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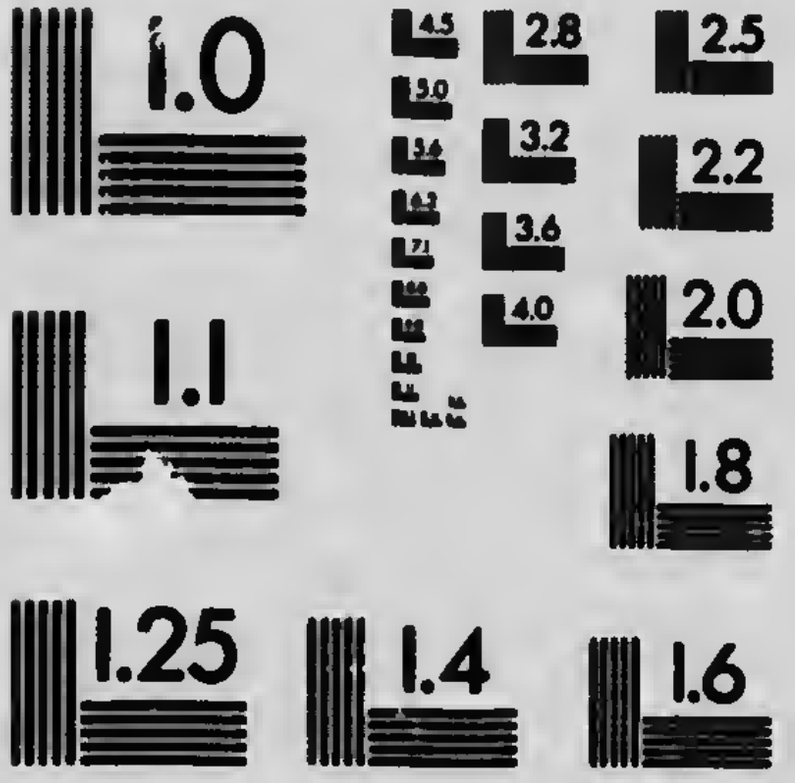

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BULLETIN 171.] [APR '09

Ontario Department of Agriculture.

ONTARIO AGRICULTURAL COLLEGE

Insects Affecting Vegetables.

By C. J. S. Bethune.

Before taking up in order the insects that attack the various plants grown in our vegetable gardens, attention may be drawn to a number of kinds that are general feeders, not limiting themselves to any particular varieties, but attacking almost everything that comes in their way ; on that account they are the most serious foes that we have to contend against and in many cases the most difficult to keep under control.

Aphids (Plant-lice)—Figs. 1 and 2—are minute pear-shaped, soft-bodied insects that may be found on almost every kind of plant, usually in dense colonies clustered thickly on the terminal twigs and buds, on the under-side of leaves, on stems and other parts, and even under ground on roots. Wherever situated they are occupied in the same manner—sucking out the life-juices of the plant and multiplying their own numbers by constant reproduction of living young all through the summer. There are a great variety of species, most of them varying shades of green in color, some are shining black, others bright red ; some again are covered with waxy filaments resembling threads of cotton wool, and others with a dusting of a mealy substance composed of the same material. Singly they are insignificant creatures, but occurring as they do in enormous numbers and multiplying with amazing rapidity, they are able to seriously injure and often to destroy the vegetation that they attack. Fortunately they are devoured by many predaceous insects, such as lady-bird beetles and their larvae and those of lace-winged and syrphus flies and other creatures (Figs. 3 to 8); washed off and drowned by heavy rains, and reduced in

NOTE.—The object of this Bulletin is to furnish the vegetable grower, whether on the farm or in the garden, with a convenient manual for the indentification of the ordinary insect and fungus pests which injure his crops, and to describe the remedies which experience has proved to be the most effective in each case. As a general rule it will be found that thorough tillage of the soil, a short rotation of crops, ample manuring and clean cultivation are the best of all remedies. All refuse remaining on the ground after the crop has been removed, such as stalks, roots and leaves, should be got rid of by burning or burying in order to leave no shelter for wintering insects and no diseased material for the spread of fungus diseases. Weeds of all descriptions, especially in fence corners and waste places, should be cut down before going to seed, or plowed under from time to time ; they harbor many of our worst pests in summer and winter, and often afford convenient breeding places for enemies which the vegetable grower is endeavoring to combat on his cultivated plants.

numbers by internal parasites; otherwise they would in time destroy all vegetable life. Ants are usually to be found prowling about the colonies; they do not eat the Aphids, as might be suspected, but are attracted by the sweet "honey-dew" that exudes from them, and take them under their special protection.

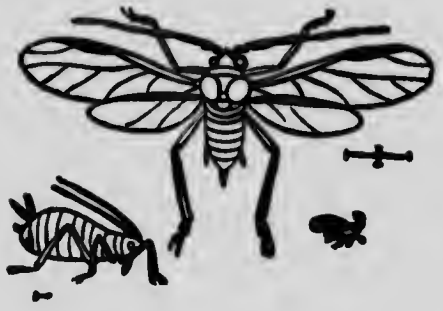

Fig. 1. Winged aphis and wingless form—much magnified.

Fig. 2. Wingless aphis—greatly enlarged.

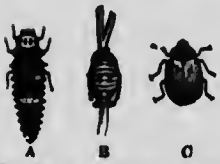

Fig. 3 Lady-bird beetle—*a*, larva; *b*, pupa; *c*, beetle—natural size.

Fig. 4. Lady-bird beetle and larva—magnified.

Fig. 5. Lady-bird beetle—slightly enlarged.

Fig. 6. Lace-winged fly.

Fig. 7. Lace-winged fly—*a*, eggs on stems; *b*, larva.

Fig. 8. Syrphus-fly larva sucking an aphid.

In gardening operations nature's checks are not sufficient, but require to be supplemented with artificial remedies such as kerosene emulsion, strong washes of soap-suds or tobacco decoction. In greenhouses they can be kept in control by burning the commercial preparation of tobacco.

ANTS. These insects are often suspected injuring the plants over which they are seen running, but as a rule they are only indirectly responsible. A few species, such as the large black Carpenter Ants, form their galleries in trunks of trees, posts and timber and do a considerable amount of damage, but the great variety of smaller species which infest our gardens do not feed upon foliage or injure growing plants. Sometimes they may be found upon unopened flower buds, but they are only attracted by some sweet secretions on the surface; as a rule their presence indicates that there is a colony of Aphids near by, which they take under their protection in order to obtain from them the sweet "honey-dew" exuded by these minute creatures. The worst injury for which ants are responsible is the establishmnt of colonies of Aphids upon the roots of many plants; the ants collect the eggs and take care of them during the winter and when growth is sufficiently advanced carry them to the roots and look after them during the summer, in order to have a constant supply of "honey dew." These colonies increase rapidly and soon check the growth of the plant and ultimately destroy it. Where ants' nests abound, frequent digging and stirring of the soil, and in field cultivation repeated disking and harrowing, will get rid of many, or they may be treated with carbon bisulphide; a small quantity should be poured into the entrance of the nest or into a hole made with a stick and quickly covered with earth; the fumes will speedily kill all the inmates. It is best to perform the operation towards evening when all the ants are within the nest.. This is a very effective mode of getting rid of the large colonies which make mounds of rubbish on lawns and in fields.

CUTWORMS. At the beginning of the growing season the gardener often finds in the morning young plants cut off near the surface of the ground that the evening before were strong and healthy. On stirring up the soil near by he may find hidden in the ground a greasy-looking caterpillar, the culprit in the case. Cutworms, so called from this habit, are the caterpillars of dull-coloured night-flying moths (Figs. 9, 10 and great variety of species and varying to some extent in their As a general rule they are partly grown at the approach of winhide away in a torpid state during the cold weather; when to activity by the warmth of spring, which causes the buds to open and the growth of plants to begin, these worms come out in search of food and attack any kind of tender vegetation that they meet with. They are nocturnal in their habits and hide away during the hours of daylight under any shelter they can obtain or just below the surface in the loose soil of newly made beds. Owing to their destructive practice of cutting off a whole plant in order to devour a portion of its foliage, they do a great deal of apparently needless damage.

After they have become fully grown they change to the chrysalis stage in the ground and in early summer the moths appear, many of them making their presence known in our houses by their attraction

to light. Before very long another brood of caterpillars comes upon the scene, often more numerous and more destructive than the first. Some of them climb up into fruit trees and destroy the foliage, others

Fig. 9. Variegated Cutworm—*a*, moth; *b*, *c*, *d*, caterpillars; *e*, egg (magnified); *f*, eggs on a stem.

Fig. 10. Cutworm and Moth.

Fig. 11. The Glassy Cutworm.

attack farm crops, vegetables, grape vines, the plants in flower gardens, etc., while occasionally a single species appears suddenly in enormous numbers and sweeps like an army over the land devouring everything that comes in its way.

Happily a very simple and completely effective remedy has been found for these destructive creatures. It is called the "poisoned bran-mash" and is made in the following manner: Mix half a pound of Paris green in 50 lbs. of bran (the proportion for larger or smaller quantities is 1 to 100); the poison should be added to the dry bran little by little and stirred all the time till the whole is tinged with the green colour, then add water sweetened with sugar, or molasses, till the mixture is sufficiently moistened to crumble nicely through the fingers. If bran cannot be procured, shorts or flour may be used, and for field work may be distributed dry by means of a seed drill. The mash should be scattered about the plants that are liable to attack in the evening, and

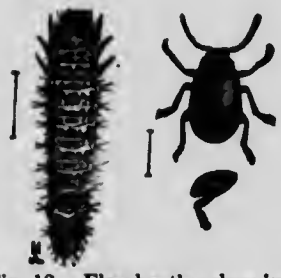

Fig. 12. Flea-beetle, showing dilated thigh of hind legs, and larva much enlarged.

Fig. 13. Flea-beetle—*a*, leaf, with larvæ at work upon it; *b*, larva, greatly enlarged; *c*, pupa; *d*, beetle magnified.

strange to the worms will devour it in preference to their ordinary vegetable food. When they begin to feel the effects of the poison they wander off to find a hiding place or burrow in the ground and there die. Their dead bodies will be readily found in the morning just below the surface of the ground, often in surprising numbers. Young plants, such as cauliflowers, tomatoes, &c., may be protected when set out by wrapping a bit of newspaper around the stem between the root and the leaves and reaching a little below the surface of the ground. The worms will not attempt to bite through or climb over it.

FLEA-BEETLES. There are several species of these minute insects which attack a large variety of plants; some confine their attentions to one or two kinds, while others are general feeders. The beetles are about one-tenth of an inch in length, oval and convex in form, usually

shiny black or bronzed in color, sometimes ornamented with broad, pale stripes along the back; they all possess enormously developed thighs on the hind legs (Fig. 12), by means of which they are enabled to jump with great agility and hence have acquired the name of Flea-beetles. They appear in early spring, often in large numbers, and eat small holes in the foliage of young plants (Fig. 13), preferably the thick seed-leaves. The larvæ, as far as known, feed for the most part on the roots of weeds, as well as upon some garden vegetables; clean cultivation, especially of fence corners and bits of waste land, is therefore of much importance in the control of these and many other kinds of insects. The beetles may generally be found all through the summer when they especially attack the foliage of potatoes, turnips, beets, tomatoes, and many other plants. In many cases, fungus diseases, such as potato blight find suitable places for the growth of their spores in the holes made in the leaves by these beetles.

Cheese-cloth screens are very effective in warding off attacks upon young plants, such as cucumbers, etc., but where their use is not convenient or practicable the beetles may be controlled by the use of the poisoned Bordeaux mixture, the combination being effective against both the insects and the fungus diseases. For tender foliage arsenate of lead is preferable to Paris green as it is not so likely to cause injury by burning.

Grasshoppers (or Locusts as they should be called)—Fig. 14—are often very destructive in the later summer months, especially if the weather should be dry and hot. They are general feeders, few kinds of vegetation coming amiss to them when they are numerous and the supply of food at all scanty. Usually they are most abundant in dry pastures and the neighboring grain fields; this is due to the fact that their eggs are laid in grass lands, especially where the soil is dry and sandy, and the young nymphs grow there to maturity. They do not pass through any chrysalis stage, but gradually become bigger after each moult till the fully-winged adult state is reached. Many mechanical devices have been employed for their destruction, but the use of these troublesome methods can now be dispensed with since the discovery of the "Criddle mixture," a poisoned bait which derives its name from Mr. Norman Criddle, of Aweme, Manitoba, who proved its complete efficiency after a series of experiments. It is made and applied as follows: Take a three-gallon patent pail and fill it with fresh horse droppings, then empty into a barrel; repeat this five times. As each pailful is poured in, mix thoroughly with the manure about a quarter of a pound of Paris green and half a pound of salt which has been dissolved in water. There would thus be used about one pound of Paris green and two pounds of salt to half a barrel of manure. The mixture may be drawn in a cart to the infested places and scattered broadcast with a trowel or wooden paddle. The grasshoppers are attracted to it from considerable distances and are killed in large numbers. It has been found most

effective to distribute the mixture on alternate days, a little at a time, rather than to use larger quantities at longer intervals. In the case of grain fields, oats being especially liable to attack, the mixture should be thrown into the grain along the sides of the field and the grasshoppers will eat it in preference to anything else. Care should be taken not to allow cattle or poultry to have access to it.

PLANT-BUGS. In the American use of the word the name "Bug" is erroneously applied to insects of every kind—to a beautiful butterfly or moth as well as to a disgusting bed-bug. The name, however, when correctly employed denotes insects belonging to the order Hemiptera, which are provided with sucking and not biting mouth-parts, and which do not pass through any quiescent chrysalis stage but are gradually

Fig. 14. Grasshopper or Locust.

Fig. 15. Tarnished Plant-bug — much magnified (*Lugger*).

developed from the newly hatched larvæ to the winged adult. To the true bugs belong two species which are very abundant in gardens, attacking plants of all descriptions, flowers and vegetables alike. These are the Tarnished and the Four-lined Plant-bugs.

The Tarnished Plant-bug (*Lygus pratensis*)—Fig. 15—is to be found all through the season on plants of almost every kind, sucking the juices of flower buds and foliage and sometimes of the leaves of young fruit trees. The mature insects are oblong in form with a triangular head and prominent eyes, and tapering to a rounded angle at the tail. The color is variable, usually grayish brown, marked with yellowish and black dashes, and having a slight bronzy reflection; its length is a little over a quarter of an inch. They are very active insects, taking flight readily when disturbed, or dodging round to the other side of the plant.

The Four-lined Plant-bug (*Poecilocapsus lineatus*)—Fig. 16—is much the same size and shape as the preceding, but is yellow in color, with dark lines down the back and four black dashes along the thorax. Its at-

tacks are most noticeable in early spring, when it may be found on mint, sage, currant and gooseberry bushes, and often also on potatoes. It sucks the juices of the tender terminal leaves, causing them to shrivel up and turn black, and frequently severely injuring the plant. The standard remedy for these and other sucking insects is spraying with strong kerosene emulsion; where this cannot be applied, as in the case of many flowering plants, dusting with pyrethrum insect powder has been found quite effective. Much may be done by knocking off the bugs with a stick into a pan containing a little water covered with a film of coal-oil; this should be performed in the cool of the morning when the insects are less lively than during the heat of the day.

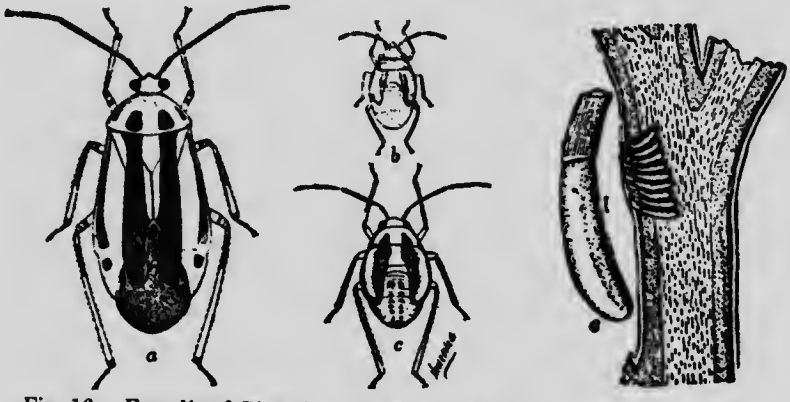

Fig. 16. Four-lined Plant-bug: *a*, adult; *b* and *c*, immature nymphs; *e*, eggs laid in a slit (*Lugger*).

White Grubs. These are the larvæ of May-beetles or "June-bugs" (*Lachnosterna*) which breed for the most part in old pastures. The beetles appear about the end of May or early in June and attack the tender foliage and buds of fruit and ornamental trees, often inflicting a considerable amount of damage. They come out at night and swarm about the trees, making a loud buzzing noise; many are attracted by lights in houses and cause some consternation among the inmates through their clumsy flight about the room and the noise that they produce; as they can neither sting nor bite no alarm need be caused by their presence. During the night they feed and by morning all disappear, hiding underground where the soil is loose and under grass or rubbish about fences and buildings. At this period boys might be employed to search for and kill them; trap-lanterns have sometimes been used with advantage, and spraying the trees they frequent with Paris green will destroy large numbers. The beetles deposit their eggs on the stems or roots of grasses just below the surface of the soil; from these the grubs hatch out and feed for two or three years underground. During the summer of their third season they change to the pupal state

and transfrom to beetles about September, but do not come out until the following spring. This long larval stage accounts for the fact that in some localities the beetles only appear once in three years. (Fig. 17).

The grubs, when fully grown, are thick, fat creatures, white in color—hence their name—with the body partially curled up and the last segments discolored from the food showing through the skin. When an old pasture is broken up they live for a time on the grass and roots that have been turned under and then attack whatever plant may

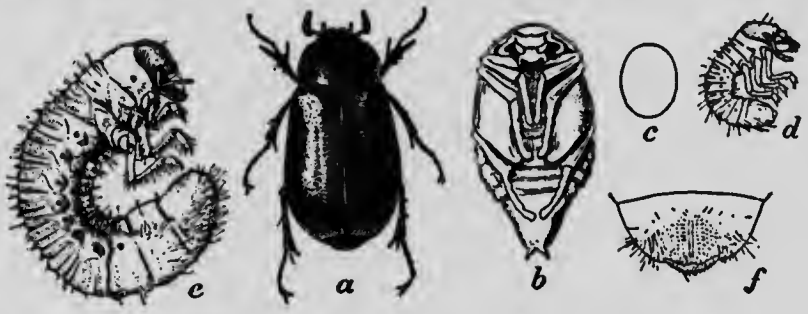

Fig. 17. White-grubs: *a*, beetle; *b*, pupa; *c*, grub; *d*, pupa (*Chittenden, U.S. Dept. Agric.*)

Fig 18. *a*, Wire-worm; *b*, Click-beetle.

be grown. The first and second crops usually suffer most, especially strawberries and corn; clover is least affected by them and may be seeded down with rye, then small grains followed by corn or potatoes. Late and deep plowing will break up the winter quarters of the grubs and beetles and expose them to frost and also to the various animals that prey upon them. Pigs and poultry greedily devour them; crows and other birds and skunks also destroy large numbers when they can get access to them.

In gardens digging deeply and trenching in the fall is very useful, but in the flower beds where perennials are grown this is impracticable, and therefore recourse can only be made to disturbing the soil between the plants as much as possible in late autumn and early spring. Lawns and golf-links are frequently very badly affected as they are left for many years undisturbed; sometimes the roots of the turf have been so completely eaten off that the sod may be rolled up like a carpet. In such cases the best plan is to dig up the part affected and destroy the grubs, put in a fresh layer of soil and resod or sow with grass seed. For small patches, watering with kerosene emulsion, and washing it well in with plenty of water from the garden hose, will kill the grubs. Where large areas are found to be affected on golf-links or in pastures, the most effective plan is to enclose the place with hurdles and turn in a few young pigs; they will soon root out and devour all the grubs, and may then be removed to another spot.

WIREWORMS are the larvæ of Click-beetles, so called from their curious habit of springing up in the air with a "click" when laid upon their backs. The beetles are long and narrow, rounded above, with very short legs and usually dull gray or black in color. (Fig. 18). The grubs are long and cylindrical, with a very hard integument from which they get the name of "Wire-worms," and yellow or whitish in color. The life history is very similar to that of the White-grubs; they breed chiefly in old pastures, take two or three years to mature, and feed upon the roots of any plants that may be convenient to them; they are especially injurious to corn, and often may be found during the winter feeding inside potatoes in which they burrow great holes. No treatment of the soil with salt, poisons, &c., has any effect upon them; the only remedy is a short rotation of crops as in the case of White-grubs; plowing in August and cross-plowing again in September will destroy large numbers of them. In gardens, as the beetles usually spend the winter under any shelter they can find, clean cultivation, especially along the fences, is of great importance; in spring many may be destroyed by placing bunches of clover or weeds poisoned with Paris green under shingles or bits of board where the beetles go for shelter.

ASPARAGUS.

ASPARAGUS BEETLES. The two species, the Blue (*Crioceris asparagi*) and the 12-spotted (*C. 12-punctata*), have spread over a great part of Ontario during the last few years and in many places are very abundant. Both species are often to be found upon the same plant; the former (Fig. 19) is shining blue-black in color with creamy-white blotches on the wing covers which vary a good deal in size and shape, and sometimes form a cross of the ground color of the back; the sides and the thorax are dull red and the head black. The other species (Fig. 20) is the same length, about a quarter of an inch, but is somewhat stouter; the whole insect is dull red and polished and has twelve round black spots on the wing covers.

Both these beetles pass the winter in the adult stage and are ready to attack the aspargus shoots as soon as they appear above ground in the spring; these they gnaw and spoil for table use, and the Blue species deposits upon them its shiny black eggs which are attached by the tip to the plants. (Fig 21). Later on the eggs of both species may be found upon the growing plants, and the larvæ soon appear. Those of the Blue beetle are dark olive gray grubs, which feed openly upon the foliage; the grubs of the 12-spotted are yellowish or somewhat orange in color, feeding at first upon the tender foliage, but boring into and devouring the pulp of the seed capsules as soon as they are large enough to attack. The life cycle of both kinds requires only six or seven weeks for its completion and we therefore find all through the season till sharp frosts come in the autumn, eggs, larvæ and beetles in great numbers at the same time; the pupal stage is passed beneath the surface of the ground.

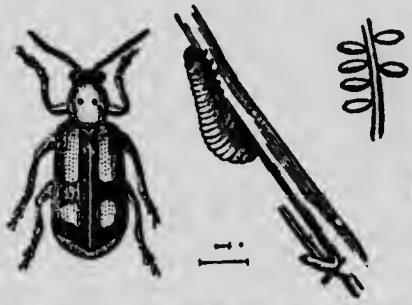

Fig. 19. Blue Asparagus beetle, larva and eggs—magnified.

Fig. 20. Twelve spotted Asparagus beetle—magnified.

Fig. 21. Blue Asparagus beetle, larva and eggs on shoot.

Remedies: The simplest and most efficient remedy is to let poultry have the run of the beds; they will devour both beetles and grubs and will not touch the asparagus.

Where this is not practicable, the young shoots shouk be dusted with fresh air-slaked lime when the morning dew is on the plants; this, of course, should be washed off before cooking. At the same time some of the shoots may be allowed to grow and attract the beetles which may then be killed with Paris green or arsenate of lead. If the plants have many eggs upon them, they should be cut off and burnt and others left to grow in their place.

After the cutting season is over the plants should from time time be sprayed with one of the arsenical poisons, but when the se capsules are formed this will be of no avail against the grubs of the r spotted species. To get rid of it, the seed bearing plants should cut off and burnt. In early autumn it will be well to cut down and bu the whole of the plants.

Beans.

The Bean Weevil (*Bruchus obtectus*). This insect has only oee reported from a few places in Ontario and Quebec, and does not appe to have become established as a pest. It is a very small beetle, on tenth of an inch long, only half the size of the Pea-weevil, which other respects it closely resembles. It is grayish brown in color, du to a coating of dense fine hair; the wing-covers are marked with a seri of lines running lengthwise and have a mottled appearance. The beet is oval in shape, the head is bent down and terminates in a short squa beak; the end of the abdomen is not covered by the wings, and diffe from that of the Pea-weevil in being destitute of the two oval blac spots which are characteristic of the latter.

Fig. 22. Bean Weevil much enlarged and natural size; infested bean.

The eggs of the insect are laid upon the young bean pods; th grubs, as soon as they are hatched, bore through and enter the bean inside, several making their way into a single bean. Maturity is reache in the autumn, when the beetles emerge if the season is warm; otherwis they remain all winter in the ripened bean. If unmolested they wil increase and multiply in the dry seeds and continue their work of destruc tion for a long time. It is therefore useless to hold over the seed for a year, as may be done to get rid of the Pea-weevil.

Remedy: Whenever this insect is found to be present, the beans should be fumigated as soon as practicable after they are harvested. This is done by putting them in a barrel or tight bin and pouring on them one ounce of bisulphide of carbon for every 100 lbs., and then clos ing the receptacle tightly and leaving it for 48 hours. At the end of this time every insect will be dead. As the fumes of this substance are inflammable and explosive, it should not be used near any light or fire.

Beans that have been injured by the insect should on no account be used as seed, as most of them will fail to germinate, or at any rate will produce only feeble plants.

The Bean Plant-Louse (*Aphis rumicis*). Windsor or Broad Beans and Horse-beans are not much grown in this country, though in some places they are found of value as an addition to ensilage. Some difficulty is experienced in obtaining satisfactory crops owing to their liability to attack by this black Aphis, which is a serious pest in Europe. At the time of flowering the colonies of this insect are to be found covering the tips of the plants so thickly that they look as if dusted with soot; if let alone they soon multiply enormously and greatly reduce the vitality of the plants.

Remedies: The most successful plan is to cut off the tips of the affected plants and destroy the colonies of Aphis by burning or trampling under foot. This has the additional benefit of checking the growth and causing the pods to fully develop. Spraying with kerosene emulsion or strong soap-suds will also be effective.

Other Insects. Beans, like other vegetables, are liable to be injured by Cutworms when the plants are small, and later on in the season by the Tarnished Plant-bug. Broad beans are also subject to attack by the Black Blister-beetle, which is one of the enemies of the potato plant, and sometimes appears in destructive numbers.

Beets and Spinach

Beets and spinach are liable to be attacked by many of the common garden pests that are general feeders, such as Cutworms which bite off the young plants close to the surface of the ground, Wire-worms and White-grubs which feed upon the roots, Flea-beetles, Leaf-hoppers, the Tarnished Plant-bug and Grasshoppers which affect the foliage. Descriptions of these insects and the methods of dealing with them will be found elsewhere in the Bulletin. Mention may be made of a few other insects which ocasionally attack these plants in injurious numbers.

Blister Beetles. (*Epicauta cinerea, Pennsylvanica, etc.*)—Fig. 23—These are long, narrow, soft-bodied insects which belong to the same family (*Meloidæ*), and possess the same blistering qualities as the "Spanish-fly," which is used by druggists in the preparation of certain plasters. There are three species found in Ontario which may be distinguished by their color: the Black, the Gray and the Spotted; a fourth, the Striped, is occasionally to be found. Of these the Black is the most common and may often be seen feeding harmlessly on the flowers of the Golden-rod. At times these beetles appear in swarms and rapidly devour the foliage of beets, potatoes and a few other plants, and after inflicting a considerable amount of damage suddenly disappear. They may be controlled by spraying with Paris green, but this should not

be resorted to unless the attack is serious, as their grubs have the ver
useful habit of feeding upon the eggs of grasshoppers and may therefor
be included amongst the beneficial insects. A better remedy, which ha
been employed with success, consists in driving the beetles away fro
an infested field by a party of men or boys walking in a line acros
and waving branches from side to side. The beetles thus disturbe
fly ahead, and by following them up may be cleared out entirely; onc
they are driven out of a field they seldom return. Spraying wit
Bordeaux mixture will keep them off the plants, and may be employe
if necessary.

The BEET LEAF-MINER (*Pegomyia vicina*) Blotches may often
seen on the leaves of beets and spinach, which are found on investig
tion to be caused by a minute maggot which feeds on the green tiss
below the skin. The parent insect is a two-winged fly about a quart
of an inch in length, which deposits its eggs on the foliage of these plant

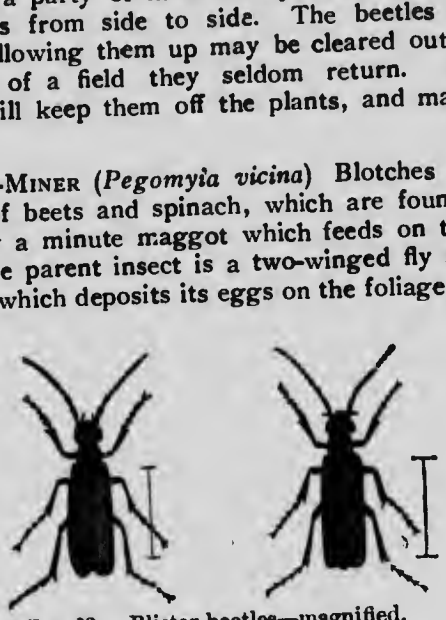

Fig. 23. Blister beetles—magnified.

the maggots when hatched immediately burrow beneath the surf
and cannot therefore be reached by any applications. The only met
that seems at all available is to pick off and destroy the infested lea
a laborious plan which can only be adopted where the plants are gr
on a small scale. If the attack is serious it would be worth while
adopt this method in order to get rid of the trouble and guard aga
its repetition.

CATERPILLARS. The foliage of beets and spinach is liable to
attacked by some caterpillars, but as a rule they are in small numb
widely scattered over the plants and seldom inflicting much dam
This does not apply to the extraordinary outbreaks on rare occas
of the Army-worm and the Variegated Cutworm, which devour e
green thing that they come to, beets as well as everything else. An
the others referred to may be mentioned the Yellow Woolly-
(*Diacrisia virginica*), which is a hairy caterpillar, readily seen fro
bright yellow color, and attaining to an inch and a quarter in le
when fully grown.—Fig. 24—It turns into a beautiful snow-white m
with a few black dots on its wings and rows of black and yellow

on its body. When feeding they are conspicuous, and may be picked off by hand; but usually they are beneath the leaves when at rest. If very numerous, Paris green may be employed. They are general feeders and do not confine themselves by any means to garden vegetables, but attack many kinds of weeds as well.

Cabbage and Cauliflower.

These plants are subject to a series of attacks by insects from their first appearance above ground to maturity. Cutworms destroy a great many seedlings and young plants when they are set out in the spring. Later on Plant-lice make their appearance, and cover the leaves with their colonies, sucking out the sap and causing the foliage to dry up and wither; they become excessively numerous towards the close of the season, and in addition to the injury they inflict, cause the plants to

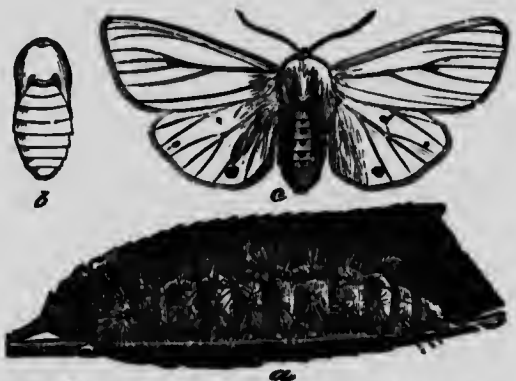

Fig. 24. Yellow Woolly-bear : *a*, caterpillar ; *b*, chrysalis ; *c*, moth.

present a disgusting appearance. Throughout the summer the leaves are liable to be devoured by several caterpillars and in August and September by Grasshoppers, while the roots are frequently caused to rot by the Maggots of a small fly. Aphids and Cutworms and other general feeders are treated elsewhere; reference will therefore be only made here to such insects as are peculiar to the Cabbage and other Cruciferous plants.

The White Cabbage Butterfly (*Pontia rapæ*)—Fig. 25. This insect, which came to us from Europe about fifty years ago, is now one of our commonest butterflies, and may be seen flitting about everywhere from early spring till cold weather sets in. It is one of the worst pests that the cabbage grower has to contend with unless measures are taken to prevent its ravages, and happily this is a matter of no great difficulty. The butterfly lays her eggs on the leaves of the food-plant; the

caterpillars are velvety green and almost exactly the color of the leaves upon which they are feeding; when at rest they lie at length upon the midrib and are not easily seen. There are two broods in the year, the later being much the more numerous, and sometimes a third if the autumn should be fine and warm. The caterpillars riddle the outer leaves and then burrow into the heads, devouring the substance and spoiling the plant for table use by their excrement. Besides Cabbages and Cauliflowers they attack also mignonette, stocks and nasturtiums.

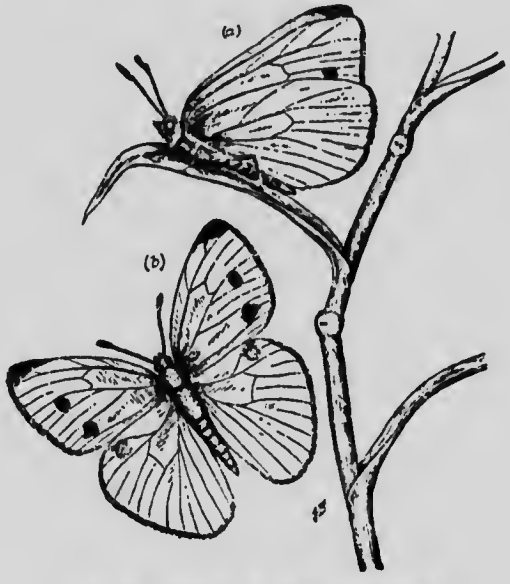

Fig. 25. White Cabbage Butterflies.

Remedy: Pyrethrum insect powder is thoroughly effective. One pound should be mixed with four pounds of cheap flour and kept in an air-tight jar or canister for twenty-four hours so that the poison may be thoroughly incorporated with the flour. The plants infested by the caterpillars should then be dusted with the mixture which can be applied with a small bellows, or in a cheese-cloth bag tapped lightly with a slender rod. This powder will kill insects, but is perfectly harmless to human beings. Another method, which is more rapid in its effects upon the worms, is to dissolve two ounces of the Pyrethrum powder in three gallons of lukewarm water and spray at once. The liquid kills immediately all the caterpillars it reaches, while the dry powder often takes many hours to produce the same result. Paris green and other virulent poisons should never be applied to Cabbages and vegetables of any kind that are intended for table use.

The Zebra Caterpillar (*Mamestra picta*)—Fig. 26. There may often be found feeding upon Cabbage and some other garden plants of the same family, a handsome caterpillar about two inches long, when fully grown. It is velvety black on the back and has two bright yellow stripes along the sides, which are connected by a series of irregular yellow lines on a black ground-color; the head and feet are reddish. These strikingly contrasting colors render the caterpillar a conspicuous object on the green foliage that it feeds upon, and make it an easy task to pick them off by hand. There are two broods in the year, the moths, which are dull reddish-brown with white underwings, appearing in May and August. The young caterpillars, when first hatched, feed in colonies and devour the green substance of the leaves, thus producing white blotches on the foliage and rendering their presence easily noticeable. Should they be too numerous to be destroyed by hand picking, resort may be had to Pyrethrum powder applied as mentioned above, or to

Fig. 26. Zebra Caterpillar and Moth.

white hellebore which may be dusted on the leaves or sprinkled by mixing one ounce in two gallons of warm water, stirring from time to time to prevent the powder from settling at the bottom of the watering can.

The Cabbage Plusia (*Autographa brassicæ*, Riley)—Fig 27. A pale green caterpillar, with whitish lines running lengthwise of the body, may sometimes be found devouring the leaves of cabbages, lettuce and other vegetables, feeding usually on the under side of the foliage. It is called a "semi-looper" from its raising the middle of the body when walking, owing to the absence of some of the usual prolegs. Though abundant and destructive in the neighboring States, it has not often been found in injurious numbers in Ontario, but may at any time prove a serious pest. In the early part of the season they may be got rid of

by dusting with a mixture of one pound of Paris green in twenty pounds of lime, applying the powder to the under side of the leaves. A liquid spray may also be used of the ordinary composition.

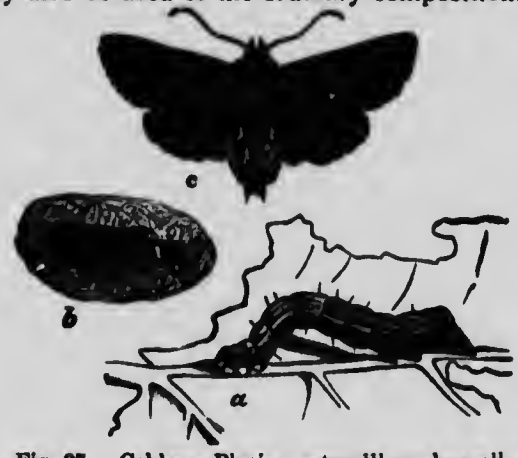

Fig. 27. Cabbage Plusia: caterpillar, chrysalis and moth.

THE DIAMOND-BACK MOTH (*Plutella maculipennis*, Curtis)—Fig. 28—is from time to time a serious pest, as its caterpillars appear in large numbers and devour the foliage of cabbages, turnips and other cruciferous plants. These worms are much smaller than those of the preceding species; are green in color, and remarkably active when disturbed;

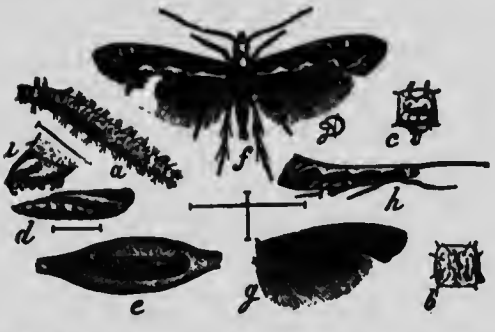

Fig. 28. Diamond-back Moth: *a*, caterpillar: *d*, pupa; *e*, cocoon; *f* and *h*, moth—all much enlarged.

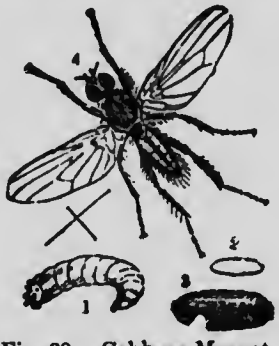

Fig. 29. Cabbage Maggot, puparium and fly—enlarged.

they will then wriggle about in a violent manner and drop to the ground by a silken thread from the leaf on which they are feeding. As they devour all the green substance of the foliage the plant attacked soon withers and dies. There are usually two broods in the year, the first

set of caterpillars appearing at the beginning of July, and the second towards the end of summer; in favorable seasons there may even be a third. The winter is spent in the pupal stage, the lace-like cocoon enclosing the chrysalis being attached to the under side of the leaves. The moth is a beautiful little creature, dark or ashen gray in color, with a series of white marks on the forewings which form, when the wings are closed, a row of diamond-shaped markings down the middle of the back; from this characteristic the moth receives its name.

The remedy that seems most effective is spraying the underside of the leaves wherever attacked with kerosene emulsion, at the same time applying fertilizers, such as nitrate of soda, to induce a vigorous growth. As a preventive measure all remains of stalks and foliage, after the crop has been taken in, should be destroyed in order to get rid of the wintering chrysalids. Though the insect is an importation from Europe, it is largely kept in check by parasites and only occasionally becomes a serious pest.

The CABBAGE MAGGOT (*Phorbia brassicae*)-Fig. 29—is one of the most serious insects that growers of this vegetable have to contend with. Young plants, soon after being set out in the spring, are often found to have their roots infested with these maggots, their presence being indicated by the dying of the plants. They are white, footless larvæ, the offspring of slender two-winged flies, smaller than the ordinary house fly; the eggs are laid on the stems of the plants close to or just beneath the surface of the ground; when hatched, the maggots burrow down into the roots, where they tear the tissue with the hooks which take the place of their jaws, and live upon the sap, the breaking up of the cells of the plant causes a rot to set in and the entire destruction of the root soon follows. When full grown the maggots form their reddish brown puparia in the soil near by, and from these a second brood of flies soon emerges. Working under ground as they do, it is a difficult matter to apply any effective remedy; the only one that has proved useful is a decoction of pyrethrum insect powder (quarter of a pound to a gallon of water) or white hellebore of the same strength. The earth is drawn away from the root of an affected plant and half a tea-cupful is poured in; the soil is then replaced and hilled up around the stem.

Preventive measures are less troublesome and usually more effective. One of the best is the screening of newly set-out cabbages and cauliflowers with cheese-cloth. Light frames of slats are made 8 feet long, 2 wide and 2 high; over these is tacked cheesecloth which should reach to the ground on all sides, and prevented from blowing about by heaping a little earth on the edges. These frames cost very little and can be readily moved when required and stowed away for future use; they should be put on as soon as the plants are set out and left till they are well-grown. The frames not only prevent the flies from laying their eggs on the plants, but also keep off the other insects which are liable to attack them.

Tarred paper disks, three inches in diameter, with a slit from one side to the middle, are used to place around the stems of plants when they are set out, and prevent the flies from laying their eggs upon them. These are somewhat troublesome to make and put on and are not nearly so effective as the cheese cloth screens.

Carrots.

The Black Swallow-Tail Butterfly (*Papilio asterias* [*polyxenes*])—Fig. 30. There may often be found feeding on the foliage of carrots and parsnips a handsome velvety green caterpillar ornamented with bands of yellow. This is the larva of one of our largest and most beautiful butterflies, black in color, ornamented with rows of bright yellow spots. The caterpillars do not feed in colonies and consequently are not often injurious, the amount of foliage consumed by an individual

Fig. 30. Black Swallow-tail Butterfly.

seldom affecting the vitality of a plant. Being conspicuous, they may, if sufficiently numerous to require repression, be picked off by hand and crushed under foot. They are kept in check, however, by a large parasitic fly, which lays an egg on a caterpillar from which hatches out a grub that feeds within the body of its host until the chrysalis is formed, and then completes its work of devouring all that remains, a fly with four clear membranous wings coming out instead of the butterfly.

The Carrot Rust-Fly (*Psila rosæ*)—Fig. 31—is a much more serious enemy to the plant than the preceding species. It is a comparatively recent importation from Europe, having been first observed in this country about twenty-five years ago. It is a great pest in the Maritime Provinces, but so far is only locally found in Ontario. Its attack may first be noticed in spring when the leaves of young carrots turn reddish, and on examination the roots will be found covered with rusty

blotches—hence the name of the insect. The parent of the mischief is a small two-winged fly, quarter of an inch long, body dark green, head and legs pale yellow and the eyes red. From the eggs, which are laid on the stem below the surface of the ground, the young maggots make their way into the root, and tear the tissues in a similar manner to the cabbage maggot described above; the attack causes the rusty blotches to appear. The maggots of a later brood infest the full-grown roots and continue their work of destruction in the root-house during the winter. Celery and parsnips are also attacked.

Fig. 31. Carrot Rust-fly : 1, 3, 4, 5, 7 natural size ; 2, 6, 8 enlarged.

Preventive measures seem to be the only remedies available. To deter the fly from laying her eggs, the rows of young carrots, when ready for thinning out, should be sprayed with kerosene emulsion, or dusted with sand or plaster in which coal-oil is mixed, half a pint being used to a pailful of the material. The application should be made weekly, and especially after hoeing, until about the middle of July.

In gardens where carrots are grown for table use and size is not an object, late sowing is found to be advantageous, the plants thus escaping the egg-laying of the fly. Repeated sowings a week or so apart, will secure the freedom of some of the crops from attack. The plants should not be grown two years running in the same piece of ground. Stored roots, if found affected in the winter, may be treated with carbon bisulphide, one ounce to 100 lbs. of roots, placed in pans on top of the pile, provided that they are in fairly air-tight bins. They should be left for 48 hours and then exposed to the air in order to get rid of the fumes, which are very inflammable; no light or fire should be anywhere near when this substance is being employed.

Celery.

Celery, as a rule, is not much affected by injurious insects; those that do attack it are the same as the enemies of carrots and parsnips, to which reference is elsewhere made. The handsome caterpillars of the Black Swallow-tail Butterfly (*Papilio asterias*)—Fig 30—may often

be found eating the foliage, but they are never very numerous and can easily be controlled by handpicking. A small caterpillar called the CELERY LEAF-TYER (*Phlyctænia ferrugalis*) is sometimes abundant and injurious; it feeds for the most part at night; when young it eats small holes in the leaves which are hardly noticeable, but as it grows larger it becomes more voracious and consumes a considerable amount of foliage. When fully grown they roll up a leaf and tie its edges together with silk, forming thus a convenient case in which to pass the chrysalis stage. The moth is about three-fourths of an inch in expanse of wings, pale brown in color, with a reddish suffusion; the wings are marked with irregular cross lines of black and some circular spots. There are at least two broods in the year. The insect is sometimes known as the Greenhouse Leaf-tyer from its attacking a variety of hot-house plants; out-of-doors it by no means confines itself to celery, but may be found on a great variety of vegetables. As soon as the caterpillars are noticed the plants attacked should be sprayed with Paris green, applied to the under side of the leaves. In the green house any infested leaves should be cut off and destroyed.

One of the most serious enemies of celery is the Rust-fly described among the insects affecting carrots. The maggots attack the thick part of the roots of young celery plants and prevent their proper growth; they also produce the characteristic rusty blotches on the stems and spoil them for table use.

CORN.

The insect enemies of Indian Corn are legion, and may be found attacking every part of the plant, root and stem, leaves and ears, the tassel and silk, and the ripe harvested corn; about 350 different species are recorded from North America. Happily a large number of these insects are not found in Canada, and many others are only of occasional occurrence; it is, therefore, unnecessary to describe more than a few species which are always with us and against which constant warfare has to be waged.

Attacking the roots we find White-grubs and Wire-worms very destructive, especially where corn is planted on old pasture land broken up a year or two before. These insects have already been described. Another serious enemy is the Corn Root-aphis, which is attended by its ant protectors; it is especially injurious to the plants when young. The winged forms migrate to various common weeds such as plantain, pigweed, &c., showing the importance of keeping fields and gardens free from these places of refuge.

As soon as the tender blades of corn appear above the soil they are liable to be cut off by these nocturnal marauders, the Cutworms, which can be circumvented by the use of the poisoned bran-mash. The grubs of the 12-spotted Cucumber beetle often infest the roots of corn when

the plants are young, and a great deal of loss is occasioned by them. Later on, as the plants grow bigger, they may be attacked by Grasshoppers and seriously injured.

The Corn Stalk-Borer (*Papaipema nitela*)—Fig. 32—is an occasional destroyer of the plant. The caterpillar, which grows to an inch and a half in length, lives inside the stem and devours all the interior to such an extent that the plant withers and dies; when approaching maturity the worm works its way down to the root and there changes to the chrysalis stage. The moth, which is fawn-colored and has the front pair of wings crossed by a pale curved line, comes out in the autumn and lays her eggs on the stems of a variety of plants as well as on the

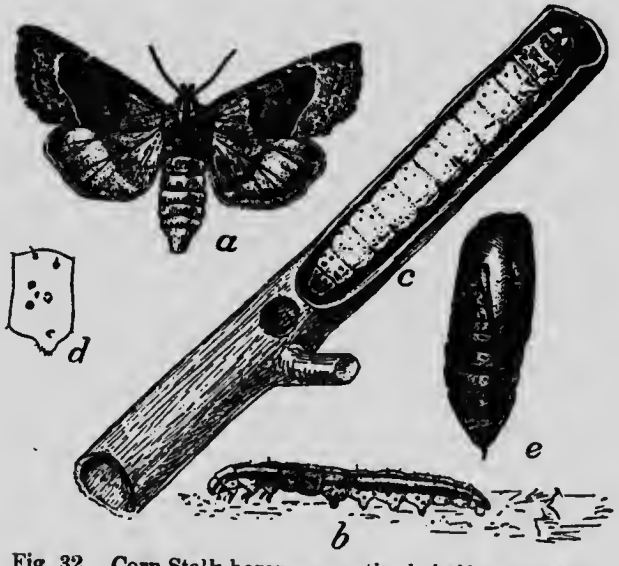

Fig. 32. Corn Stalk borer: *a*, moth; *b*, half-grown caterpillar; *c*, mature larva in stalk; *e*, pupa.
(*Chittenden U.S. Dept. Agric.*)

corn. The caterpillar is known to infest the tomato, potato, dahlia, and many other cultivated plants as well as many kinds of weeds. The only remedy seems to be clean cultivation and the destruction in the fall of all stems and roots of plants which are likely to have eggs laid upon them. Being an internal feeder there is no way of poisoning the caterpillar, and usually its presence in a stalk is only known by the premature withering of the plant.

The Corn Ear-Worm (*Heliothis armiger*)—Fig. 33—is another general feeder which includes corn in its attacks. In the south it is the notorious "Boll-worm" which is so destructive to cotton; here it

attacks tomatoes and a few other plants as well as corn. The presence of the caterpillar is first made known by small holes to be seen in the leaves enveloping the growing ear; on investigation the worm will be found devouring the milky grains and spoiling the ear by its excrement and the rot which usually sets in; sweet corn is especially liable to be spoilt by this attack. Any ear that is seen to be affected should be opened and the caterpillar destroyed; this seems to be the only thing that can be done. The moth is a handsome creature, ochre yellow in color with darker bands across the wings, which measure an inch and a half when expanded. With us there is but one brood in the year and much may be done to keep the insect in check by clean cultivation in the fall of the year.

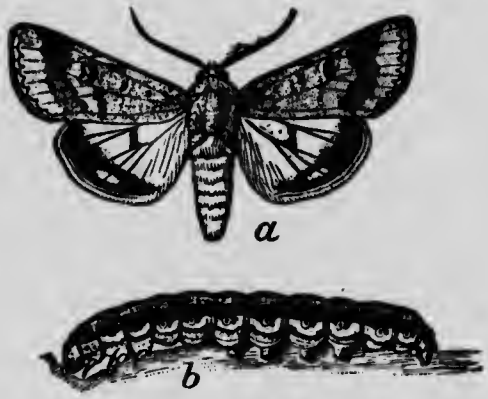

Fig. 33. The Corn Ear-worm: *a*, moth; *b*, caterpillar.

Fig. 34. Chinch-bug, greatly maguified.

In the great corn-growing States to the west and south the crop is very seriously injured year after year by the Chinch-bug (Fig. 34), a small black bug, with a white mark on each side of the wings. As it appears in millions, these hosts inflict an enormous amount of damage by sucking out the juices of the plant. We are fortunately free from this pest in Canada, though an occasional specimen has been found in Ontario.

Cucumber and Melon.

Cucumber Beetles: the Striped (*Diabrotica vittata*)—Fig. 35—and the Spotted (*D. 12-punctata*). The former of these insects may be found all through the season on cucumbers, melons, squashes and pumpkins from the time that the plants are first set out till the frost destroys the foliage in the autumn. The beetles hibernate in the adult stage and are ready to attack the seedling plants as soon as they appear above the soil; oftentimes they are sufficiently numerous to kill the tender plant

by eating the leaves and gnawing the stem; later on they may be found in the flowers, where, however, they seem to feed on the nectar and not to do much harm. The beetle is less than half an inch in length, oval in shape, yellow in color with a black head and three black stripes down the back. The larvae are slender white grubs which feed upon the roots of the plants and sometimes burrow up into the stem, continuing their injuries for about a month, when they change to the pupal stage and later on come out as a second brood of the beetles. The latter are very lively insects, flying quickly from plant to plant when disturbed; sometimes when their usual food is not available they attack the young pods of peas and beans, and may be found on a variety of other plants.

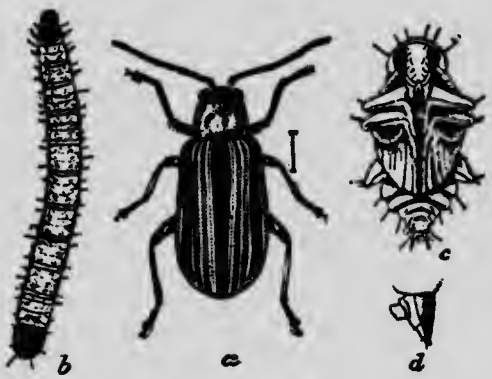

Fig. 35. Striped Cucumber Beetle, grub and pupa—much enlarged,

Fig. 36. Spotted Cucumber Beetle enlarged.

The Spotted Cucumber beetle (Fig. 36) is larger than the Striped, and less oval, broadening considerably towards the posterior end of the body; its color is yellowish green, with a black head and three rows of four black spots, making twelve in all, on the wing covers. It is a more southern insect than the Striped beetle, and in many parts of the United States it does serious injury to the roots of corn. In Ontario it is usually found associated with the other species on cucurbitaceous plants, but in fewer numbers; it is also a much more general feeder, attacking a great variety of plants; its life history is smewhat similar to the preceding, but it seems to feed mostly upon the pollen of blossoms in the beetle stage, the grubs being the chief cause of injury by their attacks upon roots and stems.

The treatment for both these insects is chiefly preventive. Young cucumber and melon plants should be protected as soon as they are set out with the cheese-cloth screens described as a protection against the Flea-beetles, or by smaller screens made with two flexible sticks crossed at right angles and with their ends securely fixed in the ground,

and then covered with a piece of cheese-cloth which can be kept from being blown about by heaping a little earth on the edges. These screens may be safely removed when the plants have grown too big to be covered by them. Another plan is to grow a few squash plants earlier than the others so as to attract the beetles to them, and then treat them with Paris green, one pound mixed with 50 lbs. of lime or plaster; this may be dusted over the plant when the beetles congregate upon it. In the autumn all the refuse of the vines should be gathered up and either burned or buried in a compost heap, so as to kill the hibernating beetles. Spraying the young plants with poisoned Bordeaux mixture has also been found effective.

The SQUASH-BUG (*Anasa tristis*)—Fig. 37. This familiar insect is usually very abundant and injurious through all the south-western counties of Ontario, but during the last two or three years it has almost entirely disappeared. It will not be long before it again becomes numerous and troublesome. The bugs are much larger insects than the beetles described above, being nearly three quarters of an inch in length, of a dirty blackish color above and speckled creamy beneath; they have the usual repulsive odor common to the "stink-bugs," to which family they belong. Late in autumn the bugs may be found in all sorts of places, crawling about in search of winter quarters, and should then be crushed under foot. In the spring they come out, and begin their injurious work of sucking out the juices of young cucurbitaceous plants. The eggs, which are metallic in color, are laid in batches on the under side of leaves near the base of the plant; from them soon hatch out the young bugs, but not all at once, so that we may find nymphs of all sizes on the under side of the same leaf. They not only injure the foliage by sucking out its juices but also poison it as well, causing a speedy wilting of the leaves they attack. If any withering leaves are observed they should at once be inspected, and if a colony is found at work it can soon be exterminated by crushing under foot.

These bugs are difficult to get rid of as the usual remedies for sucking insects, kerosene emulsion, for instance, have but little effect upon them, except when applied to the colonies of young nymphs. The methods recommended above for the Cucumber beetles are also the best remedies for these disagreeable insects. In the early part of the season the parent bugs may be trapped by laying pieces of shingle or board near the plants; the bugs will be found taking shelter under them in the morning and can easily be destroyed.

FLEA BEETLES, described above, are often very injurious to young cucumber and melon plants, and also a species of Aphis. Occasionally the fruit is attacked when green by small caterpillars, one called the Pickle-worm (*Diaphania nitidalis*) and another, the Melon caterpillar (*D. hyalinata*); both turn into beautiful little moths. In the south they are regularly injurious year after year, but with us, happily, they are quite rare; should they become numerous at any time they could be easily controlled by the use of arsenical poisons.

Onion.

The Onion Maggot (*Phorbia ceparum*)—Fig. 38—is very similar in mode of attack and life-history to the Cabbage Maggot already described; it is unnecessary, therefore, to repeat these particulars. It is often extremely destructive, and has almost driven market gardeners to

Fig. 37. Squash-bugs: *a* to *e*, nymphs, in different stages of growth; *f*, adult bug—much enlarged.

despair. The preventive measures referred to above are hardly suitable for a plant whose style of growth is so different from that of a cabbage, and few persons would take the trouble to protect onion beds with cheese-cloth screens nor could tarred paper disks be employed. There

is, however, a simple method of protection which has been found effective: as soon as the tiny shoots of the onions begin to appear above the soil, the rows should be treated with a whitewash made of lime and water and thick enough to form a thin crust over the surface. The effect of this is to close up all crevices and openings in which the parent fly would lay her eggs, and prevent the maggots which may hatch from any eggs laid above ground from reaching the roots beneath. The young plants penetrate through the thin crust of lime without difficulty.

Later on, when hoeing, any plant that is not growing satisfactorily should be cut out and crushed under foot so as to destroy the maggots. Furthermore, onions should not be grown a second time on, or close to, a bed which has been infested with these insects. Pyrethrum insect

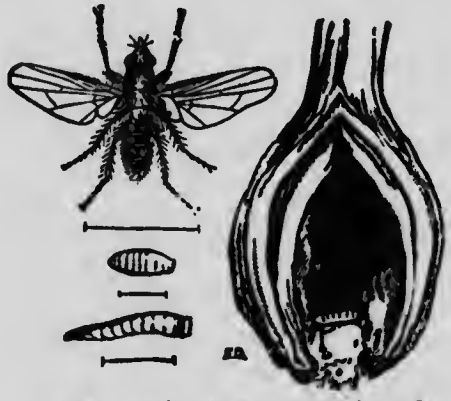

Fig. 38. Onion Maggot, puparium, fly and infested bulb.

powder or white hellebore may be applied in the same manner as recommended for the cabbage maggot. Many other substances, such as salt, plaster, Paris green, &c., have been tried without any satisfactory results. When taking up the onions in the fall any bulbs infested by maggots should be carefully destroyed.

Parsnip.

The Parsnip Webworm (*Depressaria heracliana*). When parsnips are left in the ground all winter and allowed to grow up for seed-bearing purposes during the following season, they are very liable to be attacked by this insect. Towards the end of June when the stems are tall and bear fine umbels of flowers, it is often found that the bloom is disfigured with webs which draw the whole into an untidy mass, and on examination a colony of small caterpillars will be found at work within. When they have finished consuming the flowers, they burrow

into the stem and feed upon the soft inner lining; here they change to the chrysalis stage during the latter part of July, and are often so numerous that the hollowed stems will be found packed with larvæ or pupæ. The caterpillars are of a dirty green color above and yellowish on the sides and beneath; most of the segments are furnished with shining black warts, each of which terminates in a fine bristle. The moths come out about the first of August and hibernate in any shelter that they can obtain, often coming into houses for the purpose; they are dusky gray in color, with no conspicuous markings, and with the body much flattened; the expanse of the wings is less than an inch, and the length of the body under half an inch. The insect is an European species.

These caterpillars may be found in abundance working in a similar manner on celery plants that have grown up for seed and on wild carrot and other kindred umbelliferous plants. In the garden they should be treated with Paris green as soon as they are noticed; if the umbels are drawn into a web they should be cut off and burnt, and if the stalks are perforated the same operation should be performed on them. Wild carrots and parsnips should be cut down wherever they may be found in neighboring fields or waste places.

Parsnips are also attacked by the insects already mentioned in connection with carrots and celery.

Peas.

The Pea-Weevil (*Bruchus pisorum*)—Fig. 39. The life-history of this insect resembles in many respects that of the Bean-weevil, already described. The beetle is about one-fifth of an inch in length, brownish-gray in color, with two conspicuous oval black spots on the end of the abdomen which is not concealed by the wing-covers. The head is bent under the front of the body and ends in a square-cut beak. When peas are in blossom these little beetles may be found upon them, waiting for the young pod to be disclosed; on it the minute eggs are laid, and the grubs, as soon as hatched, bore through and enter the small green peas, one beetle only infesting a single pea. Here the grub remains, feeding upon the substance of the pea, passing through the pupal stage, and only attaining maturity when the peas are ripe and ready for harvesting. Most of the beetles remain inside the peas until they are sown the following spring, but some emerge when the peas become ripe and remain in the field or in the barn all winter. Unlike the Bean-weevils, this species does not increase and multiply in the stored peas but will die if they are kept over for another year.

Treatment: The pea crops should be harvested early, a little on the green side, so that the pods will not shell out before removal from the field; threshing should be done as soon as possible, and all refuse from the machine should be swept up and burnt. If any weevils are noticed in the peas, the crop should be put into bins or barrels and fumigated with carbon bisulphide in the manner recommended for the Bean-weevil.

Peas that contain weevils, even though they are dead, should not be sown, as the plants grown from them will be stunted owing to the lack of food material in the pea; a considerable proportion would probably not grow at all, owing to the germ having been devoured by the beetle. The remains of the crop, not taken from the field, should be raked up and burnt. If every pea-grower would adopt these methods we should soon be rid of the pest, as the beetle does not attack any oth[illegible].

The Pea Moth (*Semasia nigricans*)—Fig. 40—is not o[illegible]und in Ontario, but is very common and at times extremely destructive in the Maritime Provinces; its occasional occurrence with us renders it necessary to be on our guard against it. The parent moth is small, less than half an inch in expanse of wings, and of a dull slaty-grey color. It lays its eggs on the growing pods of peas; the caterpillars soon hatch out and bore their way into the pod where they feed upon the young peas, consuming many of them and filling the space with a mass of excrement. When full grown the worms leave the pods and form their small oval cocoons below the surface of the ground.

Fig. 39. Pea-weevil, natural size and much enlarged.

Fig. 40. Pea-moth and caterpillar; moth greatly enlarged and natural size; affected pea.

Where there is reason to expect an attack, the pea vines should be sprayed as soon as blossoming is over with a liquid wash of one pound of soap in twenty-five gallons of water in which has been thoroughly mixed four ounces of Paris green; the spraying should be repeated a couple of times at intervals of a week or ten days. The object is to poison the young caterpillars when they are eating their way through the pod.

Sowing early varieties as early as possible in the season has been found useful, the pods being too far advanced to be injured when the worms appear. Very late sowing is also recommended in order that the blossoming may not take place till after the moths have ceased egg-laying.

An important point is to plow or dig deeply in the fall any piece of land where infested peas have been grown in order to bury the cocoons and prevent the moths coming out in the spring. All unripe pods should be burnt as they may contain worms, and peas should not be grown again upon or near the same piece of ground the next season.

The Pea Aphis (*Nectarophora destructor*). This large green plant-louse has during recent years become extremely destructive to the vines of peas. In some parts of the neighboring States, where large acreages were devoted to this crop for canning purposes, the annual loss was estimated at many millions of dollars, three-fourths of the crop being in some instances destroyed. The usual remedies for plant-lice have already been referred to under "Aphis," but they are of little value when contending with an attack on a very large scale. A method that has been found effective is to sow the peas with drills and wide enough apart for a cultivator to work between the rows, instead of the usual broadcast plan. As soon as the plants are seen to be infested boys are employed

Fig. 41. Colorado Potato-beetle.

to brush the insects off, and they are followed at once by the cultivator, which buries the lice and prevents their getting back on the vines. The operation has to be repeated a few times, but the results have proved entirely satisfactory and to warrant the labor and expense.

Potato.

The Colorado Potato Beetle (*Leptinotarsa decemlineata*)—Fig. 41—is so familiar to everyone that it is hardly necessary to give any description of the destructive creature. The adult beetles come out of

their winter hiding places about the end of May and feed at once upon the earliest appearing potato plants; soon after this the females lay their bright orange colored eggs on the under side of the leaves in batches of various numbers up to fifty or more. The grubs hatch out in about a week and set to work to devour the foliage; their dark orange color renders them somewhat conspicuous, so that an attack can hardly fail to be noticed. When fully grown the insect changes to the pupal stage in a cell a few inches below the surface of the ground. A period of about eight weeks is required to complete a life cycle, and then a second brood of beetles appears, lays its eggs and starts new colonies of grubs; the third brood comes out in September and may be observed crawling or flying about in search of winter quarters. The broods are by no means distinct, as all the grubs do not mature at the same time, consequently the insect may usually be found in all its stages at any time during the summer.

Fig. 42. Three-lined Potato-beetle.

Fig. 43. Three-lined Potato-beetle; eggs, larva and pupa.

The well-known and long-tried remedies are Paris green or arsenate of lead combined with Bordeaux mixture, the latter ingredient assisting in warding off the attacks of fungus diseases and also in destroying Flea-beetles, when they are present, as they commonly are. Spraying should be done early in June as soon as any grubs are to be seen, again a month later and three times, at intervals of a fortnight, between the end of July and the first of September.

The THREE-LINED POTATO BEETLE (*Lema trilineata*)—Fig. 42—looks very like the Striped Cucumber beetle, but is larger and of a darker yellow color. Before the coming of the Colorado beetle, this was the chief insect enemy of the potato, but now, though common, it is not usually particularly destructive; its life-history is much the same, the adult beetle coming out in the spring and laying her eggs on the under side of the leaves of the young plants; these are yellow in color and are laid along the midrib of the leaf. The larvæ have the extraordinary habit of piling their excrement on top of their backs, possibly as a protection against their enemies, and thus present a disgusting appearance (Fig. 43

43). The grubs appear in June and go through their transformation in time for another brood to come forth in August; the beetles from this later brood do not emerge till the following spring.

When this insect is at all abundant, it can easily be controlled by the application of Paris green; the measures everywhere taken to check the Colorado beetle have no doubt prevented this species also from becoming numerous.

The Potato Flea-Beetle (*Epitrix cucumeris*) is one of the most serious pests of the potato plant. The tiny creature—it is less than one-twentieth of an inch long—eats small holes all over the surface of the leaves and causes much injury in this way, but a worse result is that the spores of the fungus diseases called "Blight" find a suitable place in these holes for germination and the complete destruction of the leaf soon follows. Flea-beetles as a class have already been referred to; it is unnecessary, therefore, to do more than state that spraying with Bordeaux mixture is a satisfactory remedy for both the insect and the blight.

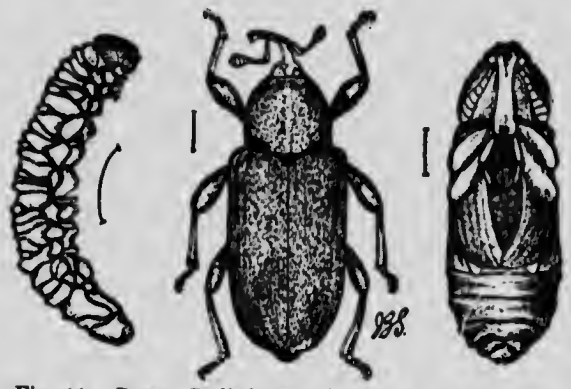

Fig. 44. Potato Stalk-borer; beetle, grub and pupa.

Blister Beetles are often reported from the northern parts of the Province as appearing suddenly in great swarms in the potato fields and greedily devouring the foliage. An account of them has already been given under insects attacking Beets and Spinach.

The Potato Stalk-Borer (*Trichobaris trinotata*)—Fig. 44—is an occasional cause of injury to the plant in this country, but in some of the States to the west and south it is considered almost as great a pest as the Colorado beetle. As the name indicates, the attack is made by boring the stalk; this is done by the grubs, which are whitish in color and without legs. The small beetles, about quarter of an inch long, are ashen-grey in color and belong to the family of weevils or snout beetles, having the head developed into a long beak; the base of the wing-covers is marked with three distinct black spots, which

readily distinguish it from similar species. About the month of June the parent makes a hole in the stalk of the potato with its snout and deposits an egg and repeats the operation a number of times. The grubs which hatch fro them burrow up and down in the stalks, devouring the interior, and en full-grown, about the beginning of September, form their cocoo de the stalk near the base of the plant; the beetles emerge later b ut remain in this retreat all winter.

No application of poison is of any avail, as the grubs are out of reach in the stalk, but much may be done to exterminate the insect by cleaning up and burning all the remains of the plants after the potatoes are dug in the fall; this is advisable also in order to destroy the germs of fungus diseases.

Fig. 45. Tomato-worm.

Fig. 46. Chrysalis of Tomato-worm.

Radish.

Radishes are very liable to attack and serious injury when they first come up in the seed beds by the minute Flea-beetles described among the insects that are general feeders; cheese-cloth screens are found to be the best protection. The Radish-magot (*Phorbia*) is the same or a very closely allied species to that which attacks the roots of cabbages, and may be treated in much the same way; protection with cheese-cloth is by far the simplest and entirely effective method of securing perfect radishes in the spring.

Tomato and Tobacco.

These two plants may be associated together as the same insects are liable to attack both; but it is highly probable that the growth of tobacco on a large scale in the south-western counties of Ontario will cause other enemies of the latter plant to make their unwelcome appearance. Cutworms early in the season are very destructive to the young

plants, but may be warded off by the use of the poisoned bran-mash. The leaves are liable to be attacked by the Flea-beetles, the Tarnished Plant-bug and Grasshoppers. The most conspicuous enemy of both plants is

The Five-Spotted Hawk Moth, or Tomato worm (*Protoparce celeus*). This is a large caterpillar, attaining to a length of nearly four inches when fully grown and correspondingly thick (Fig. 45); it has a series of oblique pale lines along the sides and a prominent tail; in color there are three varieties, pale green, dark green and almost black. They are very voracious feeders, and soon strip the foliage from a plant; but being so conspicuous they can be readily got rid of by hand picking. When growth is completed, the caterpillars burrow into the earth and form a cell in which they transform to a dark brown chrysalis, which has attached to the head and under side of the thorax a projection resembling the handle of a jug (Fig. 46) and containing the enormously long sucking tube with which the moth is provided. Usually it remains buried in the ground until spring, but occasionally some of the moths come out in the autumn if the weather should be warm. They are large, handsome, swiftly flying creatures, ashen-gray in color with a variety of paler and darker lines and markings; the abdomen is ornamented with five large orange spots on each side which give the insect a very characteristic appearance. These Tomato worms have often been supposed to be poisonous, and many marvellous tales have been told of their deadly stings and bites; they are, however, quite incapable of either stinging or biting, and may be handled without the least danger.

The Corn Ear-Worm (*Heliothis armiger*), which has been described above, frequently attacks green tomatoes before they are fully grown and bores large holes which utterly destroy the fruit. It also feeds on tobacco, eating into the unripe seed capsules and devouring the contents. In the case of tomatoes the only plan seems to be to cut off and destroy all the infested green fruit. Where tobacco is extensively grown, if there should be an annual attack by these caterpillars, it would be advisable to grow a strip of corn as a "trap-crop" along the sides of the field; the moths would lay their eggs on the young ears of corn in preference to the tobacco plant, and these could be gathered and burnt or fed to pigs before the worms attained to maturity.

Turnips.

Turnips are attacked by several of the insects already described as enemies of the cabbage, viz., the Zebra Caterpillar, the Diamond-back Moth, the Cabbage Maggot, and the same species of Plant-louse (Aphis). The last mentioned insect has been more complained of recently by turnip growers than any other pest; its ravages in late summer and autumn of 1908 were widespread over the province, due to the pro-

longed dry, warm weather which was favorable to their increase, and in many cases whole fields were rendered worthless. The usual remedies, kerosene emulsion and strong soapsuds, were found effective when applied in time; but in most cases the attack was not noticed till the damage was beyond repair. Much may be accomplished by keeping a sharp look-out for the colonies of plant-lice when hoeing is being done; an affected plant should be at once cut out and the lice crushed under foot; early measures of this kind will prevent a serious infestation later on.

The TURNIP FLEA-BEETLE (*Phyllotreta vittata*) differs from our other species in having a wavy yellowish stripe down each side of the wing covers, but its habits are much the same as those of the rest of

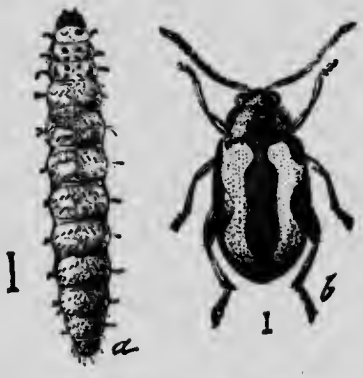

Fig. 47. The Turnip Flea-beetle and larva—greatly enlarged.

the family. Its attacks on the young plants when they they first come up are often very serious and prevent the growth of a large proportion of the crop, necessitating a resowing. As the first brood of beetles disappears toward the end of June it has been found that turnips sown during the third week of that month escape attack, and produce as good a crop as those sown earlier. When the beetles are observed to be attacking the young plants they may be got rid of by dusting with Paris green and land plaster, one pound of the poison to twenty of the plaster; this should be done when the plants are moist with dew in the early morning. A condition of the soil which induces rapid and vigorous growth is of great importance, as it enables the young plants to get beyond the danger point before much injury has been sustained.

Fungus Diseases of Vegetables.

By J. W. Eastham and J. E. Howitt.

It is important that those having to deal with fungus diseases should understand the cause of such disease, in order that they may apply intelligently remedies for their control. Fungus diseases are caused by a low group of minute plants known as Fungi. These plants, unlike ordinary flowering plants, have no green coloring matter and are entirely unable to manufacture their own food. All their nourishment therefore must be obtained from decaying animal or vegetable remains or from living animals or plants. Those Fungi which derive their nourishment from living plants in so doing injure them in various ways, and thus give rise to what are known as fungus diseases.

The bodies of Fungi which cause plant diseases are usually very simple, consisting of fine delicate threads or tubes (hyphæ), some of which become modified and produce reproductive structures, termed spores, which may be considered similar to the seeds of flowering plants. Sometimes the fungus threads live upon the surface of the plants and obtain their nourishment by sending down little suckers (haustoria) into the cells below; most frequently, however, they live within the plants, either in or between the cells. Two kinds of spores are frequently produced, thin-walled summer spores which spread the disease during the summer, and thick-walled resting or winter spores which carry the disease over the winter. Spores are scattered by various agencies, chief among which are wind, water and insects. On coming in contact with a suitable host plant they send out little threads which enter the plant through the breathing-pores on the leaves, through the skin, or through wounds. Once within, the little threads grow very rapidly, drawing their nourishment from the cells of the host plant and setting up a diseased condition.

Generally speaking, in combating fungus diseases methods of prevention only are practicable, as once a fungus is within a plant nothing can be done to destroy it. Care should be taken to keep the crops in a healthy, growing condition and free from injury by insects. Unthrifty plants and those attacked by insects are more liable to fungus diseases than healthy ones. Rotation of crops should be practised so that the winter spores left in the soil may not infect next season's crop. Weeds should be destroyed as they frequently harbor fungi. Diseased crop refuse should be burnt and not thrown on the manure heap. Fresh manure should be avoided as it frequently contains living spores of parasitic fungi. Intelligent and thorough spraying with Bordeaux or other fungicides will do much to prevent the spread of fungus diseases.

Asparagus.

Rust (*Puccinia asparagi*). This disease is very common and is familiar to every grower of asparagus. It has three distinct stages. The first is known as the "cluster-cup" stage or the spring form. In this stage the spores are produced in cup-shaped pustules, which are grouped in oval clusters and are orange-yellow when mature. This stage is seldom noticed by asparagus growers. The second or summer stage

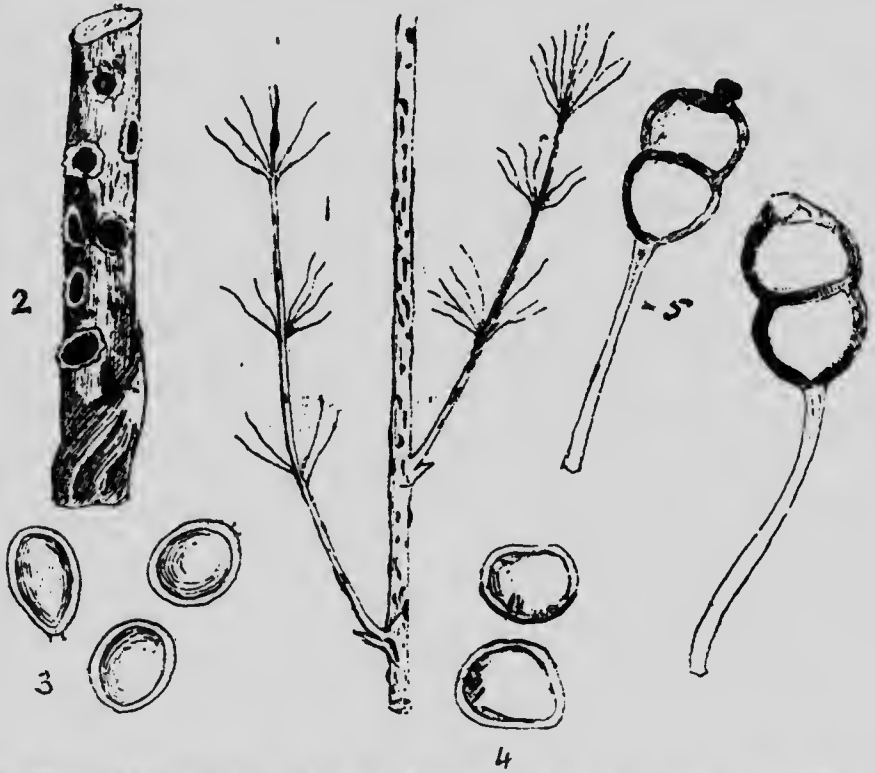

Fig. 48. Asparagus Rust. 1, attacked stem showing spore clusters; 2, cluster-cup form; 3, spores from cluster-cup; 4, spores from summer stage (uredo spores): 5, resting or winter spores (teleuto spores).

is the one usually first noticed by the growers, and called by them the "red rust" on account of the elongated reddish-brown pustules which are seen breaking through the skin of the stem. In these pustules reddish, one-celled spores are produced, known as uredospores. It is in the summer or "red rust" stage that the disease spreads most rapidly and appears to do the greatest amount of harm. Towards fall, or whenever the vitality of the asparagus plants is reduced, the third and final stage

known as the "black rust" or winter stage appears, due to the fact that the red spores in the pustules are replaced by dark brown, two-celled, thick-walled spores known as teleutospores. These germinate in the spring and produce the first stage again.

Treatment: Rust may be largely controlled by spraying with resin-Bordeaux from July to September at intervals of ten days or two weeks. This is a difficult and rather costly undertaking and will hardly pay

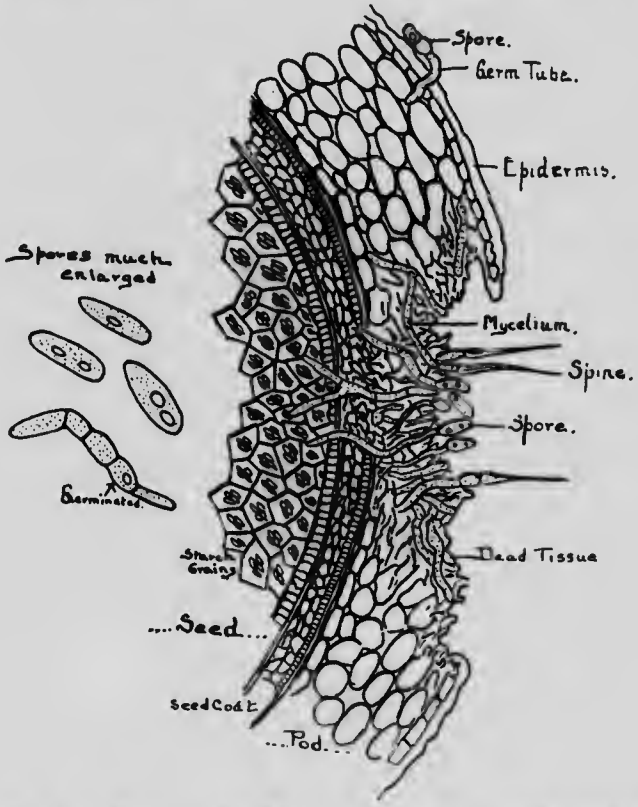

Fig. 49. Bean Anthracnose. The right-hand figure shows a section taken through a spot on pod and the seed beneath. Note how the hyphae in the "pod-spot" are penetrating into the cells of the seed. On the left are shown a number of enlarged spores.—(After Whetzel.)

except on large [illegible]. Dusting with flowers of sulphur has given good results. Cutting and burning all the diseased stems in the fall will help to keep the rust in check. Rust resistant varieties should be planted.

Beans.

Anthracnose or Pod-Spot (*Colletotrichum lindemuthianum*). This is the commonest and worst disease to which beans are liable. It attacks

stem, leaves, pods and seeds, beginning with the first leaves of the seedling plant. The disease appears as round, rusty or black, sunken spots. In the centre of each of these is produced a mass of spores which

Fig. 50. Bean Anthracnose. Badly attacked pod, showing the dark spots characteristic of the disease.

are embedded in a gummy substance. This substance, when dry, keeps the spores attached to the spot but, when moistened by rain or heavy dew, it becomes soft and allows the spores to be scattered.

The spots are most conspicuous on the pods, and hence the disease is sometimes termed "pod-spot." The fungus working in the diseased areas finally penetrates through the wall of the pod into the seeds. Here it remains in a more or less inactive condition until the seed is sown when it becomes active and forms the starting point of the disease. The seedlings from such attacked seeds will often show the spots on the seed-leaves. Once spores begin to be formed the disease spreads rapidly.

Treatment: Since the disease originates with infected seed, the most important point is to secure, if possible, clean seed. This can be

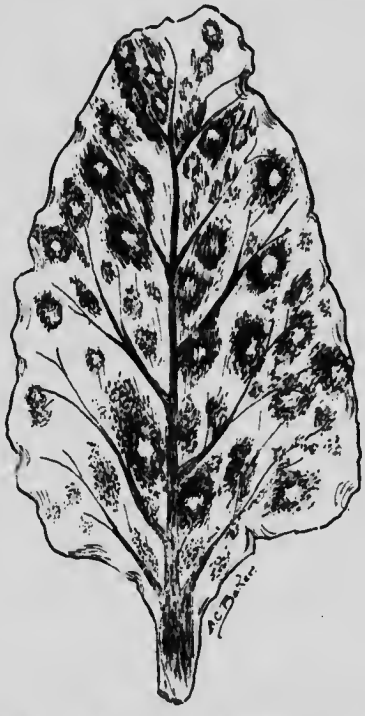

Fig. 51. Leaf of Beet attacked by Leaf-spot Fungus (*Cercospora beticola*).

obtained by gathering it from pods which are free from spots, the disease, as far as is known, only infecting the seed through the pod. Although seeds that are badly attacked may be readily recognised by their discolored areas, hand-sorting of such seed previous to sowing is practically valueless, as a large percentage of the apparently healthy ones will contain the fungus. Treating the seed with formalin is also useless. Care should be taken not to work amongst the plants when they are wet with rain or dew since it is at this time that the spores are

ready to be distributed and each spore may start a new spot. Spraying with Bordeaux mixture appears to be capable of controlling the disease provided it can be done thoroughly enough. This, however, is only possible when done by hand on garden crops. Under ordinary field conditions it is of little value.

Rust (*Uromyces appendiculatus*). This appears as small, round, rusty brown, raised spots on the surface of the leaves. Leaf-stalks and pods may also be affected. Later the spots darken in color owing to the formation of a different kind of spore (teleutospore) which serves to carry the fungus over the winter.

Treatment: Burn the remains of diseased plants. Some varieties are found to be more resistant than others, and where possible these should be selected. Early spraying with Bordeaux mixture will diminish the injury. The disease, however, is not often of a serious nature.

Beet.

Leaf Spot (*Cercospora beticola*). This occasionally causes serious injury, though garden varieties appear to be more resistant than the sugar beet. The disease causes small brown spots with purplish margins, which are scattered irregularly over the leaves. Later, these spots become ashey gray in color. When very numerous the leaf-tissue is to a large extent destroyed and the value of the leaf to the plant correspondingly lessened.

Treatment: Spray with resin-Bordeaux at intervals of 10 to 14 days, beginning about the middle of July. The disease is seldom bad enough to require treatment.

Cabbage and Cauliflower.

Club Root (*Plasmodiophora brassicæ*). This disease attacks cabbage, cauliflower, turnips, radish and other members of the Cruciferæ. It is caused by a slime-fungus. Plants attacked are noticed to markedly flag or wilt, and if their roots are examined irregular thickenings and knob-like swellings are found upon them. These often reach the size of a man's fist. The tops of affected plants develop very slowly, cauliflowers and cabbage attacked forming little or no head. The plants are often completely killed, due to the fact that the swellings on the root prevent the proper absorption of water. The cells of the swellings are unusually large and filled with brownish, irregular masses of protoplasm. Each such mass represents the vegetative body of a single organism. The vegetative bodies feed and grow at the expense of the cell contents. They pass from cell to cell and when the food supply is exhausted each one divides into a large number of spores, which, when the swellings decay, are set free into the soil. Naked, motile pieces of protoplasm emerge from the spores when they germinate. These it is thought enter

the plants through the root hairs. This disease may remain in the soil for several years. It is chiefly spread in manure and by means of infected seedling stock.

Treatment: *"Practise crop rotation. Set out only healthy plants. Do not use manure containing cabbage refuse. If necessary to use infested land apply good stone lime, 2 to 5 tons per acre. Apply at least as early as the autumn before planting, two to four years is better. Lime the seed bed in the same manner." Burn all refuse from diseased crop. Do not use manure from stock fed upon clubbed roots. Keep down weeds belonging to the Cruciferæ; they may harbor the disease.

Black Rot (*Pseudomonas campestris*). This is a bacterial disease which attacks cabbage, cauliflower, rape, and Swede turnip. The bacteria get into the veins of the leaves clogging and turning them black. The lower leaves are usually first affected. The leaves drop and no heads are formed. This disease is especially bad on low damp soils.

Treatment: Avoid low, damp soils, practise rotation of crops, soak seed 15 minutes in a solution made by dissolving one pint of formalin in thirty gallons of water.

Soft Rot (*Bacillus oleraceæ*). This is another bacterial disease of cabbage and cauliflower. (See O.A.C. Bulletin 136.)

Celery.

Cercospora Leaf-Blight or Early Blight (*Cercospora apii*). This appears early in the season often showing in the seed-bed. It is characterised by more or less circular spots, greyish green in color at first, then becoming brown and later ashy. Separate spots generally have a well marked border. When numerous they run together into irregular patches. This disease disappears with the coming of the cool nights of autumn when it may be followed by the late blight.

Treatment: Spray five to eight times during the season beginning whilst the plants are still in the seed-bed. Bordeaux may be used for the first application. Ammoniacal Copper Carbonate should be employed for the rest. Refuse from diseased crop should be destroyed.

Septoria Leaf-Blight or Late Blight (*Septoria petroselini*, var. *apii*). This appears later in the season than the last. The spots produced are usually more irregular and tawny in color. Little black fruiting bodies develop in the spots on both sides of the leaf. The disease continues active until the plants are lifted and may subsequently cause serious rotting in storage. Neither this pest nor the last seems to give much trouble on shady, well-drained land.

Treatment: Spraying with ammoniacal copper carbonate, continued till the plants are lifted. Diseased leaves should be stripped off before the plants are placed in storage. Remains of diseased crop should be destroyed.

*Cornell Bulletin 252.

Corn.

Corn Smut (*Ustilago Zeæ*). This is an exceedingly common di
ease, familiar to every grower of corn. On stalks, leaves, staminate ta
sels, and ears appear peculiar growths, usually spoken of as "boils.
These growths are white and polished in the early stage but becon
darker as they mature. They are filled with black spores which produ

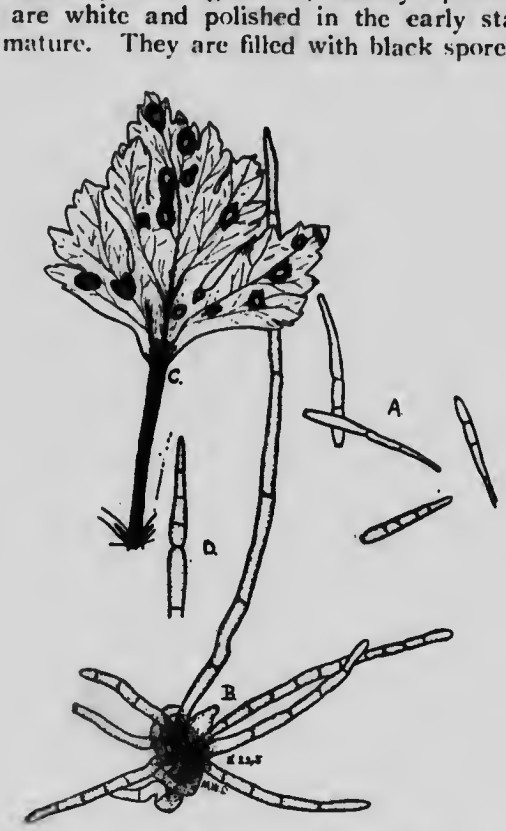

Fig. 52. *Leaf Spot or "Early Blight" of Celery.* *a*, Spores; *b*, Hyphae projecti
through a breathing-pore of the leaf into the air; *c*, a diseased le
showing the spots caused by the parasite; *d*, Spore still attached
parent hyphal (conidiophore).

great numbers of secondary spores. These are spread by the wind
other agencies and may infect any of the tender growing tissue of th
corn plants. Thus the disease is spread during the growing seaso
Some of the spores winter over in the soil or in manure and start th
disease afresh the next season.

Treatment: Remove and burn all the smut growths as soon as the
appear; avoid fresh manure; practise rotation of crops. Seed trea
ment is not effective.

RUST (*Puccinia sorghi*). This disease is seldom serious. Attacked leaves show elongated reddish or blackish pustules on both surfaces.

CUCUMBER.

DOWNY MILDEW or BLIGHT (*Plasmopora cubensis*). This fungus attacks cucumber, melon, squash and pumpkin plants, damaging, and in bad cases, destroying the foliage. The disease appears as yellow spots of indefinite outline. If the weather conditions are favorable these rapidly enlarge, and finally the entire leaf withers up.

Treatment: Spray with Bordeaux, beginning when the plants begin to run and repeating every ten to fourteen days throughout the season. This treatment, though valuable for keeping the disease in check on cucumbers, has not been found very effective with melons.

WILT (*Bacillus tracheiphilus*). This attacks the same plants as the last disease. It is caused by a minute organism—a bacillus—which multiplies with great rapidity in the sap-vessels of the leaf and stem, breaking them down and preventing the flow of sap. As a consequence the plant wilts and rapidly dies. If an attacked stem or leaf-stalk be pulled apart, a sticky fluid exudes from the broken surface which may be drawn out into long threads.

Treatment: The disease is largely distributed by cucumber beetles. These should therefore be kept down by the means recommended under insect pests of the cucumber. Remains of diseased plants should be burned.

LETTUCE.

The following fungus diseases are usually only of importance in greenhouse cultivation.

"Drop" (*Sclerotinia Libertiana*). This is the most serious disease to which lettuces are liable. It shows itself in a rotting of the stem followed by sudden and total collapse of the plant, hence the name "drop." The greatest loss occurs when the plants are just about full grown. The fungus appears to spread almost entirely by the mycelium or tissue of the fungus growing through the soil. Dense, compact portions of this mycelium form little masses (sclerotia) by means of which it is enabled to pass over the unfavorable conditions intervening between successive crops.

Treatment: Sterilizing the upper layers of the soil by applications of boiling water before sowing the seed will much reduce the loss. Covering the surface with sterilized sand or earth has been found to materially lessen the disease, the effect being proportional to the thickness of the layer added. If these treatments cannot be applied, the only alternative is to change the soil for each crop of lettuce.

Two other fungous diseases, the Downy Mildew (*Bremia lactucæ*) and the Grey Rot (*Botrytis vulgaris*), may attack lettuce but are not

serious enemies when the crop is properly managed. In this connection it is important to water the plants in some way that will not wet the foliage, especially after the plants are half grown. To this end sub-irrigation has been successfully employed.

Melon and Squash.

See Cucumber.

Onion.

Onion Blight or Mildew (*Peronospora Schleideniana*). This is the commonest disease of the onion, and it frequently decreases very materially the onion crop by destroying the leaves and thus reducing to a marked extent the size of the bulbs. It usually first makes its appearance in late June or July. Attacked leaves first show peculiar violet tinted areas, due to the fact that these areas are covered with the fuzzy spore-bearing portions of the fungus. The diseased leaves very soon become pale or yellowish in spots and collapse and break down. If examined they are seen to be more or less covered with the spore-bearing part of the fungus which gives the surface of the leaves a furry appearance. In severe attacks all the leaves in field or patch are very soon destroyed. They are often, however, quickly replaced by a new crop which in turn is generally destroyed by the disease and from this second attack the onions do not usually recover. Two kinds of spores are produced by the fungus, viz., thin-walled summer spores borne on the minute branched spore-bearing parts of the fungus covering the surface of the attacked leaves, and thick-walled resting spores (oospores) formed in the tissues of the dead leaves. The summer spores are freely scattered by the wind during the summer and new leaves thus become infected. In this way the disease spreads very rapidly, especially during damp, muggy weather. Dead leaves containing the thick-walled resting spores lie on the ground during the winter, and in the spring the spores germinate and give rise to the disease if onions are again planted on the same ground.

Treatment: Once the leaves are attacked nothing can be done to save them, though the disease may be prevented from spreading and the second crop of leaves saved by thorough and frequent spraying with Bordeaux. Prevention therefore is the only treatment. Spray thoroughly with resin-Bordeaux, beginning about the end of June and continuing throughout the season. Rake up and burn the diseased tops, as by so doing many of the resting spores will be destroyed. Practise rotation of crops, as the disease is carried over the winter by the resting spores on the ground, and it is believed that they retain their vitality for two or three years. Plant onions on well drained land over which there is free circulation of air.

ONION SMUT (*Urocystis cepulæ*). This disease attacks onions grown from seed. It destroys many of the seedlings shortly after they appear above the ground. The diseased seedlings which are not completely killed in the early stage are so severely injured that they die later or produce small and misshapen bulbs. The disease also appears on mature bulbs in the fall. Affected leaves are enlarged and often distorted and dark in color with black streaks. If they are broken they are found to be filled with a black, powdery mass which is composed of the spores of the fungus. Black masses of these smut spores are also found on the bulbs. The spores winter over in the soil, hence the danger of planting onions on smut infested soil. The disease is not, as generally supposed, disseminated to any extent in the onion seed. It may, however, be carried long distances on the bulbs.

Treatment: (1) Transplanting. If the soil is smut infested grow the seedlings on smut free soil, then transplant. This is a certain preventive, but it involves considerable labor. (2) Rotation of crops will reduce considerably the amount of the smut.

(3) Drill into the rows when planting seed 100 lbs. sulphur mixed with 50 lbs. of lime, per acre. Such applications have been found to greatly reduce the amount of the smut. Lime and sulphur sown broadcast are not effective.

BLACK MOULD (*Macrosporium parasiticum*). This fungus generally follows the Downy Mildew, causing the dead and dying leaves to become blackened and covered with a thick black fungus growth. As far as is known it does not attack healthy leaves, and therefore its appearance on dead and dying tops should not cause any alarm.

PEAS.

BLIGHT or LEAF SPOT (*Ascochyta pisi*). This attacks stem, leaves, pods and seeds, originating with infected seed (compare Bean Anthracnose). The stems of attacked plants may show discolored areas of dead tissue sometimes extending completely round them and destroying the shoot. The stem attack is generally worst near the ground. Attacked leaves show round or oval discolored spots from $\frac{1}{8}$ to $\frac{1}{2}$ an inch in diameter. On the pods the disease appears as sunken spots much like those of bean anthracnose but pale in color. The fungus in these spots works through into the underlying seeds and infects them. In the discolored areas on the various parts of the plant the fruiting bodies (pycnidia) will be found as yellowish raised points.

Treatment: Seed free from the disease should be sown. This may be obtained by selecting it from healthy pods. Spraying with Bordeaux mixture, beginning when the plants are from two to four inches high, and repeating at intervals of five to ten days according to the weather, will do much towards controlling the disease. Though such treatment may not be worth while for the sake of the general crop, it is advisable

to apply it on a small scale to plants set apart for seed production, since healthy pods bear healthy seeds and healthy seeds will produce a clean crop the following year.

Powdery Mildew (*Erysiphe polygoni*). This usually appears late in the season. The fungus is of superficial habit, and forms a whitish or grayish coating which may occur on any part of the plant above ground. Later, minute black fruiting bodies are to be found scattered over the mildewed surface.

Treatment: Since the fungus grows on the surface of the plant it is killed by application of Bordeaux mixture.

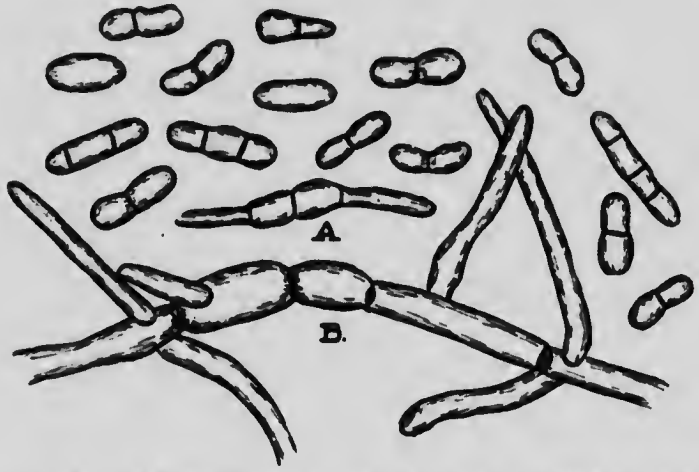

Fig. 53. Pea Blight Fungus. *A*, spores; most of these are 2-celled when mature. *B*, a portion of the mycelium.—(After Selby.)

Potato.

Late Blight or Downy Mildew (*Phytophthora infestans*). This is the most destructive disease of the potato. It causes more or less damage every year, and in seasons when weather conditions are suitable to its growth and development the loss frequently exceeds fifty per cent. of the crop. The effects of the disease are not noticed until late summer. The first indication of the disease is the appearance of small brown patches upon the leaves, most frequently at the margins. These soon enlarge, become black and the leaf curls. In severe attacks the leaves and stems become black and decayed in a very short time emitting a very disagreeable yet characteristic odor. If the brown spots on the under side of the leaves are examined when the disease is active, a delicate white mildewy growth will be observed especially around the margins. The disease also manifests itself by producing brown, dead patches just

below the skin of the tubers. A subsequent rotting of the tubers often takes place, which is now generally supposed to be due to the spread of the disease within them. During the summer months numerous small spores are produced on the lower surface of the diseased spots. These are readily dispersed by wind and moisture, and thus the disease soon becomes spread over an entire field. So far as is known the disease

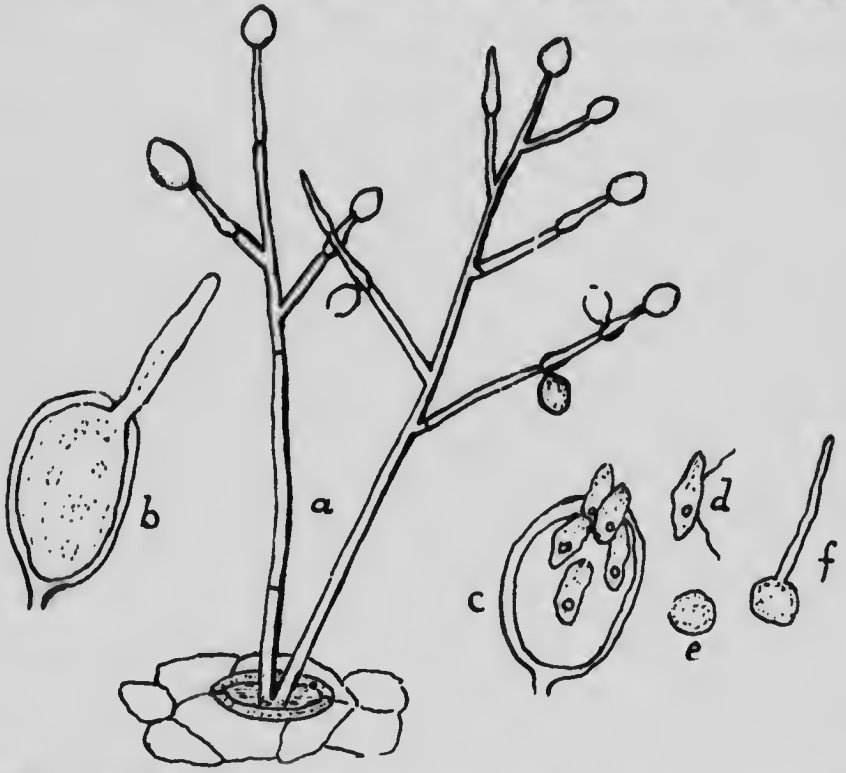

Fig. 54. Late Blight. *a*, Hyphae protruded through a breathing-pore of the leaf and bearing spores; *b*, a spore (conidium) germinating; *c*, a spore-case (sporangium) the contents of which have divided up to form a number of active swimming spores (zoospores); *d*, a zoospore with its two whips; *e*, the same after withdrawing the whips; *f*, the same germinating.

is carried over the winter only as the fungus threads within the attacked tubers. Thus the source of new infection is supposed to be from stored potatoes used for seed and from old tubers left on the ground. On these it is supposed that a new crop of spores is produced, which find their way on to the potato leaves.

Treatment: Spray with Bordeaux. Begin spraying about July 10th, and keep the vines covered with Bordeaux until danger of infection is

over, which will be about the middle of September. It will require from 4 to 6 sprayings to accomplish this. Plant quickly maturing varieties and avoid those which are most susceptible to the disease. Avoid wet soils, if possible. To prevent the rotting of the tubers: delay digging ten days until the tops dry. Do not pile and cover with diseased tops. Hill or mold up 5 inches deep.

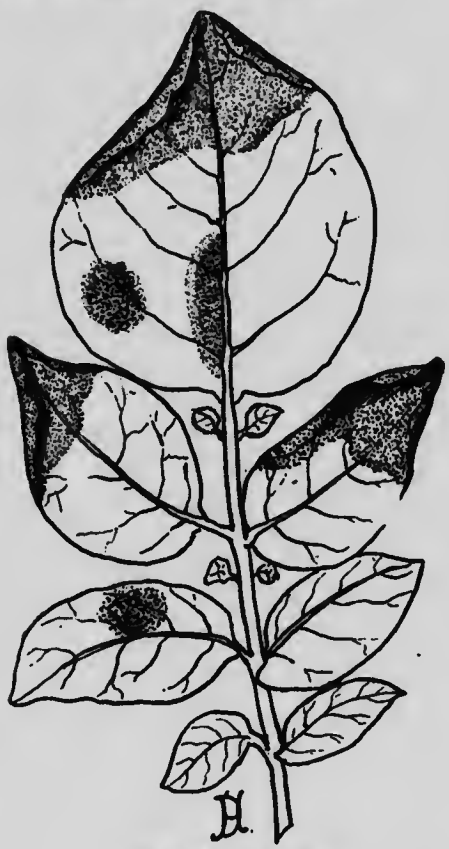

Fig. 55. Late Blight.

Fig. 56. Early Blight.

Early Blight or Leaf Spot Disease (*Alternaria solani*). This disease sometimes appears when the plants are from 6 to 8 inches high, but is most abundant about the time the tubers are forming. In severe cases the foliage is badly damaged and the tubers remain small. Unhealthy plants and those attacked by the flea-beetle suffer most from this disease. Small scattered grayish brown circular spots are first observed upon the leaves. These take on a minutely velvety appearance, and gradually become larger, and run into each other, until in some cases half the leaf may become brown and curled. As the spots enlarge faint

concentric rings appear on them described as "target brand" markings. It is thought that the disease passes the winter in a resting condition in the dead leaves and that the spores may winter over in the soil.

Treatment: Spray with Bordeaux and Paris green when the plants are three or four inches high, and repeat every two weeks through June and July. This treatment will control both the fungus and the flea-beetles. Clean up and burn the diseased tops.

Potato Scab (*Oospora scabies*). This disease causes the familiar blackened, pocket-like cavities and roughened corky spots on the skin of the tubers. On the surface of these spots during their development are produced numerous minute spores which remain attached to the potatoes or in the soil over the winter. It is known that the spores may remain in the soil for several years and then produce the disease again. Alkali fertilizers are known to produce conditions favorable for the development of this disease.

Treatment: Rotation of crops. Avoid alkali fertilizers such as lime and wood ashes. Do not use fresh manure from stock fed on scabby potatoes. For seed select tubers which are free from scab, and disinfect them by soaking them (before they are cut) for two hours in a solution made by adding one-half pint of commercial formalin to 15 gallons of water. Disinfect all bags, baskets, implements, etc., which have been used in handling scabby potatoes.

Wet Rot (*Bacillus* sp.) A common bacterial disease of potatoes producing soft rot.

Radish.

White Rust (*Albugo candida*). This attacks many kinds of plants, wild and cultivated, belonging to the Mustard family (*Cruciferæ*). It is very common on Shepherd's Purse. The disease appears as white shining spots and patches on the leaves and stalks. At these places large numbers of summer spores are produced. Later, resting spores are formed in the attacked tissues and these carry the disease over the winter if the affected leaves are allowed to lie on the ground. Attacked plants may be stunted and deformed but the disease can hardly be described as a serious one.

Treatment: Pull and burn attacked plants. Keep down such weeds as Shepherd's Purse and Mustard which are the natural hosts of the pest.

Tomato.

Leaf Spot (*Septoria lycopersici*). This is the most destructive disease attacking the leaves and stems of tomatoes, and it is very hard to control. Small grayish-brown, angular spots containing minute black fruiting bodies appear upon the leaves and stems. The lower ones are first attacked and the disease spreads upwards, often almost defoliating

the plants. Many growers report that this disease is worst on high, dry, gravelly or sandy soils. It is carried over the winter in the diseased stems and leaves.

Treatment: Spray with Bordeaux a week after transplanting and repeat at intervals of ten days or two weeks. It is often advisable to stake and tie up the plants for greater convenience in spraying. Pinch-

Fig. 57. Leaf-spot of Tomato. Attacked leaves and stem. (From Ohio Bull. 73.)

ing off the lower leaves which touch the ground when the plants are set out is also recommended. The diseased tops should be raked up and burnt.

Black Rot (*Macrosporium tomato*). This fungus attacks the stems, leaves and fruit. It is by the destruction of the fruit, however, that it causes the most serious loss. Roundish black velvety spots appear on the blossom end of the tomatoes. These increase in size and sometimes

involve the whole fruit. On the surface of the diseased spots dark colored, many-celled, club-shaped spores are produced.

Treatment: Spray with Bordeaux, beginning when the flowers open, and repeat at intervals of ten days or two weeks. Remove and destroy diseased fruits. Burn the diseased tops.

Scab (*Cladosporium fulvum*). Olive brown, felt-like areas occur on the under side of the leaves and brown discolorations on the upper surface. In severe cases the leaves turn black, shrivel up and die. Tawny-colored, two-celled spores are produced on the clustered stalks of the fungus on the under surface.

Treatment: Spray with Bordeaux early and repeat at intervals of ten days or two weeks.

Fig. 58. Black Rot on Tomato.

Turnip.

See Cabbage.

Damping-Off of Seedlings.

The seedlings of many plants are liable to be attacked by a disease which weakens the stem at or near the ground, causing the plant to fall over and ultimately die. In most cases this is probably due to the fungus *Pythium de Baryanum*. As the name of the disease indicates, it is usually associated with too moist a condition of the soil or atmosphere. Cruciferous seedlings, *e.g.*, radish, cress, seem especially liable to it. If an attacked seedling be examined it will be found that the stem tissue is shrunken and collapsed at the place where it has fallen over, and at

this point the parasite will likely be seen growing out as a fine mould. Two kinds of spores are produced, the one germinating immediately and serving for the rapid spread of the disease, the other a resting spore.

Treatment: For a seed-bed secure well drained soil not previously infested with the disease. Avoid thick sowing, shade, and over watering. Attacked plants should be removed as soon as noticed, together with the adjacent soil. This stops the formation of spores and prevents the hyphæ growing from the attacked plants over the intervening soil to new plants.

INSECTICIDES.

Paris Green and Bordeaux Mixture.

Four pounds of fresh lime, 4 pounds of bluestone, and 4 ounces of Paris green, thoroughly mixed in 40 gallons of water. In all cases where spraying with Paris green is recommended in the foregoing pages it is advisable to add the bluestone (or Bordeaux mixture) in order to counteract fungus diseases at the same time as the insects are destroyed. The bluestone (copper sulphate) should be dissolved by suspending it in a wooden vessel containing 4 or 5 gallons of water, and the lime slaked in another vessel; if lumpy, the lime should be strained through coarse sacking. Pour the bluestone solution into a barrel and half fill with water; dilute the slaked lime to half a barrel and mix the two together. The Paris green should be made into a paste with warm water, poured into the barrel and stirred thoroughly. The mixture is then ready for use. The addition of the lime prevents the poison from scorching the foliage.

Arsenate of Lead.

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

"The arsenate of soda and the acetate of lead (sugar of lead) should be dissolved separately and then poured into a tank containing the required amount of water. A white precipitate of lead arsenate is immediately formed, and when thoroughly stirred, is ready for spraying. Its finely divided condition keeps it in suspension for hours and thus simplifies the work of spraying. The preparation may be used several times stronger without the least danger of scorching the most delicate plants. When sprayed upon the foliage it forms a coating which adheres so firmly that it is but little affected by ordinary rains." (Bulletin 154, Harcourt and Fulmer.)

Kerosene Emulsion.

The following is the formula recommended by Dr. Fletcher (Central Experimental Farm, Bulletin No. 52):

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

Boil the soap in 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 three gallons of emulsion will make 30 gallons of wash.

Kerosene emulsion may also be made conveniently by using an equal amount of sour milk instead of the soap and water in the above formula, and churning for the same time to get the stock emulsion.

Another method is to use lime, which will hold the kerosene in suspension, or the following, where lime cannot be obtained:

The requisite amount of kerosene is placed in a dry vessel and flour added in the proportion of 8 ounces to one quart of kerosene. It is then thoroughly stirred and two gallons of water 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. It has been found that by scalding the flour before adding the kerosene, an excellent emulsion which does not separate in the least after standing for a week, can be prepared with 2 ounces of flour, by mixing the resulting paste with one quart of kerosene and emulsifying with two gallons of water.

Tobacco Wash (for destroying Aphis).

Soak 4 pounds of tobacco waste in 9 gallons of hot water for four or five hours (in cold water for four or five days); dissolve one pound of whale-oil soap in one gallon of hot water; strain the decoction into the dissolved soap and apply with a spray pump as forcibly as possible.

Soap Washes.

Dissolve one pound of whale-oil soap in four gallons of warm water for black or brown Aphis, and one pound in six gallons for green Aphis.

Another remedy for Aphis is the following: Boil 8 pounds of quassia chips in 8 gallons of water for an hour, dissolve 7 pounds of whaleoil soap in hot water; strain the quassia decoction and mix with the soap solution; then dilute to make 100 gallons. Spray forcibly while hot; this will kill the plant-lice and not injure the plants.

Cook's Carbolic Soap Wash.

Hard soap, one pound, or soft soap.....	1 quart.
Crude carbolic acid	1 pint.
Water (boiling)	1 gallon.

Dissolve the soap in the boiling water; while still hot add the carbolic acid; emulsify thoroughly. This is the stock solution. For use, dilute with 30 to 50 times its bulk of water. Very effective against root-maggots of cabbage, radish and onion.

Hellebore.

White hellebore (fresh)	1 ounce.
Water	2 gallons.

Pyrethrum, or Insect Powder.

Pyrethrum powder (fresh)	1 ounce.
Water	3 gallons.

Or,

Pyrethrum powder	1 ounce.
Flour (cheap)	5 ounces.

Mix thoroughly, allow to stand over night in a closed tin box, then dust on plants through cheese-cloth.

The Poisoned Bran Mash.

For Cutworms.

Mix half a pound of Paris green in 50 lbs. of bran (the proportion for larger or smaller quantities is 1 to 100); the poison should be added to the dry bran little by little and stirred all the time till the whole is tinged with the green color, then add water sweetened with sugar, or molasses, till the mixture is sufficiently moistened to crumble nicely through the fingers. If bran cannot be procured, shorts or flour may be used and for field work may be distributed dry by means of a seed drill.

Criddle Mixture.

For Grasshoppers (Locusts).

Take a three-gallon patent pail and fill it with fresh horse droppings, then empty into a barrel; repeat this five times. As each pailful is poured in, mix thoroughly with the manure about a quarter of a pound of Paris green and half a pound of salt, which has been dissolved in water. There would thus be used about one pound of Paris green and two pounds of salt to half a barrel of manure.

FUNGICIDES.

The principal fungicides in use owe their power to some salt of copper. Such are Bordeaux mixture and its modifications, and ammoniacal copper carbonate, the latter being used chiefly when staining of fruit or foliage such as follows the application of Bordeaux would be objectionable. Potassium sulphide (Liver of Sulphur) is chiefly employed against powdery mildews. These fungi, being of superficial habit, may be successfully combated by less powerful fungicides than the copper salt ones, and of these potassium sulphide has the advantage of being easily prepared and of not staining the plants.

The instructions which follow on the preparation of Bordeaux mixture, soda Bordeaux, copper carbonate, and ammoniacal copper carbonate are taken from Bulletin 154 of the Ontario Department of Agriculture, "Insecticides and Fungicides," by Prof. Harcourt and H. L. Fulmer. This publication is recommended to all interested in spraying. It may be had on application to the Department of Agriculture, Toronto.

Bordeaux Mixture.

The first thing to do in the manufacture of the Bordeaux mixture is to decide on some recommended formula. The formula which has long been advocated in Ontario is known as 4-4-40 formula. It is as follows :—

Crystallized copper sulphate (Bluestone) ...	4 pounds.
Quick lime	4 pounds.
Water	40 gallons.

With good lime it only needs about one pound to act on all the copper; the excess given, three pounds, covers all danger which might arise from the use of a poor article. A large excess of lime is a disadvantage; it causes the Bordeaux mixture to exert a low fungicidal action, it is apt to cause the machinery to clog and to cause an uneven application, and the particles of lime offering more resistance to rain, will cause the mixture to be more rapidly washed from the trees. It may be an advantage, however, in a very wet season, by causing the Bordeaux to retain its efficiency longer and by allowing less injury to be done to foliage.

As both copper sulphate and lime dissolve and slake, respectively, much quicker in hot water than cold, it is better to use heated water in order to save time. The very best lime obtainable is used, and if freshly burned, all the better. In slaking do not use an excess of water, but just enough to keep the lime moist. When the action is completed enough water is added to make a thin whitewash and then the whole is

strained through coarse sacking to remove any lumps which would clog the nozzle of the spray pump. This done, enough water is added to make the volume up to one-half of what the final mixture will amount to. The copper sulphate solution is diluted to the same extent. The two are now mixed, the operation being best performed by two men, each with a bucket, one handling the lime and the other the copper sulphate. They are poured into the spray tank, two bucketsful at a time, until the whole is brought together. In this way a precipitate is obtained which will remain in suspension with only occasional agitation. If mixing is done before dilution, a very coarse precipitate is formed which settles rapidly to the bottom of the spray tank and requires almost constant stirring.

If large quantities of spray mixture are going to be used, it is an excellent plan to make up "stock" solutions of the copper and lime. This can be done by dissolving, say, one pound of copper sulphate in each gallon of water and making up a barrel full of it. Each gallon of the solution taken then represents one pound of the bluestone. The salt can be conveniently dissolved by filling the barrel with water and then suspending it therein, enclosed in a canvas sack. The lime can be handled in the same way, being sure, of course, that the contents of the barrel are thoroughly stirred up before dipping out any portion. Keep the barrels covered when not in use.

Precautions to be Used in Making. Before Bordeaux mixture is sprayed, it is absolutely necessary that all copper should be in the form of the sky-blue precipitate, *i.e.*, enough lime must be used to act on all the bluestone. Formulæ advocated by the experiment stations always contain enough lime to precipitate all the copper, but it may sometimes happen that such a very poor quality is used that there will be some of the sulphate left unchanged. There are several simple ways by which one can tell when enough lime is present. Those who are very familiar with the reaction which occurs can tell by the color of the precipitate, it having a greenish tinge when an insufficiency of lime is present instead of the deep sky-blue color. However, those who are not familiar with the process must use more decided tests. Three simple ones can be employed, as follows:

1. Take some of the clear solution which is left on top when the sediment settles and place in a white saucer. Add a few drops of a solution of potassium ferrocyanide to it. If a reddish-brown precipitate or coloration appears, more lime is needed.

2. Take a portion of the clear fluid as before, and blow the breath gently over the surface. If a thin white pellicle or covering forms over the top, enough lime has been added.

3. Take a bright piece of steel, such as a knife blade, and hold it in the mixture for a minute or more. If it becomes coated with copper, more lime is required.

Test number one is the most reliable and is the one recommended.

In handling copper solutions use only wooden, brass, and copper vessels; all other receptacles would be corroded and destroyed by them; besides, the fungicide itself would be injured.

Copper compounds are *poisonous* and therefore should not be left lying around where children or animals can get at them.

COMBINED WITH AN INSECTICIDE. Bordeaux mixture is quite often combined with Paris green to impart to it an insecticidal value. In this case the mixture takes the place of water for holding the green in suspension. Other recommended arsenicals can be used for this also, such as lead arsenate and calcium arsenate. But if soluble compounds of arsenic are used, such as sodium arsenite, it would be necessary to slightly increase the amount of lime used in making the original Bordeaux mixture.

SODA BORDEAUX.

This fungicide is made from copper sulphate just as the ordinary Bordeaux mixture. It differs, however, in that caustic soda is used to neutralize the acid property of the bluestone instead of lime; and that the final mixture contains sodium sulphate instead of calcium sulphate (gypsum). The resulting form of the copper, copper hydrate, is exactly the same, and exerts the same fungicidal power.

The main point in connection with this mixture is that caustic soda is an extremely active alkali, and any amount of it added over and above that required to combine with all the copper will destroy foliage. Therefore, in making Soda Bordeaux, *it is important to add just the exact quantity of the soda required to change all the bluestone to copper hydrate.* This is done by adding the soda solution slowly to the copper solution, mixing thoroughly after each addition, and testing for the neutral point with litmus paper. The moment the litmus paper takes on a faintly blue tinge is the time to stop adding. The copper is then all in the form of a sediment and any more alkali added will be left in the free state.

The following tentative formula can be given:

Soda	2 pounds.
Copper sulphate	6 pounds.
Lime	5 ounces.
Water	40 gallons.

In making, add three-quarters of the soda solution at once, mix thoroughly and then add the rest gradually, mixing and testing until the proper quantity is present. It may not require the whole amount recommended, and it may require more, depending upon the quality of the soda. When the alkaline value of a sample of soda is once ascertained, then one can proceed with much more rapidity. The small

amount of lime is added to make the mixture decidedly alkaline, and therefore, safe, and to cause the precipitate to remain blue instead of changing to dark brown or black, which it does after standing some time where an excess of soda is used.

Caustic soda can be bought retail or in drums of one hundred pounds, from or through any chemist, while Gillette's lye, which is familiar to everyone, is a convenient form of soda for use in making Soda Bordeaux.

Soda Bordeaux has an advantage over the ordinary Bordeaux in that it is just as good a fungicide, and at the same time is made without the labor of slaking and preparing of lime. There are disadvantages, however:

1. Great care is necessary in the addition of the caustic soda. Any added in excess is dangerous to foliage; an excess of lime is not harmful, though not advisable.

2. Unless exactly neutral, the addition of an arsenical to Soda Bordeaux to impart to it an insecticidal power, is dangerous. Any free alkali will act upon the arsenic compound and form sodium arsenite, which, being soluble, will scorch foliage.

Copper Carbonate.

This valuable fungicide can be readily and easily made at home at much less cost than for what it can be bought on the market. The following method of making is recommended: A barrel is partly filled with water and 25 pounds of copper sulphate are dissolved in it, and into this is poured a solution of 30 pounds of sodium carbonate (common washing soda), when the copper is thrown down as a pale green precipitate of "basic" copper carbonate. This precipitate rapidly settles to the bottom, and after a time the clear solution above can be siphoned off. The barrel is filled with water again, the precipitate stirred up and allowed to settle, and the clear solution again drawn off. This washing removes the greater part of the impurities (sodium sulphate), and leaves behind 12 pounds of basic copper carbonate. This can be removed from the barrel and dried in the air, after which it is ready for use.

Ammoniacal Copper Carbonate.

This spray is made from basic copper carbonate, the preparation of which has just been outlined under "copper carbonate." When ammonia is added to this material, it dissolves to form a deep blue solution, and this solution diluted with the requisite quantity of water forms the well-known spraying compound.

Following are the quantities of material to use:

Copper carbonate	5 ounces.
Ammonia (sp. gr. 26° Beaume)	3 pints.
Water	45 gallons.

Resin-Bordeaux.

The surface of some plants, *e.g.*, onion, asparagus, etc., is of such a nature that liquids do not readily wet it, and instead of forming a smooth coating they collect into large drops and fall away. This makes effective spraying difficult. The difficulty may be overcome by using the following preparation (Cornell Bulletin 252):

Resin	2 pounds.
Sal soda crystals ...	1 pound.
Water ...	1 gallon.

Boil in an iron vessel (preferably out-of-doors) until the mixture is of a clear, brown color. This will take from one to one and a half hours. Add the above quantity to each 50 gallons of Bordeaux. In wet weather the use of half this quantity in spraying ordinary plants will prevent the washing off of the spray liquid by rain.

Potassium Sulphide.

This is also known as "liver of sulphur." As previously mentioned it is used chiefly against powdery mildews, a solution of ½ to ¾ an ounce per gallon of water being employed. This should be made in a wooden vessel and used very soon after making, as it decomposes on standing.

In some cases sulphur in fine powder (flowers of sulphur) has been found an effective substitute for potassium sulphide. The powder is simply dusted over the plants and is best applied when the latter are wet.

Formalin.

The substance known under this name is a 40% solution of formaldehyde in water. A dilute solution is fatal to fungus spores and such a solution is used as described on page 51 for treating potato tubers. Similar solutions are used for treating seeds.

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