk of lime may be prepared and kept in separate covered barrels throughout the spraying season. The quantities of copper sulphate, lime and water should be carefully noted.

To test Bordeaux mixture, let a drop of ferrocyanide of potassium solution fall into the mixture when ready. If the mixture turns reddish brown, add more milk of lime until no change takes place.

When spraying potatoes for potato rot and the Colorado Potato Beetle use six pounds of copper sulphate and eight ounces of Paris green. Arsenites must not be applied in Bordeaux mixture, when this is made with soda instead of lime, or the foliage will be injured.

PART II.

I.—INSECTS INJURIOUS TO GRAIN AND FODDER CROPS.

Hessian Fly

(*Cecidomyia destructor*, Say), Figs. 1, 2, 3.

Attack.—In autumn two, three or more small whitish maggots may be found imbedded in the crown of winter wheat or in summer just above the first or second joint of the stems of wheat, barley and rye, where they lie beneath the sheath of the leaf but outside the stem, from which they suck the sap, causing the stem to become weak and fall over. When full grown these maggots harden and turn dark-brown and then resemble small flax seeds. From these in May and June, and again in August and at the beginning of September, emerge small blackish midges with smoky wings, which measure about a quarter of an inch across the expanded wings. The females lay small bright red eggs upon the inside crease of the leaves of the growing plants. The eggs are deposited singly or in clusters upon the upper side of the leaf. The young maggots as soon as they hatch, work their way down to the bases of the leaves where they remain until the perfect flies emerge.

The Hessian Fly has been the cause of enormous losses at different times in many parts of Canada, both to spring and to fall wheat in western Ontario and the eastern provinces, and to spring wheat in Manitoba in 1902. At the present time there is hardly any injury recorded; but this dire enemy of the wheat grower may appear again in any season.

Remedies.—The habits of the Hessian Fly and the best remedies to adopt are pretty generally known by wheat growers and with a little more co-operation a great deal might be done to prevent the increase of this most destructive enemy of our staple food crop. The best remedies are:—

(1.) *Late Sowing.*—The most important preventive remedy is the postponement of the seeding of fall wheat until the end of September, which delays the appearance of the young plants until after the flies of the second brood are dead. At the same time special care should be taken to prepare the land as well as possible for the crop, and in periods of excessive abundance strips of wheat may be sown in August to be ploughed down again with all their contained larvæ by the middle of September.

(2.) *Burning Refuse.*—Many of the flax seeds of the summer brood are carried with the straw and at threshing time fall with the rubbish beneath the machine or are left in the straw. All dust and screenings, therefore, should be carefully destroyed, and all straw and small seeds should either be used up during the winter or burnt before spring.

(3.) *Treatment of Stubbles.*—Most of the puparia of the summer brood are placed so low on the stems that they are left in the stubble when the wheat is cut. In Ontario and the eastern provinces a large proportion of these give forth their flies in August and September; but some, and in Manitoba and the west probably most, pass the winter in the stubble. An effective way of destroying these is to plough the stubbles down deeply as soon after the crop is cut as convenient, so as to place the insects so deep beneath the surface that the delicate flies, when they emerge, cannot reach the surface. As most of the puparia winter in the stubble, the burning over of wheat fields, which for the purpose have been cut rather high, will probably prove the most convenient remedy for this insect in Manitoba, where there is only one brood.

(4.) *Fertilizers.*—When a crop of fall wheat is only lightly infested, it is sometimes possible to stimulate the growth of the plants in spring by making a light application (so as not to cost too much) of some quick acting special fertilizer such as nitrate of soda.

The Joint Worms

(*Isosoma* sp.), Fig. 4.

Attack.—Very small, slender, footless grubs, one-eighth of an inch in length, of a pale-yellow colour, with dark brownish jaws. As many as five to twelve of these may be found occupying cells in a more or less apparent swelling or gall on the straw or in the leaf sheaths of wheat, rye and barley, generally a little above the first or second joint from the root. Most of the larvæ winter inside the galls, but a few transform and appear as flies in late autumn. The perfect insect is a tiny black four-winged fly, only about one-tenth of an inch in length, with clear transparent wings and pale legs.

There are probably more species than one belonging to the genus *Isosoma* which attack the small grains in Canada. *I. tritici*, Fitch, and *I. hordei*, Harr., have been reared. These injuries appear to be of rare occurrence but have sometimes been serious in certain localities. All recorded occurrences have been of short duration.

Remedies.—There is apparently only one brood of the Joint Worms in Canada; and, as they pass the winter in the straw, for the most part so near to the ground that a large proportion of the larvæ are in the stubble left on the fields, they can be largely reduced in numbers by burning over the stubble or by ploughing it down deeply. The broken off hardened pieces of straw which become separated in threshing and cleaning should be carefully gathered and burnt. Sometimes no apparent galls are formed, merely slight swellings with a hard, thickened condition of the straw representing the galls. These portions break off in threshing and many are carried through with the grain. Straw from an infested crop should be got out of the way either by feeding or burning before the ensuing spring.

Prof. F. M. Webster, of Washington, D. C., who has made a special study of these insects, and who is not only an expert entomologist but also a practical farmer, recommends a regular rotation of crops and the mowing down of all grasses along the borders of fields and waste places in June, as well as keeping up the fertility of the soil, so as to produce a healthy vigorous growth, which will discourage egg laying by the female flies.

The Greater Wheat-stem Maggot

(*Meromyza americana*, Fitch), Fig. 5.

Attack.—A short time before wheat, barley and some grasses should be ripe, the ear and top portion of the stem turn white, causing an injury which has been called 'Silver-top' and 'Dead-heads.' Upon examination, the stem will be found to be severed and consumed just above the top joint by a slender transparent green maggot, one quarter of an inch in length, pointed at one end, and having black horny mouth parts. When full-fed, this maggot works up to the upper portion of the sheath and changes to a slightly flattened clear glassy-green puparium from which the fly emerges about the end of July or during August. The perfect insects are active little greenish-yellow flies, one-fifth of an inch in length with shining green eyes and three dark stripes extending down the back. The hind thighs are much thickened, and, when the fly is at rest, the fore part of the body is raised.

There is some doubt as to the number of broods which ordinarily occur in a year, but close observation in 1889 showed three distinct broods. Perfect flies of the first brood which had wintered over as larvæ in winter wheat and grasses, were found in considerable numbers in the beginning of June. These laid eggs in the root shoots

and in the stems of wheat, barley and rye, as well as in some grasses. The flies from these, the second brood, emerged at the end of July and through August, and laid their eggs upon volunteer fall wheat and barley, the flies coming to maturity in September and then laying their eggs on fall wheat and wild grasses. Larvæ from this brood were also found half-grown in large numbers in the roots of volunteer barley in the middle of September. The empty egg shells from which the larvæ had hatched, were found adhering to the first leaf of infested plants and the central leaf was dead, making it an easy matter to detect the injured plants. Flies taken at the end of September may possibly have been belated specimens of the second brood of larvæ. It is thought by some that there are only two regular broods of this insect in Canada, and this may possibly be the case; but the chief injury by this insect is done to fall wheat fields in autumn and to the root shoots of spring sown grain by the larvæ which come from eggs laid by the flies which emerge from the over-wintering brood.

The Greater Wheat-stem Maggot is an insect which has a wide range of distribution and is abundant at any rate from the Atlantic coast to the Rocky Mountains, and possibly occurs right through to the coast. The natural food plant is most probably wild grasses.

Remedies.—(1) The collection (hand picking) of the conspicuous Silver-tops as soon as they appear in the field. (2.) Treatment of volunteer crops. It has been found that the flies which emerge in summer lay very freely upon any young plants which may spring up in fall wheat and barley fields directly after these crops are reaped. Harrowing fields immediately after harvest would encourage the growth of a volunteer crop upon which eggs would be laid; and this could be ploughed down before September. As the flies begin to emerge late in July, strips of wheat or barley sown near infested fields would act as an alluring bait to attract females to lay their eggs. The succulent young plants would probably be more attractive than wild grasses at that time and would also be in advance of any volunteer crops. These strips should be ploughed under in August to destroy the half-grown larvæ. This probably would prove the most effective means of checking this insect. (3) Late sowing. It has been found that fall wheat sown after the 25th September was much less attacked by this insect than that which was sown at the ordinary time.

The Lesser Wheat-stem Maggot

(*Oscinis carbonaria*, Loew).

Attack.—Small yellowish-white legless maggots, ¼ of an inch in length, found in autumn destroying the bases of the shoots of grasses and fall wheat. Also occurring in spring wheat and grasses in June, attacking the young root shoots, close to the ground. The two small black hook-like jaws are distinctly visible and the last division of the body bears two little knob-like processes. The puparium is found where the larvæ have fed, and is pale chestnut brown. The two knobs at the end of the body are still conspicuous. The fly is shining black and very small, large specimens being only 1-15 of an inch in length. The underside is pale green, the legs are partly yellow and the fly is extremely active.

This is the same insect as has been treated of in my former reports under the name of the American Frit Fly (*Oscinis variabilis*, Loew). Prof. F. M. Webster having kindly examined my specimens collected in 1890, when a serious outbreak occurred in central Canada, informs me that they are undoubtedly *Oscinis carbonaria*, for which he proposes the appropriate name of the Lesser Wheat-stem Maggot. The differences between this and *O. variabilis* (which is now called *O. soror*, Macq.,) are slight.

The life histories of the two Wheat-stem Maggots are similar, and the same remedies are applicable for both.

Remedies.—In a general way, the remedies which are recommended for the Hessian Fly, will answer for both of the Wheat-stem Maggots. Particular attention should be given to volunteer crops, and a regular short rotation of crops should be adopted in districts where these flies appear. As both the Wheat-stem Maggots breed largely in wild grasses, the burning over of grass lands, except timothy, which fortunately is not attacked, and all waste places, will offer much protection. This should be done in winter or early spring. Prof. Webster also draws special attention to the value of late seeding of fall wheat.

The Wheat Midge

(*Diplosis tritici*, Kirby).

Attack.—When wheat is in blossom in the month of June, minute yellow midges with black eyes may be found, particularly towards evening, flying over the fields and laying eggs in the florets of the ears of wheat. These eggs in about a week hatch into small reddish-orange maggots, which sometimes to the number of ten or twelve lie inside the chaff and suck the juices from the swelling kernel. When mature, they leave the ears of wheat and penetrate about an inch beneath the surface of the ground, where they spin tiny cocoons, inside which they remain normally until the following spring, when the perfect midges emerge. Under special circumstances, however, some of the flies appear in late summer and lay their eggs upon volunteer wheat or the young fall wheat.

It is many years since the Wheat Midge, which is generally known by farmers and millers as 'the weevil,' has been the cause of much loss in the wheat crop of the Dominion. Fifteen years ago the losses were enormous; but, just when it seemed at its worst, it suddenly disappeared entirely and since that time has not been the cause of widespread injury. There have been occasional outbreaks, as in the Niagara district in 1898 and last year in the fertile Chilliwack district of the Fraser River valley, B.C., where it was estimated that in some fields fully half the crop was destroyed.

Remedies.—The remedies for the Wheat Midge depend largely upon the way it passes the winter. The methods which have given the best results are as follows:—

(1) Deep ploughing directly the crop is carried, so as to bury the larvæ so deep that the flies cannot work their way out through the soil.

(2) The burning of all chaff, dust or rubbish known as 'screenings' or 'tailings' from beneath the threshing machines, as these contain many of the larvæ which are carried with the crop. If fed to chickens or domestic animals, this should be done in a place where none of the puparia can escape destruction.

(3) Clean farming, including the cutting of all grasses along the edges of fields and the ploughing down of all volunteer crops found in wheat fields before winter sets in, so as to destroy an autumn brood where one exists.

(4) The cultivation of such varieties of wheat as experience has shown are least affected by this insect.

The Western Wheat-stem Sawfly

(*Cephus occidentalis*, Riley & Marlatt), Fig. 6.

Attack.—Slender white grubs found inside stems of wheat which have fallen down just before it ripens. The head is rounded, yellowish; mandibles darkened. Body swollen at the first two joints after the head and tapering slightly to the end of the body, where there is a short blunt tubercle with a dark hard tip. When full-grown these grubs are nearly half an inch in length, and by this time each one will have bored through all or most of the knots in the stems of wheat in which they are, leaving a discoloured tunnel extending from the top joint, down to the root, where, when mature, after partially gnawing through the stem, they spin thin transparent cocoons

in which they pass the winter and change to pupæ the following June. From these emerge, about mid-summer, black shining four-winged sawflies about one-third of an inch in length, banded and spotted with yellow. These flies lay their eggs in the young wheat, just as the ears are appearing from the sheath, and the larvæ hatch very soon, coming to full growth by the end of August, when the attack is usually noticed by farmers from the number of straws which fall down or break off, owing to the larvæ having gnawed away some of the inside substance of the straw so as to cut a ring all round it before spinning their cocoons.

For several years a wheat-stem sawfly has occurred intermittently at various and widely separated localities in Manitoba and the North-west Territories, and has sometimes been the cause of so heavy a loss as one-quarter of the crop, but usually much less than that. It was at first supposed that this insect was the same species as was treated of in 1889 by Professor Comstock (Cornell University, Coll. of Agric. Bull. 11) as the European *Cephus pygmæus*, L. which appeared suddenly at Ithaca, New York, in 1889 and then disappeared entirely and has not since been observed there. Under the name of *C. pygmæus*, I have referred to the Western Wheat-stem Saw-fly in previous publications; but, specimens of our North-western insect have recently through the kindness of Professor A. D. McGillivray been identified as *Cephus occidentalis*. The differences in the markings of the two species are very slight and are also variable. The habits of the two insects are identical. It seemed more probable that the species which gives trouble in our western wheat fields would prove to be a native species which had spread from wild grasses, than that a European species should have been introduced into the West without appearing at intervening points. Larvæ of two different species of *Cephus* have been observed in the stems of wild grasses in Manitoba; and it can hardly be doubted that one of these is the same as has injured wheat from time to time in the same districts.*

Remedies.—As most of the insects pass the winter in the base of the straw, all stubble should be burnt over in autumn or spring, or should be ploughed down deeply before the middle of June, so as to make it impossible for the flies to work their way up to the surface. Stubble fields left for summer-fallowing should be turned down early in June; and, should the insect at any time become more destructive than it has in the past, early summer-fallowing should be practised every other year. Some of the cocoons are spun high enough up in the straw to be cut by the binder; therefore, all straw from an infested field which has not been fed by spring, should be burnt.

The Grain Aphis

(Nectarophora granaria, Kirby; &c.), Fig. 7.

Attack.—Green, yellow, reddish, or dark-coloured plant-lice, sometimes occurring in large numbers upon the heads and leaves of wheat, oats, barley and rye, weakening the plants and preventing the kernels from filling as well as they should. These plant-lice generally disappear suddenly just as the grain is beginning to change colour, being as a rule destroyed by their many parasitic and predaceous enemies before much harm is done to the crop.

It is probable that there are two or three species of plant-lice which attack grain as described above. It is known that some broods of several species feed upon one class of plants during part of their lives and upon grasses of various kinds at other periods of their existence. Some of these, as the Apple Aphis, occasionally may be found upon the small grains and grasses. It is convenient to speak of all these kinds occurring upon grain crops under the name of Grain Aphis.

Remedy.—So far, no treatment has been discovered for controlling plant-lice when on grain crops; but fortunately they seldom affect the output to any considerable

* Since the above was written, Mr. Norman Criddle has reared the species in some numbers from steams of *Agropyrum caninum*, a common wild grass in the West.

extent. The Apple Aphis (*Aphis mali*, Fab.) frequently develops into a serious enemy of young fall wheat; and, as this insect passes the winter as an egg upon the twigs of apple trees, the regular spraying of apple orchards with kerosene emulsion (Remedy 2), would not only clear those trees of a serious enemy, but also to a large measure protect the fall wheat of the following season. A similar alternation of generations takes place in the case of the Hop Aphis, which passes the winter in the egg state on plum trees, from which a winged brood of the plant-lice the following summer migrates back again to their summer quarters on the hop. Spraying the plum trees during the winter reduces largely the occurrence of Hop Aphis later in the year.

Wireworms

(Larvæ of Click Beetles, *Elateridæ*.)

Attack.—Slender, cylindrical, yellowish or reddish-brown, tough and shining grubs with flattened heads and dark jaws. These grubs have only three pairs of legs on the three segments following the head and a single short sucker-like foot in the middle of the last segment, beneath. When full grown they are about an inch long and only about 1-12 of an inch wide. With these will be found many specimens in spring of about just half the size of the larger ones. Wireworms occur most frequently in low ground and attack the roots of almost all plants, but particularly young wheat and corn just as it is coming up. They also bore into the tubers of potatoes in autumn. This injury is most frequent on land which has been for several years in sod, and the attack is most severe in the second season after the sod has been ploughed down.

Wireworms are the grubs of a large family of beetles known as Click-beetles, easily recognized by their power of snapping their necks with a click with such force as to spring up into the air if they fall on their backs. These beetles are many of them dark brown in colour, of an elongated oval form, about three times as long as broad, and tapering to the end of the body. The eggs are laid in summer about the roots of grasses and weeds, and the larvæ of most species take two years to come to full growth. They change to pupæ inside cells in the ground in July, and to perfect beetles about three weeks later in August. Most of these beetles, like the May Beetles, remain in their pupal cells until the following spring before emerging.

Remedies.—Agricultural methods are the only ones that have been of much avail. The wireworms which are injurious to the farmer are particularly those which feed on the roots of grasses. When sod is ploughed down, the larvæ during the first year feed for the most part on the decaying grass and its roots. Those in their second year of growth change to beetles in the first year, and do little harm, as they have had plenty of food in the decaying sod without attacking the crop; but the young larvæ which were only half grown when the sod was broken, attack the crop of the following year, because there is nothing else on the land for them to eat. It has been found that barley and rye are less attacked than any others of the small grains, and also that clover is little injured. Those early maturing grains are, therefore, better suited as a crop for the second season after sod, because the land can be ploughed immediately after they are harvested, and thus the pupæ and the freshly formed and still soft beetles are disturbed in their pupal cells, and many of them destroyed. Clover may be sowed in spring with either of these crops, and either ploughed down with the stubble in September or left on the land until the following autumn, when the land should be ploughed as soon as there is a good growth after the first cutting. A short rotation in which land is not left in grass for more than two years, will to a large measure prevent the ravages of wireworms. Prof. S. A. Forbes recommends ploughing down sod in autumn and sowing to fall wheat or rye, with clover on these in the spring, the clover to be left for two years and then followed by corn or roots. Some farmers have obtained good results in clearing land of wireworms by ploughing twice in the same autumn, the first time in August, the land to be well harrowed a week later, and then cross-ploughed in September.

Extensive experiments made by Prof. Forbes in Illinois and Prof. Slingerland in New York, showed the uselessness of many recommended remedies, such as coating seed grain of all kinds with poison, the surface application of salt and other chemicals, and even of a clean fallow to starve the wireworms out.

White Grubs

(*Lachnosterna fusca*, Fröh.; &c.). Fig. 10.

Attack.—White Grubs are the larvæ of the May Beetles or June Bugs, so-called from their great abundance in May and June, when they may be found in large numbers flying around trees and bushes, showing particular preference for certain kinds, as willows, oaks, ashes, plums, maples and lilacs. The eggs are deposited in the ground, one to three inches below the surface, and hatch in from ten to eighteen days. The larvæ feed on roots during the remainder of the season and burrow very deeply into the ground as winter approaches, returning again the following spring and doing a great deal of harm by eating the roots of grasses and many other kinds of plants, particularly corn and potatoes, their injuries being most noticeable in the season after sod has been ploughed down. It is claimed by Dr. S. A. Forbes that two winter and summer is passed as a larva and that the grubs do not change to pupæ until June and July of the third season, the perfect beetles issuing from the pupæ three weeks afterwards, but passing the third winter in the pupal cells and emerging the following June. Thus three full years are consumed from the time the eggs are laid until the perfect beetles appear.

Remedies.—Unfortunately, there are no measures which can be depended on for the destruction of White Grubs in most crops; but as the eggs are laid in grass lands, land which has been in sod for several years should not be planted to corn or potatoes, the second year after breaking. The first year the grass which is ploughed down to a large measure, feeds any grubs which may be in the ground; and as pigs are particularly fond of these grubs, a crop such as rape or turnips may be sown with advantage and the field turned into a hog pasture, when the pigs will not only feed on the crop, but hunt out many of the grubs in the soil. It is claimed that these animals will, in the course of a few weeks, completely clear a badly infested field. On account of the depth to which the grubs burrow before winter, this crop must be fed off before the first frosts. Clover, it has been particularly noticed, is rarely attacked by White Grubs; therefore, this crop becomes of special value for land on land which it is intended to use for corn or potatoes the following year. as is sometimes the case, White Grubs appear in large numbers in meadows, this is manifested by the dying of the grass in large patches. If, on examination, grubs are noticed, pigs should be at once turned in, and before autumn the land renovated with fresh seed.

Leaving land under grass for several years gives opportunities for White Grubs to increase; hence a short rotation in which clover follows grass or is grown at intervals, will prevent the increase of these insects. In this special rotation the grains should follow clover before corn or potatoes. The collection of the perfect beetles by beating trees at night time has sometimes been practised with advantage. Also a flock of poultry following a plough in infested fields it is claimed has done good work.

When May Beetles attack fruit trees or are found abundantly on other trees, spraying the foliage with arsenical poisons will destroy large numbers, or, as they are much attracted by lights, the beetles may be killed in lantern traps by placing lanterns in large pans of water with coal oil on the surface.

When White Grubs are found destroying lawns some good may be done by spraying the grass freely with kerosene emulsion (Remedy 2) and washing it in with water.

Cutworms in Grain, Fig. 8.

Different kinds of cutworms attack grain crops during the spring and sometimes eat them bare. They seem to be most numerous where weeds have been allowed possession of the land during the previous autumn. The species which has been most frequently detected feeding upon the small grains is the Red-backed Cutworm (*Paragrotis ochrogaster*, Gn.). Two other species, however, when they occur, are much more difficult to reach, because they feed chiefly upon roots and work almost entirely beneath the surface. These are the Glassy Cutworm (*Hadena devastatrix*, Brace), and the Yellow-headed Cutworm (*Hadena arctica*, Bdv.). These are of a dirty whitish colour, very similar in general appearance, but the former has a reddish-brown head, and the body is tinged with bluish green, while the Yellow-headed Cutworm has a smoky-gray body, and the head and neck-shield are tawny-yellow. The crops most attacked by these cutworms are oats, wheat, corn, and grass in meadows.

Remedies.—When grain is found to be attacked by cutworms the fields should at once be examined to discover if possible what species is at work. If the cutworms are of a surface-feeding kind, like the Red-backed Cutworm, they may frequently be controlled with comparative ease by scattering poisoned bran lightly through the grain, near the spots where the caterpillars are most numerous, or ahead of them, when they are so numerous as to have assumed the marching habit. (See page 30.) If land is systematically kept clear of weeds in autumn, there will seldom be trouble from cutworms in the crop of the following year. Prairie or sod land which is to be broken for seeding the next year should be fed off as late as possible or mowed before breaking. In this way the female moths will not be attracted to the tall vegetation on such lands when laying their eggs.

The Corn Worm

(*Heliothis armiger*, Hbn.). Fig. 35.

From time to time complaints are received from various parts of the country of more or less injury to sweet corn in autumn by the caterpillar of a noctuid moth which is known by various popular names. It is what Professor Lugger called the Sweet-Corn Moth, or Tassel Worm, in Minnesota, and is also the same as the notorious southern 'Boll Worm' of the cotton, to which crop it frequently does great damage and for which it has been found very difficult to find a practical remedy. The name of widest use is the Corn Worm, although its injuries in Canada are not confined to Indian corn, for the caterpillars have also been found boring into the fruit of tomatoes and attacking many other plants. There is but one brood in the year in Canada, the caterpillars occuring in autumn and the moths from these emerging the following summer. The worst injury by this insect in Canadian crops is to the cobs of sweet corn, because the work of the caterpillars renders the ears unsightly and discoloured so as to be unfit for the table.

Remedies.—Unfortunately this is a very difficult insect to keep in check. When it attacks corn, as described above, it is seldom noticed until a considerable amount of harm has been done. Where the caterpillars are troublesome regularly every year, growers, it is claimed, get into the way of recognizing at a glance, ears which are infested, by the discoloration of the silk earlier than is natural in perfect ears. As soon as an infested ear is discovered, the leaves of the husk are pulled back and the caterpillars destroyed by hand. Where, as in Canada, it is only at long intervals that harm is done in any one place, corn growers are taken by surprise, and the injury is done before it is noticed. It is claimed that many of the moths may be taken in lantern traps consisting of a lamp standing in an open pan containing water with a little coal oil on top of it. Any one, therefore, who knew the appearance of the insect, upon recognizing the moths in years of great abundance flying around lights

at night, might place lantern traps as described above in his crop, and thus prevent future loss; but this insect, like many others which appear in an intermittent manner, will always be a source of trouble. On fields where a crop of corn is known to have been attacked by the Corn Worm, the old stems should be removed from the field as soon as the crop is gathered, and the land ploughed deeply in autumn so as to break up the cocoons and expose the pupæ to the weather and their various enemies among the small birds and mammals.

Grasshoppers or Locusts.

Figs. 11, 12, 13, 14.

Attack.—Grasshoppers, or locusts, sometimes multiply enormously, especially during a dry season following another of the same character. They then become very destructive to grain and other crops. Most of the injurious species pass the winter in the egg state. The females deposit their eggs in the ground in 'pods,' or masses, of about thirty or more cemented together by a mucous fluid. The young grasshoppers are wingless and can only travel by hopping, but after several moults they acquire wings and are able to move freely from place to place, some species, especially the voracious so-called Rocky Mountain Locust (*Melanoplus spretus*, Fitch), being able to fly long distances. The species is found only in the West. It is about one and a quarter inches long, from the head to the tips of the closed wings. Another migratory and destructive species, rather smaller in size, is the Lesser Migratory Locust (*M. atlanis*, Riley). This latter is much more generally distributed throughout the continent.

Several non-migratory locusts have in some years appeared in destructive numbers, as the Red-legged Locust (*M. femur-rubrum*, DeG.) and the Two-Striped Locust (*M. bivittatus*, Say), in all parts of Canada. In the West, Packard's Locust (*M. packardii*, Scudd), and the Pellucid Locust (*Camnula pellucida*, Scudd), frequently add their injuries to those of other species.

Extensive losses from locusts have taken place in various parts of Canada in certain seasons; but by far the most important ravages have been wrought in Manitoba and British Columbia. Various species take part in this devastation, but the most destructive species in British Columbia has proved to be *Camnula pellucida*, Scudd., although much harm was done in the Nicola valley by a species closely resembling the Rocky Mountain Locust, but a rather smaller species called *Melanoplus affinis*, Coq., which has the same habits. In Manitoba the Rocky Mountain Locust and the Lesser Migratory Locust have done by far the largest proportion of injury to crops.

The eggs of the Rocky Mountain Locust are laid by preference in light soil with a firm surface, such as is presented in a field under a grain crop. So much is this the case that, when such conditions are available, hardly any eggs will be laid elsewhere. In Manitoba the young grasshoppers hatch in May, become full grown and have wings about the 1st July, when they begin migrating in swarms to fresh feeding and breeding grounds. Egg laying takes place mostly in August, and the numbers drop off rapidly from the beginning of September, although a few may be found lingering on until frost comes.

Remedies.—For the migratory species the remedies are: (1.) The ploughing down of the eggs in autumn or before the young hatch in spring. This is rendered easy by the fact mentioned above that the eggs are laid almost entirely in land which is or has recently been under crop and hardly ever on the bare prairie. (2.) The destruction of the young before the wings are developed, by ploughing down, poisoning, or by burning in windrows of straw placed as traps for them, and to which they will resort in large numbers at night. (3) Catching in implements known as hopper dozers, consisting of a light frame covered with canvas or sheet iron, in the bottom of which some water with a little coal oil on the top is placed. (4.) Poisoning. This

has been very satisfactory either with the poisoned bran mash or with the recently devised Criddle mixture. In Manitoba, where for some years grasshoppers were very destructive, after a thorough trial of hopperdozers, these implements have been entirely superceeded by the use of the Criddle mixture, which was widely used and gave general satisfaction. The latest improved formula for making the Criddle mixture is as follows:—For convenience it is made in quantities of half a barrel at a time. Take fresh horse droppings 100 parts, Paris green 1 part (= 1 pound) and salt 2 pounds, dissolved in half a pail of water, and mix thoroughly. In this connection Mr. Criddle, the originator of this mixture, says: 'We usually measure with a three-gallon patent pail, because it is more convenient to farmers than to weigh the materials. Five pails, we calculate, approximately equal 100 parts of horse droppings, and each part equals in bulk one pound of Paris green. A great drawback in using weights is that horse droppings are not always of the same weight.' This mixture is made in a half barrel and drawn on a cart to the edge of an infested field, or one likely to be infested. The mixture is then scattered broadcast along the edge of the crop by means of a trowel or wooden paddle. Locusts are attracted to it from long distances and are killed in large numbers by eating the poison. If this mixture is distributed as above, and scattered loosely through the plants at the edge of a field of standing grain, there is little danger of stock or poultry being poisoned. Should any of the mixture be left over, it should be scattered loosely over a piece of land where its fertilizing effects will be secured and where there will be no danger of poisoning animals. This is in every way the cheapest and most effective remedy for grasshoppers which I have ever tried. It has been found by Mr. Criddle that the most effective way of using this remedy is to spread a little at a time every other day, which gives far better results than scattering a lot at once, less frequently.

Fungous Disease.—Much has been written about the parasitic fungous disease which has been experimented with in different parts of the world, with a view of destroying locusts in a wholesale manner. The idea of treating outbreaks of injurious insects by means of introducing parasitic insects or fungi, is an exceedingly attractive one, and, to those who have never studied these matters, is apparently a very easy solution of a difficult problem. It seems well, however, to mention that my own experiments in this direction have been of little avail; and I regret to say that, on the whole, this fungus has not proved of much service anywhere as a reliable remedy in outbreaks of injurious locusts. For a short period, and in restricted localities with all weather conditions favourable, good results have occasionally been obtained; but the difficulty of preserving the spores alive and using them when required, has been so great that all entomologists who have experimented with the fungus, have after a short time relinquished the effort in favour of other methods not so dependent for their most effective use on climatic conditions.

Locusts Eating Binder Twine.—A source of great annoyance to farmers in Manitoba and the West, is that locusts of all kinds and field crickets sometimes eat the twine with which grain is bound in the field. This injury causes a good deal of loss and extra labour. Mr. Criddle has found that, if the balls of binder twine are soaked before use for a short time in a solution of bluestone, two pounds in seven gallons of water, this will prevent the insects from gnawing it. The balls may be soaked at any spare time, so that they are dried thoroughly before use.

The Pea Moth

(*Semasia nigricana*, Steph.), Fig. 15.

Attack.—Small, whitish, slightly hairy caterpillars, when full-grown, about half an inch in length, which live inside the green pods, attacking the peas by gnawing ragged-edge cavities into them and filling the pod around the cavities with a mass of excrement.

The Pea Moth, shown at fig. 15 (3, 4) in the perfect form, is a small slaty gray moth, three-eighths of an inch in length. The moths, however, are seldom seen, the insect being generally observed by pea growers when in the caterpillar state, in which condition it is usually called 'the worm.' It frequently does a large amount of injury to the pea crop of Canada, chiefly, however, in districts lying east of the area infested by the Pea Weevil and increasing in severity as the Atlantic sea-board is reached.

'Wormy pease' are well known to the housekeeper in all parts of Canada east of the great lakes, but it is seldom that they are sufficiently abundant in gardens to cause much complaint, except in the maritime provinces, where the insect is much more destructive than elsewhere. It is thought that the Pea Moth is identical with the European species and that it has been introduced into America at a comparatively recent date. Possibly this may not be the case. Its injuries are most severe on late pease, and it is occasionally the cause of extensive loss in crops of high class pease grown for seed. It is probable that the eggs are laid early in July and are deposited on the outside of the pods throughout the month, as very small larvæ are found in the pods almost up to the time the seeds are ripe. Larvæ begin to emerge from the pods at the end of July and enter the ground, when they spin small oval cocoons near the surface. Here they pass the winter, and the moths do not emerge until late in June the following season. Exact data as to the life-history of this insect, with the dates covering the different stages, are still lacking.

Remedies.—It has been noticed that the earliest maturing and the latest varieties of pease are freest from attack, which would point to the importance of:—

(1.) The planting of pease as early as possible and, where the Pea Moth is destructive every year, sowing the earliest ripening varieties, many of which can be grown ready for the table by the first week in July. These will be quite free from the attacks of the caterpillars.

(2.) As the cocoons are spun in the ground beneath the plants they have infested it is advisable to use every year fresh land, as far as possible removed from fields which have been used before for the cultivation of seed pease. In gardens where the land is regularly dug every year, this should be well done, so as to bury the cocoons so deeply that the moths cannot emerge, and all pea vines should be burnt with the small unperfect pods, directly the main crop has been picked.

(3.) From some experiments it has been indicated that benefit may be derived by spraying the pea vines directly the young pods are formed and twice afterwards at intervals of ten days, with a liquid wash of Paris green, 4 ounces, and soap one pound in 25 gallons of water.

The Pea Weevil or 'Pea Bug'

(*Bruchus pisorum*, Linn.), Fig. 16.

Attack.—A small, brownish-gray, very active beetle, one-fifth of an inch long, with two conspicuous black spots on the end of the body, which emerges from seed pease in autumn or in spring, leaving a small round hole.

The life history and habits of the Pea Weevil are well known. The egg is laid on the outside of the young pod, and the grub, on hatching, eats its way in and penetrates the nearest pea. Here it remains until full-grown, consuming the interior of the pea and passing through all its stages, from a white fleshy grub to the pupa, and then to the perfect beetle. As a rule, the beetles do not, under ordinary circumstances, leave the pease until these are sown the following spring. Some of the beetles, however, in certain seasons, escape from the pease, occasionally as early as harvest time, or during autumn, and pass the winter hidden away under rubbish, or about barns and other buildings. On reviving in spring they fly to the fields of growing pease, sometimes long distances away and for a time feed on the foliage of the pea plants. As soon as the young pods are formed, the females lay their eggs on them. The beetles all become fully developed at the same time, which is about the middle of August, and all, whether they winter outside the pease or inside the grain, die about the same time the following season, viz.: during the month of June.

Loss by sowing Weevilled Pease.—That seed pease which have been bored by weevils are very seriously injured, I have proved by actual experiments. Weevilled small pease gave only from 13 to 20 per cent of plants which bore pods, and these were all weaker than plants from perfect seed. Large pease gave a better percentage of from 16 to 28 per cent. Therefore, weevilled pease should not be used for seed if any other stock is obtainable. If, however, this is impossible, much more seed should be sown to the acre.

REMEDIES.

Fumigation.—Fumigation with bisulphide of carbon is a sure remedy. For the treatment of small quantities of seed, particularly by farmers, an ordinary coal oil barrel is very convenient. This will hold about 5 bushels, or 300 pounds of seed, and may be treated with 3 ounces of bisulphide of carbon, which may be poured right on to the pease. Care must be taken to close up the top tightly. This is best done with a cap made specially for the purpose, but may also be done with fine sacks dampened and laid smoothly on the top, over which boards are laid, with a considerable weight on them to hold the covering down closely. The bisulphide of carbon should be of the best quality, which will vaporize without any residue, and the exposure should be for 48 hours. Pease should be fumigated as soon as possible after harvest, but they may be treated at any time when the temperature is above freezing. As the vapour of bisulphide of carbon is very inflammable, this work should be done at a distance from other buildings and no light of any kind must be brought near. No smoking must be allowed near the buildings where the bisulphide of carbon is being used. Where large quantities of pease are to be treated at once, in specially prepared houses, one pound of bisulphide of carbon to every 100 bushels of seed, is the amount regularly used by large seed houses, as in these tightly constructed 'bug houses' there is less waste of the vapour during the necessary exposure of 48 hours.

Holding over seed.—Where only a few seed pease are used, a most reliable remedy is the holding over of seed until the second year. Pease should always be bagged up and the sacks tied at once after threshing. The weevils are not able to eat their way through the bags, even when these are made of paper. All the weevils which emerge, either in autumn or the following summer, will perish inside the bags, and the seed can be sown the following year without danger; the sound seed will not be injured by being held over. Seeds showing the hole from which weevils have emerged should be sorted out before sowing.

Treating with coal oil.—A remedy which has been used by many farmers with satisfaction, is to drench the seed about two weeks before sowing with coal oil, using about half a gallon to a barrel, or five bushels of seed. Immediately after putting on the oil, the pease should be shovelled over and over, so that all will be oiled, and the shovelling must be repeated every day for four or five days. This, if properly done, will kill all the weevils in the pease without injuring the seed.

Scalding seed.—Of the same nature, when pease are found at the time of sowing to contain weevils, is scalding the seed. This may be done by pouring them into scalding water and then either pouring the water straight off them again, or cooling off immediately with cold water.

RECOMMENDATIONS.

The control of the pea weevil, I believe, is possible but this must be done, I think, not by legislation or by giving up the cultivation of such an important crop as peas, which we cannot well do without, but by persuading everyone who sows pease to abstain from sowing any seed which contains living weevils; when purchasing seed, to refuse

determinedly to buy any without an assurance that they have been treated, and further, even with this, to examine for themselves to see that any contained weevils are really dead. I would also point out that, from the experiment already cited of growing peas from weevilled seed, such seed is only worth about one quarter as much as sound seed. To secure a supply of seed pease free from weevil injury, it will be necessary for growers and farmers to handle their crop a little differently than has been the usual practice. The injury is of an exceptional nature, and exceptional measures must be taken to avoid loss.

There are, however, special features about this attack which renders its control a simpler matter than is usually the case with injuries of an equal magnitude. The Pea Weevil is not a native insect and has no native food plant, in which it could propagate, were there no cultivated peas. Indeed, it is so restricted in its food habits that no other food plant is known than the different cultivated varieties of true peas, belonging to the botanical genus *Pisum*. These peas will not live over the winter in our climate if left in the open field, at any rate, in any part of the country where the Pea Weevil is known to breed, consequently, every seed pea sown for crop must, at some time before it was sown, have been under the control of some one by whom it could have been treated before sowing, to destroy the contained weevil, if it had one. The remedy is effective, easy and cheap, is well known and can be applied by anyone. If all growers would combine and do this, the larger number of the weevils would be destroyed in a single year. This, however, would not be sufficient, because a certain number of the insects sometimes leave the pease during the autumn when the seed ripens, and this sometimes before the pease are carried from the fields. This fact is the one great difficulty in arriving at a perfect remedy, but I do not believe that it is insurmountable.

1. I suggest that all pease for seed should be treated before they are sown to kill the weevil and that seeding should be done as early as possible, so as to get the crop ripe enough to harvest earlier than is the usual custom.

2. That pea growers should harvest their pease as much on the green side as is safe, rather than, as is usually done now, when they are dead ripe, and thresh and treat them themselves or sell at once to grain buyers. This has many advantages. Not only is the straw of very much higher quality for feed, but the seed is heavier and better for every purpose, for export, for feed and also for seed, because it is of higher germinating power, and further, because the weevil at that time is much less advanced in growth and consequently has destroyed a much smaller proportion of the bulk of the seed. The average dates for pea harvesting are from July 20 to August 20.

Experiment has shown that the weevil at all stages may be killed inside the pea by fumigating the seed with bisulphide of carbon, consequently, if growers will harvest and thresh earlier than usual for a few years and either themselves treat their seed immediately or sell to the grain buyers, who for their own sakes will do so, much good must surely result. When for any reason pease cannot be treated at once or disposed of, they should be bagged up and the sacks tied immediately so as to prevent the escape of any weevils which might emerge in the autumn. When the grain is required for feeding the pease should be ground as soon as they are dry enough, and to prevent the meal from becoming musty the new pease should be mixed with some old pease when grinding.

Difficulties to be met.—Sometimes pease ripen so unevenly that by reaping early it is feared that the sample will be very uneven when threshed; but, should this be the case, it simply means that the small and shrivelled pease are blown out of the seed pease when they are cleaned and are not lost but can be used for feed. The greatest difficulty of all is with regard to the pease which are shelled out in the field at the time of harvesting. This, however, will be to a large measure obviated by reaping early, as the seed will not shell out nearly so much as when left till the regular time. The cleaning up of pea fields moreover by turning in hogs is a generally recognized practice, and the work is done thoroughly. Where hogs are not available, poultry will do the

same work, and, where neither of these can be used, the land should be ploughed so deeply that the weevils cannot work their way out when they leave the pease. I am aware that it is not the custom to plough up pea fields for fall wheat, but simply to cultivate or dise them, because the land is left in such excellent condition; but it must be remembered that the loss from the Pea Weevil is now excessive, and, if this small change in method can be shown to be of great advantage, it surely is worth a trial.

Another difficulty suggested is that it would be hard to get all pease threshed before the autumn emerging weevils escaped, on account of the small number of threshing machines which would be available. In reply to this, experience has shown that demand will always produce supply; and I feel sure that the implement makers will not lose such an opportunity of pushing their business. The much higher price obtainable for the early threshed pease, to say nothing of the enormous value of future crops due to controlling the weevil, will very soon repay to the farmer the initial expense. Where, however, there is no possibility of getting a threshing machine, I would draw the attention of growers to the old-fashioned method of treading out the pease with horses. That this is advantageous is indicated by the fact that some of the seed merchants pay a higher price for pease threshed with horses.

The Bean Weevil

(*Bruchus obtectus*, Say), Fig. 17.

Attack.—Small beetles closely resembling in shape and movement the Pea Weevil, but only half its size, namely, 1-10 of an inch long, oval in form, with the head bent down and more or less concealed as seen from above, and prolonged into a short squarely cut snout. Antennæ distinctly jointed and enlarging towards the tip; the first 4 and the last joints reddish. The wing covers marked with ten impressed and dotted longitudinal lines. The whole body covered with short silky hairs. The lines on the wing covers are broken up into pale yellowish dashes and dark brown spots. The tip of the abdomen extends beyond the wing covers and is of the same reddish tinge as the tips of the antennæ and the legs, but is covered more or less with short silky hairs and bears a central white line, but there is no appearance of the two black spots which are so conspicuous in the Pea Weevil.

The life history of the Bean Weevil differs in some important points from that of the Pea Weevil. The eggs of both are laid upon the pods while these are young and tender. On hatching, the young grub of the Bean Weevil eats its way inside and penetrates one of the forming beans, several grubs entering a single bean, each one forming for itself a distinct cell. They become full-grown and change to pupæ in the autumn and a little later to the perfect beetles. The date of emergence from the seed depends very much, as in the case of the Pea Weevil, on the temperature in the autumn months; it may be in the late autumn or not until the spring; when the seed beans are stored in a warm building, the beetles may emerge at any time through the winter. One of the important differences between the life histories of the Pea and Bean Weevils is that whereas in the case of the former the young grubs can only enter the soft green seeds, those of the Bean Weevil can propagate for three or four generations in the dry stored seeds. This fact renders the well known domestic remedy for the Pea Weevil of holding over the seed for two years quite ineffective in the case of the Bean Weevil; that is, if a bag of pease infested with Pea Weevil were put away for two years, the Pea Weevils would emerge the first spring and die in the bags. But, in the case of a bag of beans infested by the Bean Weevil kept in the same way, the beetles on emerging would at once set to work to lay eggs upon the beans. The young grubs when hatched would penetrate the dry seeds and go through all their stages, and this breeding might be repeated as long as the supply of beans lasted. Curiously enough, the Pea Weevil does not bore holes through the paper or cotton bags in which infested seed has been stored, but in the case of the Bean Weevil such bags are readily perforated and the beetles escape,—frequently, when this happens in houses, as is sometimes the case, to the great consternation of the inhabitants.

The Bean Weevil seems to be a cosmopolitan species, the original home of which was in Asia. It was probably introduced into America through commerce and has been the cause of considerable damage in various States of the American Union. It has been mentioned in the reports of several United States entomologists, full articles being given by Professors Riley, Popenoe and Lintner. There has been a great deal of discussion as to the proper name of the species. The last decision seems to be that the beetle should be called *Bruchus obiectus* of Say. The Bean Weevil has never been very injurious in Canada.

The European Bean Weevil (*Bruchus rufimanus*, Sch.) is shown at Fig. 18. This is occasionally imported in seed, but has never established itself as a pest.

Remedies.—As in the case of the Pea Weevil, the best remedy for this insect is the destruction of the weevils inside the beans as soon as possible after the crop is ripe. Fumigation with bisulphide of carbon is the best treatment in every way.

The Bean Aphis

(*Aphis rumicis*, L.).

Attack.—Black plant-lice thickly clustered on the tips of horse beans and broad beans, and also occasionally on other smooth beans, at the time of flowering.

One of the great difficulties of growing horse beans in Canada has been the occurrence of this European species of plant-louse, which is such a serious pest of horse beans in Europe. As this crop is little grown in Canada, small attention has been drawn to it.

Remedy.—The usual practice in Europe is to cut off the tips of attacked plants, upon which the plant-lice are nearly always clustered, leaving the rest of the plant at the time of flowering free. This practice is also beneficial because it overcomes one of the chief difficulties in growing this crop, which is the failure of the pods to develop. This checking of the growth by cutting off the tips causes the flowers to set pods better than if the tips are left on.

The Destructive Pea Aphis

(*Nectarophora destructor*, Johns.). Fig. 19.

Attack.—Pale green plant-lice with legs darkened, particularly at the joints, honey tubes very long; clustered in enormous numbers at the tips of the shoots, beneath the leaves and sometimes over the whole plants of field peas, as well as upon the flowering sweet peas and clover. These insects appear suddenly in large numbers and very soon kill the plants by sucking their sap. The winged specimens are rather large for aphids, being about one-eighth of an inch in length, with a wing expanse of nearly one quarter of an inch.

The Destructive Pea Aphis in the summers of 1889 and 1900 wrought enormous injury in North America, practically destroying the whole crop of late peas from the Southern States and over the greater part of Canada, east of the prairies. This insect is now thought to be the same as the Green Dolphin (*Nectarophora pisi*, Kalt.), and is both a clover insect as well as one which occasionally develops, as in the two years named, as a destructive enemy of peas. Fortunately, this is the only recorded instance when such extensive injury has occurred. Prof. E. Dwight Sanderson states that this has been known as one of the worst pests of peas, vetches and clovers in Europe for a hundred years. The aphids leave clover on which they have passed the winter, in spring, and feed upon peas during the summer, returning to clover again in October and November.

Remedies.—This plant-louse is an extremely active species, springing from the pea plants on the slightest touch. This habit was taken advantage of by Prof. W. G

Johnson, who found that good work could be done by what he called the brush and cultivator method. The peas were planted in rows 24 to 30 inches apart and the vines were brushed backward and forward by boys with pine switches, who went in front of an Iron Age cultivator drawn by a single horse. In this way the plant-lice which left the vines quickly when shaken, were covered as soon as they fell to the ground and destroyed. This remedy was applied over large areas. One operator after trying all methods found that this was the most effective. Forty men were engaged and 600 acres of peas were brushed and cultivated every third day for two weeks, and the entire field was saved, netting the owner from 25,000 to 30,000 cases of peas of 200 dozen tins each. Another method was tried with considerable success by following the brushes with a pan containing coal oil and water. In this way a bushel of plant-lice were caught in each row of peas 125 rods long.

On sweet peas in gardens spraying the vines which showed the presence of the plant-lice by their stunted appearance, with the ordinary kerosene emulsion or with a whale oil soap wash (Remedy 5) proved quite effective.

The Clover-seed Midge

(*Cecidomyia leguminicola*, Lintner).

Attack.—Small legless, pink maggots, which eat out the contents of the clover pods and thus destroy the seeds.

The Clover-seed Midge has been the cause of serious loss to seed growers in all parts of Ontario where clover seed is produced. The life history of the insect is well known. There are two broods in the season, corresponding with the two crops of clover seed. The eggs are laid in the forming flower heads of the clover; when these hatch, the maggots penetrate the seed pods and destroy the seed. When the larvæ are full grown, about the end of June, they leave the clover heads and enter a short distance into the ground to change to pupæ. The perfect insects, forming the second brood, emerge from the ground just as the second crop of clover is coming into flower, and the females at once begin to lay their eggs amongst the forming blossoms. These eggs soon hatch, and about the time the seed is ripe the maggots leave the clover and enter the ground to pass the winter, whence they emerge again the next spring just at the time the clover comes into flower.

Remedy.—The practice of feeding off or mowing the first crop of clover before June 20, has been found the most satisfactory remedy by all who have tried it. The object of this is to destroy the immature maggots, which naturally reach full growth about the end of June and from which the second brood, which attacks the seed of the second crop, is produced.

The Clover Leaf Weevil

(*Phytonomus punctatus*, Fab.).

Attack.—Greenish white, slug-like grubs tapering to the end of the body, eating the leaves of clover at night, becoming full grown in June and spinning oval open lace-work cocoons of a yellowish green colour, about the bases of the stems and on the ground beneath the plants. The beetles appear in July and August and are heavy-bodied oval beetles one-third of an inch long, with short thick snouts. The colour is brown with narrow dotted gray lines on the wing covers and a broad pale stripe on each side. The beetles attack the second crop of clover in August and do as much harm as the larvæ in June. The eggs are laid in autumn and the larvæ become partially grown and winter over among the roots of the clover, and in the old clover stems. When growth begins in spring, they crawl up the stems and attack the leaves.

The Clover Leaf Weevil, also known as the Large Clover Weevil and the Punctured Clover Weevil, has not so far proved a serious enemy to clover crops in Canada.

although the beetles have been taken in several places by collectors. The species is commonest in the counties north of Lake Ontario; but the beetles were extremely abundant in Victoria, British Columbia, at the end of July, 1902.

Remedy.—The only remedy for this insect is the ploughing down of badly infested fields in May. Fortunately this is seldom a severe loss to a farmer on account of the great fertilizing value of ploughed down clover. As a matter of fact, this step is seldom necessary because when the grubs are found in large numbers they are almost invariably destroyed by a parasitic fungus, *Entomophthora sphærosperma*, Fres. Attacked larvæ crawl to the tops of grass stems, and, curling their bodies round the stems turn to a pallid white colour and die. A few days later the body decays and the spores are given off causing a very infectious disease among other larvæ.

The Green Clover Weevil

(*Phytonomus nigrirostris*, Fab.).

Attack.—Larvæ similar to those of the previous species, but much smaller and feeding for the most part in the stipules of the upper leaves and in the young forming heads. Much more abundant and more destructive to clover in Canada than the Clover Leaf Weevil.

Although the larvæ frequently appear at the same time and together with those of the larger species, they remain in the clover longer, almost up to the end of June. The perfect beetles appear in July and in autumn and pass the winter as such hidden away beneath dead vegetation and in moss. They are somewhat of the same shape as the Clover Leaf Weevil, but only one-third of the size, of a bright green colour with a proportionately longer beak, which is black. The white cocoons are often spun inside the bracts of the clover heads. The summer brood appears in July and is of a brown colour washed with green, but much less green than the autumn brood.

Remedy.—When clover shows the presence of the weevil, it should be fed off or cut early, when the pupæ and larvæ will be destroyed. Clover lands treated for the Clover-seed Midge will also be freed of this pest at the same time.

The Clover Seed Caterpillar

(*Grapholitha interstinctana*, Clem.).

Another insect which sometimes occurs with the above named clover weevils, and which is controlled by the same remedy, but which has never done very much harm in Canada, is the Clover-seed Caterpillar. The greenish-white larvæ a quarter of an inch long, live in the heads of the clover, destroying the seed by gnawing into the small pods at the base. The delicate cocoons are spun in the clover heads. There are two broods, the moths occurring in June, in July and in August. The moth is a little silvery gray creature with seven or eight fine white dashes along the front margin of the wings and two curved larger stripes on the inner margins, which meet when the wings are closed, forming two crescent-shaped bars, one inside the other, with the tips pointing to the outer margin of the wings. These may be easily recognized by their habit of running in circles when they settle on the leaves. The eggs are laid on peas as well as on clover.

The Clover Root-borer

(*Hylesinus trifolii*, Muller = *Hylastinus obscurus*, Marsh), Fig. 20.

Attack.—Small brown beetles, ⅛ inch long, shown magnified in the figure, which bore into the roots of clover and deposit eggs there; these eventually turn to white grubs which destroy the root of the clover plant.

The life history of the Clover Root-borer is as follows: Early in spring the mature beetles emerge from the ground, where they have passed the winter in the roots of the clover plants, which they had destroyed the previous season. After pairing, the female bores a cavity in the crown of the root, and deposits there about half a dozen small white eggs. These hatch in about a week and eat their way down into the root, hollowing it out, as shown in the figure. The burrows are filled up with the excrement of the small white grubs (fig. *b*), which when full grown are only about 1-10th of an inch in length. These change to chrysalids, and in September the perfect beetles may be found in the roots.

Remedy.—No better remedy has been suggested than the ploughing down of clover when it is found to be infested. As a rule, this is not detected until the second crop is noticed to fail suddenly. In infested districts the fields should be examined frequently, and, if any indications of the weevil are found, the clover should be ploughed under as soon after the first cutting as there is a good growth on the ground.

The Army Worm

[*Heliophila* (*Leucania*) *unipuncta*, Haw.], Figs. 21, 22.

Attack.—Brown, or sometimes blackish, striped caterpillars eating the leaves and stripping the stems of grasses and many other low plants at night. When full-grown, over an inch and a half in length, and, when occurring in large numbers, migrating in bodies from one food patch to another. On reaching full growth the caterpillars burrow into the ground and turn to light brown chrysalids, from which in about two or three weeks the moths emerge. These are of a warm, satiny brown colour, sprinkled with minute black specks, and with a small but distinct white spot a little beyond the middle of each upper wing. When the wings are closed, the moth measures about an inch in length. They are nocturnal and extremely active.

There are in Canada two broods of the Army-worm in the year, the caterpillars of the second brood appearing towards the end of July. This brood is the one which in some years attracts attention by its depredations. The Army-worm is a native insect occurring every year among grasses in low ground. It is only in years of exceptional abundance that the caterpillars spread from these places and attack crops. The insect occurs right across the continent, and injuries have been recorded from various places; but, owing to the large numbers of para-ites which always accompany an excessive increase in the caterpillars, the Army-worm is very seldom abundant in the same place for two successive years.

Remedies.—Army-worms may be prevented from marching from one field to another by ploughing a deep furrow across their path. This should be cleared out so as to leave the edge nearest to the field to be protected perpendicular. Along the trench so formed pits may be dug 12 feet apart. When the caterpillars come to the trench, they fall in and, being unable to climb up the opposite side, march along the furrow and fall into the pits, where they may be destroyed by covering them with earth and tramping it down, or with a liberal dose of coal oil and water. In case any of the Army-worms cross the trench, a strip of the plants on the opposite side should be dusted or sprayed with a strong Paris green mixture, one part in 25 of flour, ashes or land plaster, applied after the plants have been sprayed with water, or when covered with dew; or these plants may be sprayed with Paris green and water, one ounce of poison to every five gallons of water.

The Cottony Grass Scale

(*Eriopeltis festucæ*, Fonsc.), Fig. 23.

Attack.—Compact oval tufts like pieces of cotton wool (as shown life-size in the figure) attached to the stems and blades of grasses and conspicuous during autumn

and winter. These are egg sacks of a species of scale insect. They are frequently so abundant in the Maritime Provinces as to cause alarm to farmers, and there is no doubt from their numbers that, while the scale insects are active, they must cause much reduction of hay and pasture crops, by sucking the sap from the stems.

Up to the present this insect has only been observed in injurious numbers in Nova Scotia and Prince Edward Island.

The Cottony Grass Scale passes the winter in the egg condition inside the closely-felted cottony sacks. The young hatch in spring and feed on the leaves and stems of grasses, becoming full grown in July. Towards the end of the month the females lay their eggs in conspicuous cocoon-like sacks and then die, their shrivelled bodies showing at one end of the egg-sacks.

Remedy.—As the insect passes the winter in the egg state upon the old grass, the burning over the meadows and pastures late in autumn or before the growth begins in spring, gives an easy method of destroying this scale, should it at any time multiply so as to become injurious.

II. INSECTS INJURIOUS TO ROOT CROPS AND VEGETABLES.

Cutworms, Figs. 24, 25.

Attack.—In spring, as soon as seedlings appear above the ground or annual plants are set out, many are eaten off at the surface of the ground by dull-coloured caterpillars from half an inch to an inch and a half in length, which come out at night and devour almost all kinds of young vegetation, cutting it off as described above and often dragging part beneath the surface, where they lie hid during the day.

Cutworms are the caterpillars of active dull-coloured moths belonging to the Noctuidæ, or Owlet moths, of which there are upwards of four hundred different kinds in North America.

These moths are much alike in shape and in the arrangement of the more noticeable markings, and are for the most part dull-brownish or grayish moths about 1½ inches across the spread wings, which hide by day like the larvæ, and fly only by night. The moths begin to appear about the middle of June and fly till the end of the season. Most of the kinds are single-brooded, the caterpillars passing the winter half grown, and doing most damage to vegetation in spring.

The caterpillars of the different kinds are on the whole very similar in appearance and habits, being smooth, greasy-looking caterpillars of some dull shade of colour similar to the ground in which they hide during the day. Their habits are almost always nocturnal; but, when they occur in large numbers, they feed by day as well as by night, owing to the reduced food supply consequent upon their ravages.

The eggs from which cutworms hatch are laid by some species in the autumn and by others in the spring or summer. As a consequence, cutworms of all sizes can be found in spring; for these insects, according to the species, may pass the winter as a perfect moth, a chrysalis, a partially grown caterpillar, or an egg. The ravages of the young caterpillars, which hatch in the summer and autumn, are seldom noticed then, on account of the abundant vegetation at those seasons. In spring, however, not only are the caterpillers much larger and capable of more mischief, but the land is then clear of all weeds and vegetation other than the crop, and when the cutworms come from their winter retreats, there is nothing for them to eat but the farmer's early crops. Cutworms are particularly troublesome in gardens, cutting off young cabbages, tomatoes, beans and annual bedding plants. When the caterpillars are full-fed, they burrow into the ground to a depth of a few inches and turn to brown chrysalids inside a smooth cell or a light cocoon.

Injuries by cutworms in most seasons may be expected to stop by the end of June; but different species vary in the time they stop feeding, and the knowledge as to the exact species which is destroying a crop is frequently of great service to a farmer, so

that he may know when the caterpillars are full-grown and what their habits are, so that he may know for certain when it will be safe for him to resow his land, which has been ravaged by these insects. Some of the early maturing species, as the Black Army-worm (*Noctua fennica*, Tausch.), which frequently strips clover and pea fields early in the spring, stops feeding early enough for it to be safe for the farmer in many instances to apply no remedy whatever. The caterpillars, when full fed, burrow into the ground, and the crop springs up again, frequently catching up and showing no diminution in yield. Thus, a farmer who knows the habits of this insect is saved from going to the expense and trouble of applying a remedy. Other species, however, mature so late in the season that it would be unsafe and unprofitable to resow the land without special treatment to destroy the cu[illegible]s.

Cutworms are, on the whol[illegible] about the most troublesome insect enemies the market gardener has to deal with; and every year they are the cause of much destruction both in gardens and on farms. Among the more troublesome kinds which farmers should endeavour to know by sight and remember the life-histories of are: the Black Army-worm (*Noctua fennica*, Tausch.), mentioned above; the Red-backed Cutworm (*Paragrotis ochrogaster*, Gn.), which is probably the widest-spread and most regularly occurring injurious species we have. It has also a wide range of food plants, attacking almost all succulent forms of vegetation, but showing a curious preference for certain kinds in different localities. In Manitoba occasionally wheat fields are stripped and oats growing alongside are left untouched. In other localities the exact opposite to this is the case, and again in others lamb's-quarters and other weeds will be cleared from the ground and the grain left untouched. The Dark-sided Cutworm (*Paragrotis messoria*, Harr.) is a very common species, particularly troublesome to onions and young vegetables in gardens; but, like the Red-backed Cutworm it attacks almost every herbaceous plant. The Spotted Cutworm (*Noctua c-nigrum*, L.) sometimes does harm to fields of turnips, tomatoes, and rarely to oats and peas, as late as the end of July. Another very late cutworm is the Clover Cutworm (*Mamestra trifolii*, Esp.), which has on one or two occasions occurred in excessive numbers and destroyed whole fields of peas, turnips and beets in August. The Variegated Cutworm (*Peridroma saucia*, Hbn.) is a large and late species which did an enormous amount of harm on the Pacific coast in 1900; the greater part of the injury was done during the month of July, and almost all low growing crops were devastated. This caterpillar has also the bad habit of climbing trees and destroying the foliage in the same way as the White Cutworm (*Paragrotis scandens*, Riley). This last named passes the winter half grown, and is in some places and on sandy lands extremely destructive in early spring. Western species, the appearance and habits of which should be known to those who wish to fight them successfully, are *Chorizagrotis auxiliaris*, Grt., *C. agrcsis*, Grt., and *C. introferens*, Grt., which occur throughout the prairie regions and have caterpillars with the same habits and extremely similar in appearance to the Red-backed Cutworm. Neither these nor *Paragrotis perexcellens*, Grt., and *Dargida procinctus*, Grt., which frequently injure crops in British Columbia, have so far received no distinctive English names; but fortunately the habits of cutworms are such that general principles for applying remedies may be adopted for the protection of most crops. There is, however, much confusion in the reports of injuries by cutworms, and unless specimens are actually received and reared to the perfect insect, it is almost impossible, from reports of correspondents, to be sure as to the exact species to which injury should be attributed.

Remedies.—(1.) Clean Farming.—The keeping down of all weeds and the burning up of all haulms, stems of reaped crops and refuse, as early as possible in the autumn after crops are reaped, will destroy many eggs and prevent the deposition of others by presenting no suitable place for the moths to lay their eggs. The eggs are laid in autumn or spring, and such places are chosen by the moths as where there will be an abundance of food for the young caterpillars on hatching.

(2.) Traps.—Large numbers may be destroyed by placing between the rows of an infested crop, or at short distances apart on infested land, bundles of any succulent

weed or other vegetation which has been previously poisoned by dipping it, after tying in bundles, into a strong mixture of Paris green, 1 oz. in a pail of water. The cutworms eat the poisoned plants, then bury themselves and die. In hot, dry weather these bundles should be put out after sundown, and a shingle may be placed on each to keep it from fading.

(3.) Banding and wrapping.—

(*a*) It will be found to well repay the trouble and expense to place a band of tin around each cabbage or other plant at the time of setting out. These may very easily be made by taking pieces of tin 6 inches long and 2½ wide and bending them around a spade or broom handle so as to form short tubes. In placing them around a plant the two ends can be sprung apart to admit the plant, and then the tube should be pressed about half an inch into the ground. I have found this a useful means of disposing of empty tomato and other cans. To prepare these easily, they need only be thrown into a bonfire, when the tops and bottoms fall off and the sides become unsoldered. The central piece of tin can then be cut down the centre with a pair of shears and forms two tubes.

(*b*) Wrapping a piece of paper round the stems of plants when setting them out will also save a great many.

Hand-picking or digging out the cutworm whenever a plant is seen to be cut off should, of course, always be practised.

(4.) Poisoned Bran Mash.—The most remarkably effective remedy against cutworms is the poisoned bran mash which has lately come into such wide use. This is made by mixing half a pound of Paris green with fifty pounds of slightly moistened bran. In making this, it is best first to dampen some of the bran slightly with water containing a little sugar. After mixing thoroughly, add the Paris green by dusting it on the surface and stirring all the time. We have found that when Paris green is added to perfectly dry bran, owing to its weight, it will sink at once to the bottom when stirred, in the same way that it does in water. Half a pound of Paris green is enough to poison fifty pounds of bran, although double this amount may be used. If the mixture is too wet, more dry bran should be stirred in until the mixture will crumble easily and run through the fingers without adhering.

When required for garden use, all that is necessary is to sprinkle a little of the poisoned mixture by hand around such plants as are liable to attack. When crops are planted in drills or in rows, a convenient way is to mix the mixture rather dry and then distribute it by means of a Planet Jr., or other wheel seeder. In field practice, among such close growing crops as standing grain, which are sometimes injured by the Red-backed Cutworm, the poisoned bran remedy is also serviceable. The mixture can be distributed by means of a paddle or shingle and can be thrown easily to a distance of twenty feet. When distributed in this way, there is much less danger of chickens and birds picking it up than if it is placed in lumps.

The question of danger from the use of this poisoned bait is one which must be considered. It is frequently inquired about by correspondents, and some instances of the poisoning of poultry where it has been used, seemed to be justly attributable to their having eaten some of it. As a rule, there is little danger from this cause. The quantity used is so small that it is not noticed by poultry; and then, in gardens, poultry do so much harm to plants that they should never be admitted at the time of year when cutworms occur injuriously and only at special times of the year when there are no crops to injure. If, however, there should be a bad infestation by cutworms and there is no means of barring out or driving away the chickens, the owner of the crops must decide whether he will lose his crop or take special means of protecting his chickens. The experience of a great many people who have used this remedy without taking any special precautions, is that injury to domestic animals is extremely rare; and, although I have been on the watch for any trouble of this sort for many years, I do not know of a single instance when poultry have been poisoned, without doubt, by eating poisoned bran put out for cutworms. However, there will be many occasions when plants in

gardens may be protected by putting out the poisoned bran in small heaps and then covering these up with a piece of shingle or some other covering, so that the material cannot be got at by stray chickens and other poultry.

It has also been asked whether there is any danger of plants absorbing Paris green from this mixture when placed near their roots. In reply to this, it is only necessary to point out that Paris green is practically insoluble and therefore cannot be absorbed by the plant.

Root Maggots, Figs. 27, 28.

Attack.—Small white maggots which bore into the roots of radishes, freshly set out cabbages, and into the bulbs of onions, and sometimes also injure the roots of beans and Indian corn.

The Cabbage or Radish Maggot, and the Onion Maggot, which for all practical purposes may be treated of here as the same species, cause great loss in crops of cauliflowers, early cabbages, turnips, radishes and onions, almost every season.

The maggots which are found attacking cabbages, radishes, cauliflowers and turnips, and those in onions, and in beans and corn, are very similar, but they belong to three different species, *Phorbia brassicæ*, Bouché, attacking plants of the cabbage family, *Phorbia cepurum*, Meig., infesting onions, and *Phorbia fusciceps*, Zett. (Fig. 27) injuring beans and corn.

Corn sown during a cold, wet period by which germination is unduly delayed, is very liable to be attacked by the Corn-seed Maggot (*P. fusciceps*). In such cases it is well to wait for warm weather to re-sow and then push on the crop with a light dressing of nitrate of soda, 200 lbs. to the acre.

The perfect flies of all these maggots are very similar to the ordinary observer and may be described as slender flies, somewhat smaller than the ordinary house fly, which fly about close to the ground and lay their white eggs on the stems of the young plants. Here after a few days the maggots hatch and work their way down beneath the soil, where they lie close to the root or burrow into it, tearing the tissues with their hook-like mandibles and living on the sap, thus soon reducing the root or stem to a rotten mass. When full grown these maggots turn to reddish brown puparia in the soil close to the roots. The exact number of broods of these maggots which may be found in a season seems to be rather complicated by the overlapping of broods, and the delay in issuing of some individuals of each brood; but practically it may be said that cabbage and radish maggots do by far the greatest amount of harm during the month of June, and early in July, and in many years their injuries are slight after that period. With onions the injury continues throughout the season and is most noticeable in June, August and September. The injury to beans and Indian corn is only in spring, and, as a rule, is confined to plants which have been weakened by the seed being planted too deeply or by late frosts. However, in seasons of excessive abundance cabbage and onion maggots may be found all through the growing season, and cabbages and cauliflowers are occasionally injured in autumn by the maggots attacking the heads of the plants.

Remedies.—Up to the present time it cannot be claimed that any perfectly efficacious remedy has been discovered for root maggots. In certain years they seem to be so extremely abundant that even the best remedies merely seem to prolong the lives of the plants, and only a very small proportion of a crop can be saved. In ordinary years, however, much can be done to protect crops liable to attack, and the following are the remedies which have given the best results :

For Onions.—White hellebore (Remedy 3) dusted along the rows once a week from the time the young plants appeared above the ground gave comparatively clean onions, very few being attacked. Fresh gas lime broadcasted over onion fields at the rate of two hundredweight to the acre had a similar effect; but, where the caustic lime came in contact with the young onions, they were burnt out. A light dressing, between the

rows of onions, of the same material gave almost as good results as where it was distributed over the whole field. When onions have begun to form their bulbs, the earth may be hoed or brushed away right down to the roots, and in some years the maggots do not penetrate the bulbs. As soon as the earth is hoed away in garden practice, a dusting along the rows with white hellebore makes the protection more complete.

Dressings of salt, Paris green and plaster, and wood ashes have been found useless in protecting onions from the attacks of root maggots.

For Cabbages.—(1). Tarred Paper Disks.—Pieces of ordinary tarred paper three inches in diameter, with a slit running to the centre so as to allow of their being placed around the stems of young cabbages and cauliflowers at the time of planting, and pressed down close to the ground, will prevent to a large measure the flies from laying their eggs on plants so protected, or will kill the young maggots.

(2.) Insect Powder.—About half a teacupful of a decoction of pyrethrum insect powder (four ounces to a gallon of water), or of white hellebore (Remedies 3 and 4) of the same strength poured around the root of each plant, after drawing away the earth, right down to the roots, will destroy any maggots which may have started to work. The earth should be put back again and the plants well hilled up, when new rootlets will soon be formed. A light sprinkling of nitrate of soda or some special fertilizer will encourage a quick growth and much help the plants to overcome attack. Dressings of one ounce to the square yard may be used for this purpose. Cabbage plants should be examined late in June to see if the maggots are at work. The earlier the treatment with insect powder or white hellebore is applied the more effective it will be. If the mixture is applied to the roots with a force pump, although more liquid is consumed, it has the advantage of dislodging many of the maggots so that their injuries cease at once.

(3.) Cheese-cloth inclosures.—A very effective and practical means of procuring early radishes, cabbages and cauliflowers, perfectly free from root maggots, is by growing them beneath cheap frames made of light wood covered with cheese-cloth. A convenient size for small beds is 8 feet long, 2 feet wide and 2 feet high. This frame can be made for about 25 cents, of one and a half inch square wood, nailed together at the corners, and with the cheese-cloth tacked on the outside. In such a frame five cauliflowers and two rows of radishes have been grown to perfection. The frame was kept on from the time the young plants came up until the radishes were pulled.

Cauliflowers were sufficiently advanced to require no further protection and the frames were removed about the first of August.

For Radishes.—The maggot which attacks the radish is the same species as also attacks cabbages and turnips, the severity of attack on these different crops being about in the order in which they are named, so that in years of light attack radishes will draw off injury from the cabbages.

Injuries to turnips are seldom severe, and in most instances a crop shows little sign of this attack in autumn, even in seasons when the maggots may have been found in considerable numbers in the spring.

(1.) The Cook carbolic wash (Remedy 6), consisting of one quart of soft soap one pound of hard soap, in a gallon of water, with half a pint of crude carbolic acid added, and the whole boiled together for a few minutes, to make the stock emulsion, has proved over and over again an excellent remedy for radish maggots. The stock emulsion can be kept in a closed vessel, so that dust and rubbish will not fall into it, and, when required for use, one part of this mixture by measure is added to fifty of water, and should be sprayed directly upon the growing plants from the time they appear above the ground, once a week until ready for the table.

(2.) White hellebore (Remedy 3), dusted along the rows of radishes once a week from the time they appear above the ground, has given good results in most years.

From 2 years' experience with the cheese-cloth coverings, I have no hesitation in recommending these to amateur gardeners, however small their gardens may be, as a sure means of obtaining perfectly clean, as well as early, radishes and cauliflowers of the very best quality, at a comparatively light expense.

For Beans and Corn.—Injury to these crops in Canada is a rare occurrence. The only remedy which can be suggested, is to sow these crops in good season in well prepared soil and not deeper than one or two inches.

The Small White Cabbage Butterfly

(*Pontia rapæ*, L.), Fig. 26.

Attack.—Velvety green caterpillars, commonly known as Cabbage Worms, about an inch in length, with a broken yellow line along each side, and an unbroken one down the middle of the back. At first eating the outside leaves, but eventually boring right into the head of the cabbage. These, after three or four weeks, produce the white butterflies so common in gardens.

This injurious insect, which was imported into Canada about 1859, has now spread right across the Dominion, and is every year the cause of considerable loss, not only to cabbages but also to turnips and other plants of the same family. It is, however, one of the easiest of the well known insect pests to control. There are two broods during the growing season, and sometimes a late supplementary one, of which, the caterpillars are found as late as November. Farmers and gardeners should watch for the first appearance of the larvæ and apply the remedy promptly. The eggs are laid by the female butterflies on the leaves.

Remedy.—The caterpillars can be destroyed easily by dusting the plants with a mixture of one pound of pyrethrum insect powder (Remedy 4) and four pounds of cheap flour. Mix the whole together and keep it in a tightly closed canister or jar for 24 hours. The powder is then ready for use and may be dusted over the cabbages either with a cheese-cloth bag tapped lightly with a slender stick, or from one of the various insect guns, or dusters, now sold by seedsmen. The advantage of this remedy over many others which are recommended is that, although insect powder is so deadly to caterpillars and most insects, it is quite harmless to human beings and the higher animals.

The rather prevalent custom of using Paris green and other arsenical poisons on cabbages and other vegetables, must be condemned as being very dangerous without any commensurate advantage.

The Diamond-back Moth

(*Plutella maculipennis*, Curtis—*Plutella cruciferarum*, Zell.), Fig. 30.

Attack.—Small, green, exceedingly active caterpillars about one-quarter to three-eighths of an inch in length, which attack the leaves of cabbages, turnips, &c., eating numerous small holes through the younger leaves, and irregular blotches from the under surface of the older leaves. When disturbed they run backwards ,wriggling their bodies violently from side to side, and, by means of a silken thread, fall to the ground, where they lie quite still.

The caterpillar of the Diamond-back Moth is in some years a serious pest of cabbages, turnips, rape and almost all other cruciferous plants. In years of bad attack the whole plant soon turns white from the green cellular matter having been eaten away, and the plants dry up. It is probable that there are two regular broods in the year; but occasionally in late autumns some of the second brood emerge and produce a third supplementary brood, part of which comes to maturity, and the pupæ winter over and form part of the spring brood of moths. The effects of the first brood are seldom noticed until about the first week of July, and, when seen, should at once be attended to. The active caterpillars can be recognized by their spindle-shaped bodies and their wriggling motions when disturbed. When full grown, they spin open network cocoons on the lower sides of the leaves, through which the black-lined white pupæ can be easily seen. The larval stage in summer lasts from three weeks to a

month, and the pupal stage, about a fortnight. The perfect moth is a slender little creature very variable in size and markings. A well marked example is shown in the figure. The size of the moth is shown by the hair line in the middle of the figure. The general colour is ashy gray with a stripe of light somewhat diamond-shaped marks on the back when the wings are closed.

The occurrence of the Diamond-back Moth in large numbers is fortunately very irregular. This is undoubtedly due to the large number of parasites which always appear with a serious attack. This is a fortunate circumstance, as it is a difficult insect to control. The injuries are generally more serious in hot, dry seasons.

Remedies.—Remedies which have given good results are: (1.) Dusting the infested plants with a dry Paris green mixture (Remedy 1), using preferably lime or wood ashes as a diluent. In England, where soot from soft coal can be easily obtained, this substance mixed with equal quantities of slaked lime is found to give the best results. (2.) Kerosene emulsion (Remedy 2), sprayed well under the leaves, has given excellent results in garden practice. (3.) As a supplementary treatment, inducing a vigorous growth with light dressings of nitrate of soda, or some special fertilizer, are most useful. (4.) Several reports mention the advantage of watering thoroughly the attacked plants, where this is practicable. (5.) As a preventive measure, care should be taken to keep down all weeds and plants of the mustard family and to destroy in autumn all surplus plants of a crop which has been attacked. In this way the over-wintering brood will be destroyed.

The Cabbage Plusia

[*Autographa* (*Plusia*) *brassicæ*, Riley]. Fig. 31.

Attack.—Pale green caterpillars, about an inch and a quarter long, striped with longitudinal whitish lines, walking like the loopers (the larvæ of the geometers), owing to their only having three pairs of prolegs at the end of the body. These caterpillars are very voracious, and when full grown they spin gauzy silken cocoons on the leaves.

The Cabbage Plusia, or Cabbage Looper, is particularly destructive to cabbages, lettuces and some other plants when it occurs; but, fortunately, its injuries to crops in Canada are very rare. It is, however, an insect which at any time may become as serious a pest in Canada as it has proved in the northern United States, close to our borders. There are probably two broods in a season.

Remedies.—It is claimed that this enemy of the cabbage is very much more difficult to destroy than the ordinary 'cabbage worm' of Canada, which is the caterpillar of the small white cabbage butterfly. Dusting the plants with Paris green and lime (one pound to twenty of the diluent) will kill the caterpillars early in the season; but it requires frequent applications and some implement by which the powder can be driven up beneath the leaves, where the caterpillars mostly feed. If a liquid spray is used containing arsenical poisons, one pound of soap should be added for every twenty gallons of wash. In addition to the above, another species belonging to the same family and styled, 'The Eyed Cabbage-looper' (*Autographa precationis*, Gn.), by Mr. Chittenden, in Bulletin No. 33, n.s., 'Some Insects Injurious to Vegetable Crops,' U. S. Bureau of Entomology, is extremely common in Canada, and may at any time develop into an enemy to the farmer and gardener. The life history is similar to that of the Cabbage Plusia, and the same remedies may be applied. A figure of this common insect is shown herewith. (Fig. 29).

The Zebra Caterpillar

(*Mamestra picta*, Harr.), Fig. 32.

Attack.—Rather large handsome caterpillars, when mature about two inches in length, velvety black on the back, beautifully ornamented with two golden yellow

stripes on each side of the body, which are connected by narrow lines of the same colour; the head and feet reddish brown. There are two broods of this insect every year. The moths of the first brood appear during May and lay their eggs in large clusters on the under sides of leaves of many different plants. These hatch in a little more than a week; and the young caterpillars for a time feed gregariously, devouring all the green cellular portion and making large conspicuously white patches on the leaves. As they grow larger they separate and feed singly. The caterpillars of the first brood are full grown about midsummer, when they spin slight cocoons just beneath the surface of the ground, and the moths emerge about the first week in August; they are rather dull-coloured, purplish brown moths with white under wings, expanding about one and a half inches across the opened wings.

The eggs of the second brood are laid throughout August and into September, and the caterpillars are to be found, as a rule, later than those of most of our moths. Being conspicuously coloured, they are often noticed crawling about, looking for food late in the autumn, when most kinds of plants have been frozen and killed. The winter season is passed in the chrysalis state beneath the ground.

The crops most attacked by the Zebra Caterpillar are turnips, cabbages, peas, clover and potatoes.

Remedies.—Spray affected plants with Paris green, 1 oz. in 10 gallons of water; or dust with insect powder (Remedy 4), or white hellebore (Remedy 3), or Paris green and lime 1 lb. to 20 of the diluent.

The Purple-backed Cabbage Worm
[*Evergestis (Pionea) straminalis*, Hbn.].

Attack.—Slender bristly caterpillars, tapering to each end, purplish on the back; with the head, two spots on the second segment, and a small plate at the end of the body black; measuring when full grown three-quarters of an inch long. These are found under the leaves of cabbages and turnips in July and in September and October. These caterpillars are most troublesome in the Maritime Provinces, where every year considerable injury is done to crops of turnips late in the season, the caterpillars congregating on the crowns of the turnips and eating cavities into the roots, as well as consuming the leaves and reducing them to skeletons. Sometimes whole fields of turnips and cabbages are destroyed.

Injury by the Purple-backed Cabbage Worm is occasionally serious in the eastern provinces, and their work is sometimes supplemented by the half-grown cutworms of several species which pass the winter in the larval condition. There are few references to the species in literature; but, as the moth is common over a very wide area in Canada, it is probable that the injury is more considerable than is supposed. There is an allied species known as the Cabbage Pionea, which is troublesome to cabbage fields in the eastern United States, the caterpillars of the two species being very much alike. The chief character by which the Purple-backed Cabbage Worm can be recognized from the larva of the Cabbage Pionea, is that its head is shining black, while that of the last-named is yellowish. The moth of the Purple-backed Cabbage Worm is a neat little species, expanding seven-eighths of an inch; the upper wings are of a pale satiny yellow, marked distinctly with a heart-shaped discal spot, two distinct transverse waved lines across the centre of the wing, the inner of which runs through the middle of the heart-shaped spot, and two less distinct lines, one at the base of the wing and the other close to the tip. There is also a conspicuous dark blotch bearing a white crescent outwardly towards the tip of the wing. The lower wings are silvery white, with a clear black margin and a narrow submarginal line inside this. The fringes of the upper wings are gray; of the secondaries, white.

There are two or three broods of this insect in the season; the moths of the first brood, which passes the winter as a chrysalis, appearing in spring towards the end of June, and those of the last brood laying eggs from which caterpillars are found in October and November. This last brood is by far the most injurious.

Remedies.—For the early broods, when found upon turnips, spraying with Paris green or dusting the plants with Paris green and some dry powder, will answer (Remedy 1). For the last brood, when it attacks cabbages, insect powder (Remedy 4) must be used, as there would be danger of using arsenites upon cabbages which had been eaten into by the caterpillars. In the case of turnips, the quantity reaching the roots would be so small and there would be so many opportunities for the poison to be washed off, that Paris green or some other active poison could be used, even up to the end of the season.

The Colorado Potato Beetle

[*Leptinotarsa* (*Doryphora*) *decemlineata*, Say], Fig. 36.

Attack.—About the end of May the mature beetles of the well known Colorado Potato Beetle, usually known as the Potato Bug, come out from their winter quarters beneath the soil, and at once begin devouring any potato plants which may have appeared above the surface. The sexes pair at once, and the bright orange eggs are laid beneath the leaves in clusters of half a dozen to about fifty. In about a week the dark-coloured larvæ hatch, spread out over the foliage, and at once attack the leaves. In four or five weeks they become full grown and enter the earth, where they change to orange-coloured pupæ in smooth oval cells two or three inches below the surface. In about a fortnight a new brood of beetles appears, which attack the plants in company with belated larvæ of the first brood. This second brood becomes mature in a rather shorter time than the first, and the third brood comes from eggs laid by them. The third brood emerges in September and is most noticeable, because by that time there are few potato tops left in the field, some fields having been dug and others bared of foliage by fungous diseases. The beetles, having very little food, wander about and are found on sidewalks, paths, &c. After a time they burrow into the ground and remain there for the winter. After the first brood the two other broods become very much confused. This is due chiefly to the long period over which the females continue laying clusters of eggs, so that the insect in all stages may be found during the summer months.

The Colorado Potato Beetle is particularly destructive in all parts of Canada east of the prairies, and is occasionally so in Manitoba and in the foothills of the Rockies. So far, it has not been recorded from British Columbia.

Remedies.—The standard remedies for the Colorado Potato Beetle are the various arsenical poisons, the most useful of these are Paris green and Arsenate of Lead, both of which may be used alone or what is far better, and now a more general practice everywhere, mixed with the Bordeaux mixture (Remedy 7). Bordeaux mixture has also a special effect in destroying the Cucumber Flea-beetle, *Epitrix cucumeris*, Harris, which is frequently a serious enemy to potatoes, tomatoes, and egg plants, and has on occasions been even more destructive to these plants than the larger and better known species. If the plants are kept well sprayed with Poisoned Bordeaux mixture, the first application in the beginning of June, then early in July and about August 1st, 15th and 31st, not only will all of the biting insects which occur on these plants be destroyed, but several fungous diseases including the Early Rot and the terribly destructive Potato Rot, will be prevented.

Blister Beetles,

Fig. 33.

Among the usually unimportant injuries to potatoes which on occasion become more extensive and involve large areas, are those due to swarms of Blister Beetles, long, cylindrical shaped beetles with soft bodies, which fly to fields and swarming over the potatoes devour the leaves rapidly. As a rule, these swarms remain only for a short time and then pass away.

A remedy which has been adopted successfully consists of driving the swarms from a crop by several people walking across it with branches or other conspicuous objects in their hands, waving them from side to side and driving these easily disturbed beetles ahead of them until they come to the edge of the crop, where they will disperse and seldom return. It is undesirable to destroy the Blister Beetles if this can be avoided, because in their larval form they are predaceous parasites on the eggs of grasshoppers; but, as in the case of nearly all leaf-eating insects, these can be destroyed by spraying the crops with a poisonous mixture such as one of the arsenites (Remedy 1). Prof. F. M. Webster has found that crops sprayed with Bordeaux mixture (Remedy 7) are not attacked by Blister Beetles and as all potato crops should be sprayed with Bordeaux mixture every year, there is no reason why they should suffer from these insects. In addition to potatoes, many other crops and plants, particularly members of the pea family, are attacked by different species of Blister Beetles.

Species which have at different times been tho cause of considerable injury to potato crops are the Black Blister Beetle (*Epicauta pennsylvanica*, DeG.), the Spotted Blister Beetle (*Epicauta maculata*, Say) and the Gray Blister Beetles (*Macrobasis unicolor*, Kirby, and *Epicauta cinerea*, Forst.).

The Four-lined Leaf-bug

(*Paecilocapsus lineatus*, Fab.), Fig. 34.

A somewhat unusual attack on potatoes, but one which always attracts attention, is by the Four-lined Leaf-bug, which is easily recognized by the tips of shoots and the foliage being curled up and spotted with dark spots nearly as big as the head of a pin, and the subsequent drying up of the injured parts. This leaf-bug attacks many kinds of plants in gardens but has a special liking for mint, sage, gooseberries and currants.

Remedies.—(1.) Spraying the nymphs or partially developed bugs which cannot fly, with a strong kerosene emulsion (1 to 6); (2.) The jarring or beating of the nymphs and perfect insects from the attacked plants into open tins containing coal oil and water; and (3.) The destruction of the eggs, which are always laid in the twigs of bushes, particularly the currant, near the tips; these are white, and, as they protrude slightly through the bark, when once seen they are easily recognized again, and thus this attack may be controlled to a large measure by winter pruning.

The Cucumber and Potato Flea-beetle

(*Epitrix cucumeris*, Harr.), Fig. 37.

This minute beetle, which does not exceed one-twentieth of an inch in length, is black, covered with short fuscous hairs, and is much more frequently complained of as a potato pest than as an enemy to any other crop. It is sometimes, in hot, dry summers, one of the worst enemies of the potato, eating many small holes through the leaves and reducing them so much that they are unable to perform their functions. The best remedy for this insect appears to be spraying the vines with Bordeaux mixture. This treatment has given far better results than spraying with Paris green. The practice, too, of spraying potatoes with Bordeaux mixture is also an excellent one, as stated above, being an effective preventive for the Early Blight of the potato, as well as of the much more destructive Potato Rot or Late Blight.

The Five-spotted Hawk-moth, or 'Tomato Worm'

(*Protoparce celeus* Hbn.).

The large caterpillar of this moth, known as the Tomato Sphinx, is frequently found in some numbers upon tomato vines, but its work is so conspicuous and the

tomato makes such rapid growth that its injuries are very seldom important in Canada. However, the caterpillar feeds on many other plants belonging to the Nightshade Family, such as the potato and tobacco. It is frequently the cause of considerable loss in the large tobacco fields in the county of Essex, where it is generally spoken of as the Tobacco Worm. This name, however, belongs properly to an allied species, *Protoparce carolina*, Linn., which occurs very rarely in Canada. The potato, however, must be considered an exceptional food plant and the insect is not likely to become a regular pest of that crop.

The Potato-stalk Weevil
(*Trichobaris trinotata*, Say), Fig. 38.

Attack.—About the middle of August several whitish legless grubs with brown heads boring inside the stems of potatoes. These cause the leaves to turn yellow and the stems to die prematurely. When full-grown, the grubs form white cocoons of fibres gnawed from the stem, usually low down in the stems. Inside these the beetles become mature in August and September, but they remain in the cocoons and do not emerge until the following spring.

The Potato Stalk Weevil has never been a serious enemy to potato growers in Canada, but might at any time become one.

Remedy.—The remedy is simple. As the perfect beetles pass the winter in their cocoons inside the stems of the plants they have attacked during the summer, if all of these are burnt in autumn instead of, as is too frequently the case, being left in heaps to rot in the fields, this insect can be easily controlled. The practice of promptly destroying with fire all haulms, tops, vines, &c., of such crops as have been taken in, cannot be too strongly advocated. Not only is untidy or objectionable litter thus removed and turned into useful fertilizing elements, but many injurious insects and fungous diseases are done away with, which would endanger the crop of the following year.

The Red-headed Flea-beetle
(*Systena frontalis*, Fab.), Fig. 39.

Attack.—Large black shining flea-beetles, one-fourth of an inch long, with a reddish blotch between the eyes. These sometimes occur in large numbers on potatoes and many other different plants, particularly clover, to which they are sometimes a serious pest. On the slightest disturbance they hop actively from the leaves which they are attacking.

The injuries to potatoes are sometimes rather severe and, when this is the case, demand attention.

Remedy.—Spraying potatoes with the Poisoned Bordeaux mixture (Remedy 7) is the best treatment. Other plants, as grape vines and many garden flowers, may be dusted with Paris green and lime, or, when convenient, sprayed with the Poisoned Bordeaux mixture.

The Turnip and Cabbage Aphis
(*Aphis brassicæ*, L.), Fig. 42.

Attack.—Clusters of gray plant-lice situated all round the bases of the stems and beneath the leaves of Swede turnips and all kinds of cabbages, from which they suck the sap, causing them to become withered and stunted and, in serious outbreaks, destroying whole crops. As a rule, these plant-lice are not noticed until the end of the

season; but in dry autumns, or on high land, they increase with incredible rapidity and become one of the most destructive enemies of the turnip grower. The eggs are laid late in autumn upon the leaves and stems of the plants.

The Turnip and Cabbage Aphis is very widespread, occurring in all parts of the Dominion. In British Columbia it is frequently very destructive to early cabbages and cauliflowers; but in eastern Canada the most important injury is to Swede turnips in fields at the time that they are forming their roots.

Remedies.—When cabbages in gardens are attacked, the colonies of plant-lice should be destroyed by spraying with kerosene emulsion (Remedy 2), or whale-oil soap (Remedy 5), on their first appearance. In turnip fields the injury is always in autumn, and the colonies of plant-lice should always be looked for when the turnips are being hoed and thinned. At this time good work may be done by simply hoeing out the infested plants and, having pulled some earth over them with the hoe, pressing it down with the foot. When the plant-lice are too numerous for this simple treatment, the infested plants, which at this time are generally in restricted areas, should be promptly sprayed with a knapsack sprayer, using kerosene emulsion (Remedy 2), or whale-oil soap, one pound in six gallons of water. As the eggs are laid late in autumn on the leaves of turnips and cabbages, remnants of these crops should always be ploughed down as soon as the crop is got in. Infested cabbages may be dipped in kerosene emulsion before storing for the winter.

The Turnip Flea-beetle or 'Turnip Fly'
(*Phyllotreta vittata*, Fab.), Fig. 40.

Attack.—Small active shining black beetles, ⅛th of an inch long, with yellowish marks on the wings, which eat the seed leaves of turnips and other cruciferous plants directly they appear above the ground. When disturbed they hop to some distance.

The injury by the Turnip Flea-beetle in hot, dry Junes is well known by farmers in every part of Canada. The larvæ have been found at Ottawa, feeding in the leaves of Curled Cress, a plant belonging to the same family as the turnip, but it is certain that this stage in the American insect is generally passed on the roots. As soon as young turnips appear above the ground the beetles swarm on them and destroy the seed leaves, which are so important to the young plants, frequently destroying whole crops and making it necessary to resow large areas.

Remedies.—(1) Paris green and land plaster, one pound of the former to twenty of the latter, dusted along the rows of young turnips, if possible when they are covered with dew, is an effective remedy against this troublesome insect. The land plaster acts as a stimulant to the plants and pushes on growth. As soon as the rough, true leaves are formed, the plants are, as a rule, able to make more growth than the beetles can destroy.

(2.) Late sowing. Careful observation has shown us that for central Ontario, the third week in June is the most satisfactory time for sowing turnips to avoid injury by flea-beetles. By that time the perfect insects of the first brood have, as a rule, disappeared, and the young plants grow rapidly and produce as good crops as when sown two and three weeks earlier.

The Red Turnip Beetle
(*Entomoscelis adonidis*, Fab.), Fig. 41.

Attack.—A showy scarlet beetle, with three black stripes down its back, a black patch on the collar, and black legs; two-thirds the size of the Colorado Potato Beetle, but narrower in outline, eating the leaves, both as larva and perfect beetle, of turnips, radishes, cabbages and all other plants of the Mustard family, or Cruciferæ.

The Red Turnip Beetle is every year abundant throughout the prairie provinces; but there are so many wild weeds of the Mustard family all through the W[illegible] that these plants have prevented the Red Turnip Beetle congregating upon cultivated crops to any serious degree. In certain localities noticeable injury has been done, and it is possible that at some future time this insect might become a serious enemy of the farmer. Although its specific name was given in reference to its feeding upon a member of the Ranunculus family, *Adonis autumnalis*, the Red Turnip Beetle has not been recorded in Canada as feeding upon any plant of other orders than the Cruciferæ. The bright red eggs are laid beneath clods of earth, large numbers joined together in loose masses. Although such a method of passing the winter is very rare among the Chrysomelidæ, to which this insect belongs, it would appear as if this were the usual habit in Canada. The perfect beetles appear during July and August and continue in the fields as late as October and November.

The larvæ are nocturnal in habit, and, although they also injure crops, most of the observed damage is done by the perfect beetles. The larvæ are slug-shaped and black in colour. When mature they are half an inch long. The pupa is formed in the ground about an inch or so beneath the surface.

Remedies.—Spraying with Paris green and other arsenites (Remedy 1), when the nature of the affected crops will allow of that practice, is the best remedy. As, however, the beetles occur very late in the season, it might be necessary to substitute dusting with insect powder or hellebore, should the beetles become abundant on crops of cabbages. Certain wild members of the Mustard family such as the Gray Tansy Mustard and the Prairie Wallflowers, seem to be particularly attractive to this insect, and might be used as decoy plants, upon which the beetles could be poisoned at short intervals.

The Carrot Rust-fly
(*Psila rosæ*, Fab.), Fig. 43.

Attack.—Early in the season the leaves of young carrots turn reddish, and the roots will be found to be blotched with rusty patches, particularly towards the tip. These carrots, when stored for winter use, although sometimes not showing much injury on the outside, may be found to be perforated in every direction by dirty brown burrows, in which are many semi-transparent yellowish maggots about ¼ of an inch long. These maggots are blunt at the tail end, but taper toward the head, where there is a black-hooked tip, forked at the base, by which the maggot makes its way through the roots. The puparium is reddish brown, and the maggots, as a rule, leave the carrots before assuming this form. The perfect fly is a quarter of an inch long, bright, shiny green-black, with yellow legs and red eyes. There are at least two broods in a season.

Carrots in the Maritime Provinces, and to a less extent and at wide intervals, through Quebec and Ontario, are often seriously injured by the larvæ of this European insect. In the Maritime Provinces it is a regularly occurring pest of the market gardener, and much loss every year is due to its ravages. To a less degree celery and parsnips are also sometimes attacked by this insect, but I have never seen in Canada more than an accidental occurrence on these crops

Remedies.—(1.) When young carrots are large enough to thin out, this should be done if possible late in the day, and the rows at once sprayed with kerosene emulsion (Remedy 2), one part of the ordinary emulsion to nine of water; or the rows may be dusted with sand, land plaster, or ashes, with which coal oil has been mixed at the rate of half a pint to an ordinary three-gallon patent pail of the diluent. One application a week should be made through June and into July, par[illegible]larly after the rows have been thinned or hoed up. (2.) Late sowing has been advan[illegible]ageous in many instances.

and, as carrots for the table may be sown very late in the year and give good crops, it is advisable to make two or three sowings, a week or ten days apart, some of which will escape injury. (3.) The common-sense practice of not sowing carrots in the same spot as they were planted the previous year, will recommend itself to all growers. (4.) The destruction of the maggots from stored carrots. Where carrots are stored in sand for winter use, the larvæ leave the roots and pupate in this soil. Care must be taken, when cleaning out the bins in spring, to destroy these puparia either by burying the sand in a deep hole or by throwing it into a pond or into a barnyard, where it will be trampled by stock.

The Asparagus Beetles

(*Crioceris asparagi*, L., and *C. 12-punctata*, L.). Figs. 44, 45, 46.

Attack.—The Common Asparagus Beetle. Slender black beetles about ¼ of an inch in length, conspicuously marked with six white blotches on the back and a red border to the neck and elytra, or wing-cases; appearing in the early spring and eating into the asparagus shoots, upon which they lay their greenish black eggs. The grubs which hatch from these eggs are dark olive and slug-like. These also attack the shoots. The Twelve-spotted Asparagus Beetle. Occurring sometimes with the above, are beetles of about the same size, but slightly broader and of a uniform reddish orange colour, with twelve black spots upon the wing-cases. The grubs, somewhat similar to those of the Common Asparagus Beetle, but of a dirty yellowish colour, feed inside the berries of asparagus.

The two above-named species of beetles are now a regularly occurring trouble of asparagus growers in south-western Ontario; both species seem to occur together and to be equally abundant. Their first appearance was in 1898, and the spread in Canada has fortunately been far less extensive than it was at first feared it might be. There are two broods in the season, the first beetles attacking the young shoots and laying their eggs upon them. The larvæ are found on the foliage during the summer. The beetles pass the winter fully developed.

Remedies.—(1.) Dusting with lime. The most effective remedy is probably the destruction of the larvæ by dusting the plants systematically every three or four days with fresh air-slaked lime, which adheres to their slimy bodies and kills all those with which it comes in contact. (2.) Poisoning. Active poisons, as a mixture of Paris green and flour, or, better, Paris green mixed with the lime mentioned above, and dusted through the plants, will kill not only by contact with the larvæ, but will destroy both them and the perfect beetles which eat the poisoned foliage. (4.) Beating. Beetles and larvæ may be beaten from the plants into nets or broad pans containing water and coal oil. Nets made specially for the purpose are most convenient. The larvæ may also be brushed off the plants with a stick, and, if this is done in the middle of a hot day, it is claimed that few will be able to get back again on to the plants. (5.) Poultry Chickens and ducks, when available, are very useful in eating the beetles when they first appear in spring.

The Spinach Carrion Beetle

(*Silpha bituberosa*, Lec.). Fig. 48.

Attack.—Shiny black, very active flattened grubs, three-quarters of an inch long, shaped like sow-bugs or wood-lice, which devour the leaves of plants belonging to the Spinach and Gourd families.

The Spinach Carrion Beetle belongs to a family, most of the members of which are scavengers, but there are two species at any rate, the present one and the Beet Carrion Beetle (*S. opaca* L.), which in the West have caused injury to grow-

ing crops of pumpkins, squashes, spinach and beet. The injury is done by the larvæ, which come out at night and destroy the foliage of these plants. The beetles of both species are very similar, are dull black, the body flat and thin, about three-quarters of an inch in length, with straight ridges on the wing covers and a little raised knob towards the end of each of these. The beetles pass the winter hidden away beneath clods, refuse, &c., and lay their eggs in June. The young larvæ appear in about a week and grow rapidly, maturing within three or four weeks.

Remedies.—The only remedies which can be suggested, are the dusting of the young plants in June when the grubs appear, with a dry Paris green mixture, or spraying them with Poisoned Bordeaux mixture (Remedy 7). In the case of spinach, which could not be poisoned in this way, it might be possible to protect it during the season when the eggs are laid by covering the plants with cheese cloth frames, as recommended for Root Maggots (see page 35). The native weed of the West, the Spear-leaved Goosefoot (*Monolepis chenopodioides*) which is stated to be the favourite food plant of these insects, might also be sown close to the spinach to draw off attack.

The Squash Bug

(*Anasa tristis*, DeG.), Fig. 49.

Attack.—Numbers of large, ill-smelling, dark brown bugs, paler beneath, ¾ of an inch long, clustering around squash vines about the end of June and sucking the sap. The eggs are laid in clusters beneath the leaves, and the young are soon found with the full grown bugs.

This destructive enemy of the market gardener attacks all plants of the Gourd family. It is a serious pest in western Ontario, but is seldom troublesome as far east as Ottawa. The insect is a true bug and has the characteristic disagreeable odour of most insects of that family. It passes the winter in the perfect form beneath loose bark of trees, under rubbish in out-buildings, &c. As soon as squashes &c., appear above the ground in spring, the bugs fly to the fields and attack the young plants. Their injuries at that time of the year are particularly severe. Eggs are laid at once and the young bugs of the first generation come to full growth in July. There are two broods in the season, but bugs of all sizes may be found upon the vines after midsummer.

Remedies.—(1.) Hand-picking of the old bugs early in the season is claimed to be the most practical remedy. This should be done early in the morning, during the cooler hours of the day, when the bugs are sluggish. The conspicuous egg clusters should also be crushed when seen.

(2.) Traps. If shingles or short pieces of board are placed among the plants, the bugs will hide beneath them at night and can be destroyed before they become active and leave these retreats the next morning.

(3.) The young bugs can be destroyed by spraying with kerosene emulsion (Remedy 2), or whale-oil soap (Remedy 5).

(4.) In a season when the bugs have been abundant, all vines should be burnt as soon as the crop has been gathered. In this way, many of the insects in all stages of development will be destroyed.

(5.) Trap Crops. A few hills of the ordinary squash may be planted among melons, cucumbers, &c., so that they appear above the ground about a week before the crop. The squashes being more attractive, the bugs collect upon them, where they can be easily destroyed.

The Striped Cucumber Beetle

(*Diabrotica vittata*, Fab.), Fig. 50.

Attack.—Yellow beetles striped with black, two-fifths of an inch in length and half as wide as long. These beetles pass the winter in the perfect state, and, directly

young seedlings of cucumbers or squashes of all kinds appear above the ground, cluster around and destroy them. Later in the year the same beetles attack the plants, devouring the leaves from beneath and also other parts of the plant. The larvæ, which are slender worm-like creatures, white, with dark heads, live in the ground about the roots, boring into them and sometimes working their way up above the ground inside the stems.

The Striped Cucumber Beetle occurs all through Canada, east of the prairies, and is frequently very destructive to young plants in spring, and particularly to the flowers. There are two broods in Canada, the second of which is frequently much more abundant but less destructive than the first to cucurbitaceous plants such as squashes, cucumbers, &c. In addition to this class of plants, the beetles sometimes do considerable damage in crops of peas and beans, gnawing the green pods and rendering them unfit for the market.

Remedies.—Covers. Young plants may be protected from the beetles with a square of cheese cloth kept raised by two flexible sticks crossed at right angles, with the ends stuck into the ground. The cheese cloth can be kept in place by putting some earth on the edges. By the time the plants have grown so as to require the removal of the covering most of the first brood will have disappeared.

Poisons. Spraying the young vines with Poisoned Bordeaux mixture (Remedy 7), will protect cucurbits against the attacks of this beetle, and also of the Cucumber Flea-beetle. Paris green and land plaster, ashes, or lime (one pound of the poison in fifty of the diluent), if dusted over the plants at short intervals of a few days, will destroy a great many of the beetles, and drive others away. A similar remedy is to sprinkle through the plants land plaster thoroughly saturated with kerosene or turpentine, both of which are very distasteful to this insect. Dusting the plants around the roots with refuse tobacco dust, is highly recommended; but this material is difficult to obtain.

The Striped Cucumber Beetles are very active and fly freely from plant to plant, and, as these plants grow very rapidly, all poisons must be frequently renewed.

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PLATE I.

FIG. 1. The Hessian Fly—enlarged and natural size.

FIG. 2. Hessian Fly-puparia—natural size and enlarged.

FIG. 3.—Hessian Fly: puparia on stem.

FIG. 4.—The Joint worm: galls on wheat stems natural size; fly—enlarged.

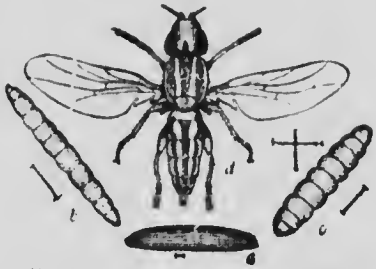

FIG. 5. The Greater Wheat-stem Maggot: *a*, egg; *b*, maggot; *c*, pupa; *d*, fly all enlarged.

(Prof. H. Garman.)

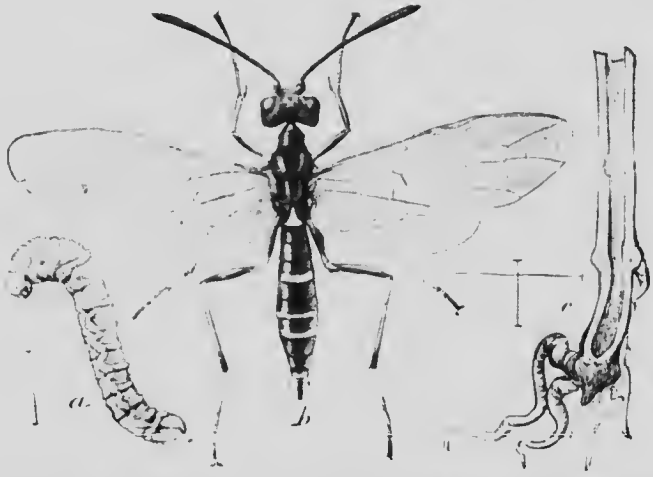

FIG. 6.—The Western Wheat-stem Sawfly: *a*, larva; *b*, female sawfly; *c*, grass stem showing work—*a*, *b*, much enlarged.

(Riley & Marlatt, Insect Life, IV. Division of Entomology, U.S. Dept. of Agr.)

PLATE II.

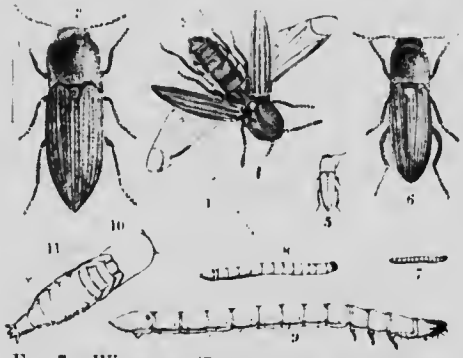

FIG. 7.—Wireworms (7, 8, 9); pupa (10)—enlarged; click-beetles (5—natural size; 2, 3, 6—enlarged). *(Curtis.)*

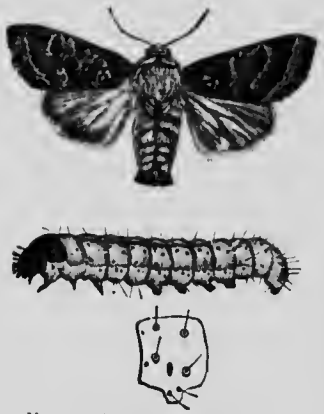

FIG. 8.—The Glassy Cutworm: moth and caterpillar.

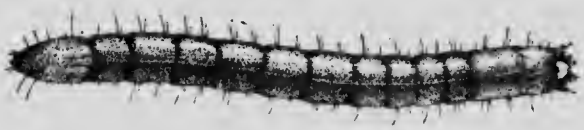

FIG. 9. Corn Wireworm—enlarged 4 diameters. *(Forbes, Bull. 77, Ill. Agr. Exp. Station.)*

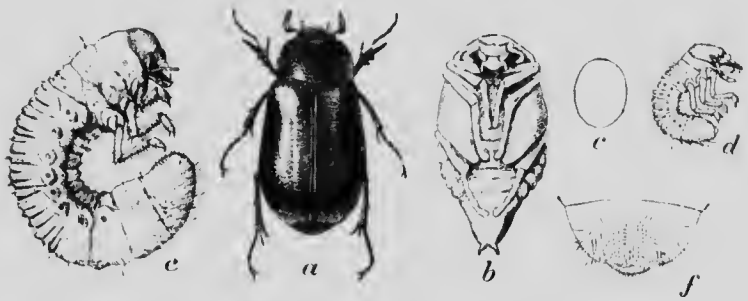

FIG. 10.—May Beetle: *a*, beetle; *b*, pupa; *c*, larva (White Grub)—slightly enlarged. *(Chittenden, Bull. 19, n.s., Div. of Ent., U. S. Dept. of Agr.)*

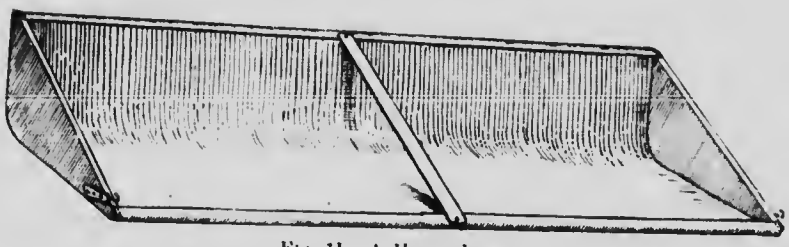

FIG. 11.—A Hopperdozer.

PLATE III.

FIG. 12.—Rocky Mountain Locusts laying eggs.

FIG. 13.—The Common Red-legged Locust.

FIG. 14.—The Two-striped Locust.

(Fig. 12: Riley.—Figs. 13, 14: Chittenden, Bull. 43, n.s., Div. of Ent., U.S. Dept. of Agr.)

FIG. 15.—The Pea Moth: caterpillar and moth—2 and 4 enlarged.
(Curtis.)

FIG. 16. The Pea Weevil: *b*, beetle; *c*, larva; *d*, pupa—enlarged and natural size.
(Curtis.)

FIG. 17.—The Bean Weevil

FIG. 18.—The European Bean Weevil.

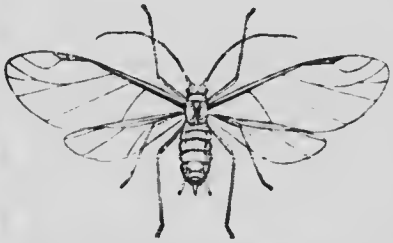

FIG. 19.—The Destructive Pea Aphis: winged viviparous female—enlarged 6 times.

Fig. 20.—The Clover Root-borer.

Fig. 21.—Army-worm.

Fig. 23.—The Cotonny Grass Scale: egg-sacks on grass.

Fig. 22.—Army-worm: moth and pupa.

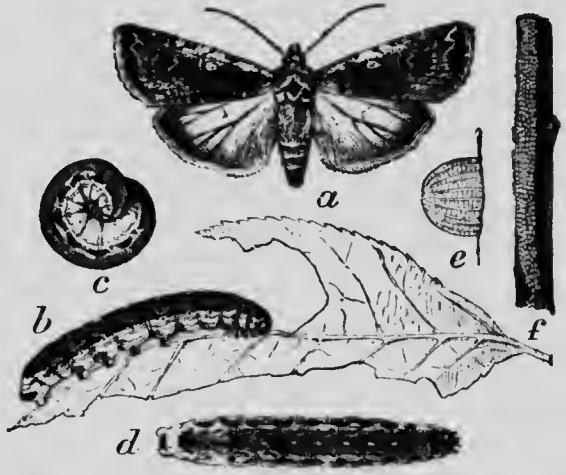

Fig. 24.—The Variegated Cutworm: *a*, moth; *b*, *c*, *d*, caterpillars; *e*, egg—enlarged; *f*, egg mass on twig.

Fig. 25.—The Greasy Cutworm.

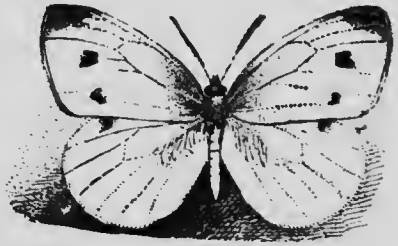

Fig. 26.—The Small White Cabbage Butterfly.

(Figs. 24, 25: Chittenden, Bull. 43, n.s., Div. of Ent., U.S. Dep. of Agr.—Fig. 26: Chittenden, Circ. 60, Div. of Ent., U.S. Dep. of Agr.)

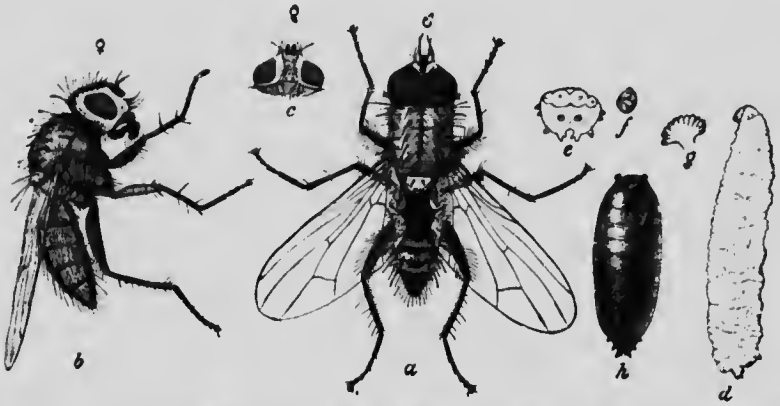

FIG. 27.—The Seed-corn Maggot: *a*, *b*, flies; *d*, maggot; *h*, puparium—all very much enlarged.

FIG. 28.—The Cabbage Maggot: 1, maggot; 2, 3, pupa case; 4, fly—1, 3 and 4 enlarged.

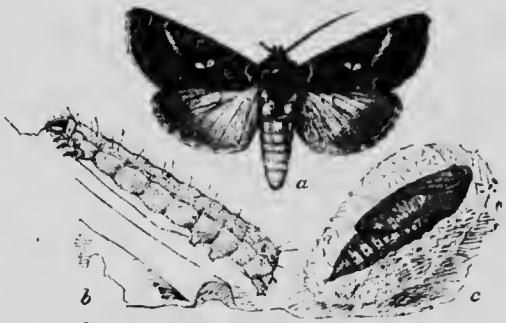

FIG. 29.—The Eyed Cabbage Looper: *a*, moth; *b*, caterpillar; *c*, pupa in cocoon—all somewhat enlarged.

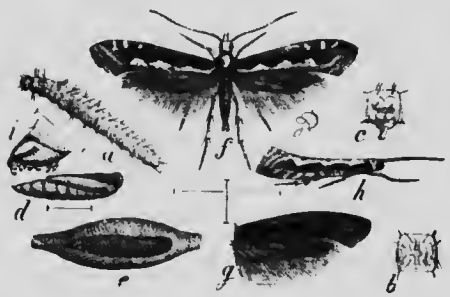

FIG. 30.—The Diamond-back Moth: *a*, caterpillar; *d*, pupa; *e*, cocoon; *f*, moth—enlarged.

FIG. 31.—The Cabbage Plusia: *a*, caterpillar; *b*, pupa in cocoon; *c*, mot...

(Figs. 27, 29, 31: Chittenden, Bull. 34, n.s., Div. of Ent., U.S. Dep. of Agr.—Fig. 30: Rep. 1884, U.S. Dep. of Agr.)

PLATE VI.

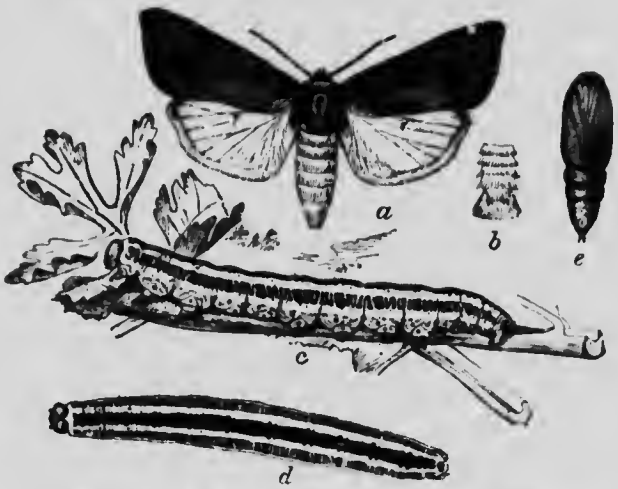

FIG. 32.—The Zebra Caterpillar : *a*, moth ; *c*, pupa ; *d*, caterpillar.

FIG. 33. The Spotted Blister Beetle enlarged.

FIG. 34.—The Four-lined Leaf-bug.

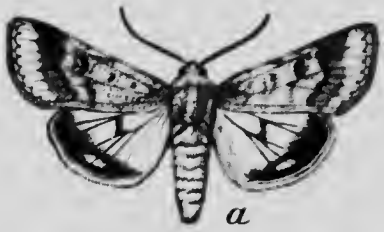

FIG. 35. The Corn Worm : moth and caterpillar.

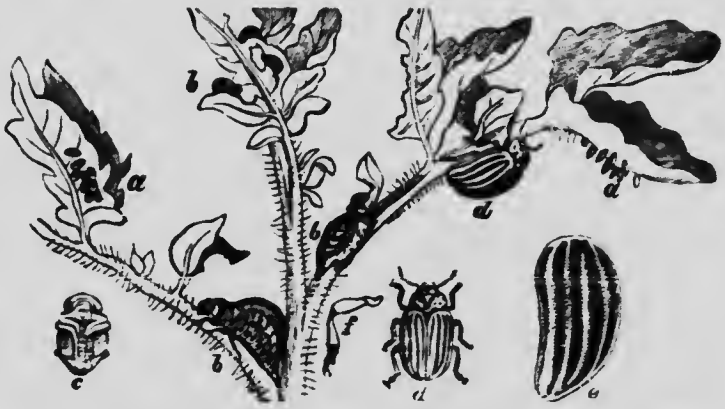

FIG. 36.—The Colorado Potato Beetle : *a*, eggs ; *b*, larva ; *c*, pupa ; *d*, beetle.

(Figs. 32, 33 Chittenden, Bull. 43, n.s., Div. of Ent., U.S. Dept. of Agr.—Fig. 35 Howard, Farmers' Bull. 120, U.S. Dept. of Agr.)

PLATE VII.

FIG. 37.—The Cucumber and Potato Flea-beetle.

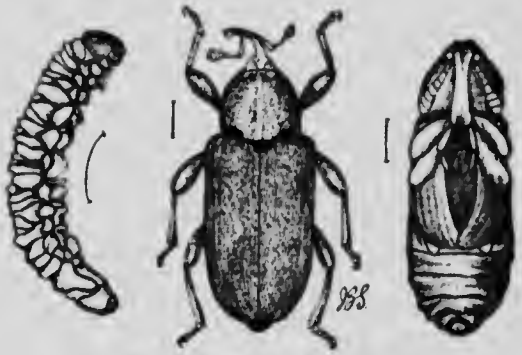

FIG. 38.—The Potato Stalk Weevil: larva, beetle and pupa—enlarged.

FIG. 39.—The Red-headed Flea-beetle—enlarged 8 times.

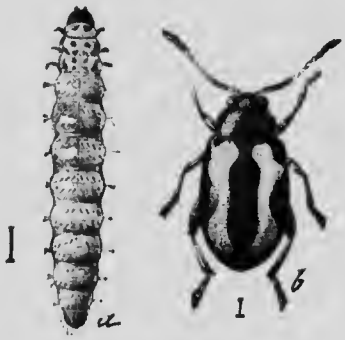

FIG. 40.—The Turnip Flea-beetle—enlarged 8 times.

FIG. 41.—The Red Turnip Beetle—enlarged 6 times.

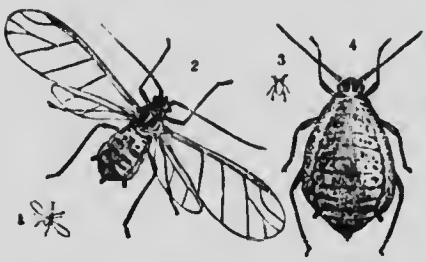

FIG. 42.—The Cabbage Aphis male; 3 and 4, wingless female—2 and 4 enlarged,

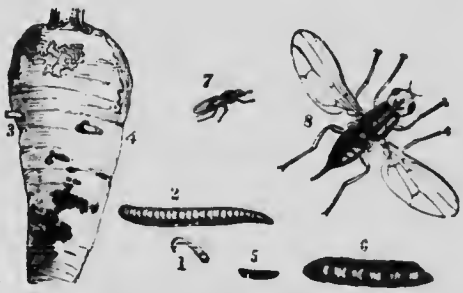

FIG. 43.—The Carrot Rust-fly—1, 5, 7, natural size; 2, 6, 8 enlarged.

(Fig. 37: Chittenden, Bull. 19, n.s., Div. of Ent., U.S. Dept. of Agr.—Fig. 38: J. B. Smith, Economic Entomology.—Figs. 39, 40, 41: Chittenden, Bull. 34, n.s., Div. of Ent., U.S. Dept of Agr.—Fig. 43: Curtis.)

Fig. 44. The Common Asparagus Beetle enlarged 8 times.

Fig. 46. The Common Asparagus Beetle: different stages on asparagus spray

Fig. 47. The Beet Carrion Beetle (5, 6); larva (1, 2, 3, 4).

Fig. 48. The Spinach Carrion Beetle enlarged 4 times.

Fig. 49. The Squash Bug.

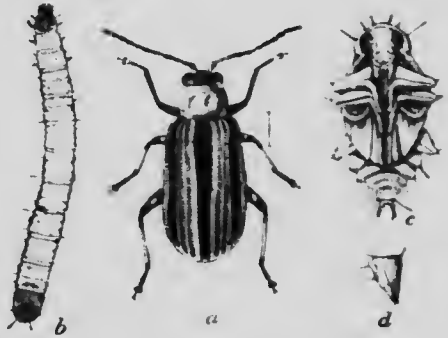

Fig. 50. The Striped Cucumber Beetle: *a*, beetle; *b*, larva; *c*, pupa—enlarged 8 times.

Fig. [illegible] [illegible] b [illegible] times.

(Figs. 44, 45, 46. Chittenden, Year Book, 1898, U.S. Dep. of Agr.—Fig. 47: Curtis. Fig. 48. Chittenden, Bull 33, n.s., Div. of Ent., U.S. Dep. of Agr.—Fig. 50: Chittenden, Circ. 31, 2nd s., Div. of Ent., U.S. Dep. of Agr.)