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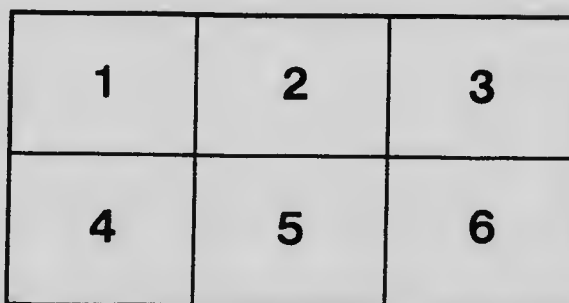
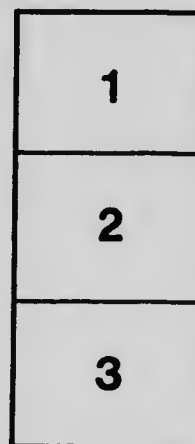
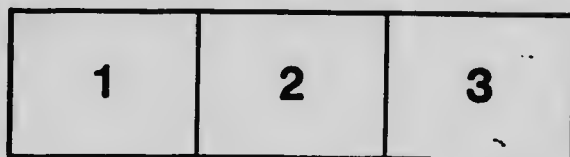
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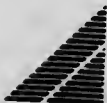
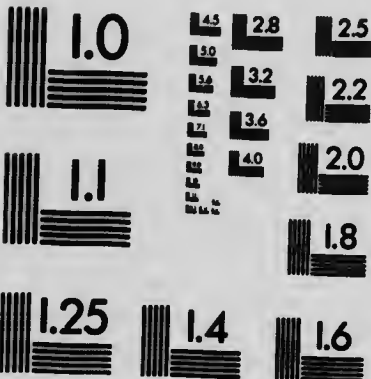
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ONTARIO AGRICULTURAL COLLEGE AND EXPERIMENTAL FARM

THE COMMON FUNGUS AND INSECT PESTS OF
GROWING VEGETABLE CROPS.

BY WM. LOCHHEAD AND T. D. JARVIS.

INTRODUCTION.

In the following pages an attempt is made to describe concisely the common fungus and insect enemies of vegetable crops, and to state briefly the best methods of controlling these pests. It is believed that the publication of such information in bulletin form will fill a long-felt want. While criticism may, perhaps, be made of some of the treatments recommended, to the effect that they are too expensive, too burdensome, or but partially effective, it can at least be said that they are the best that up to the present have been devised. It is true that with some vegetable crops the returns are so small that every means must be taken to reduce the cost of growing and marketing the crop. As a consequence, some growers will, perhaps, prefer to replant rather than practise the treatments recommended in this bulletin.

Experience will, we are sure, convince the majority of growers that spraying is, after all, a cheap form of crop insurance. It may be true that with some diseases only a few plants die, and the grower does not lose much, yet it often happens that the disease destroys practically the whole crop, and the grower is left without anything to show for his work. The spray-pump should be in evidence in every vegetable garden, and to get the best results from spraying, the following rules should be followed as closely as possible:—

1. Buy the best spray-pump outfit in the market.
2. Have stock solutions of Bordeaux and other common substances in readiness for spraying.
3. Spray thoroughly and intelligently, *i.e.*, know the *habits* of the fungi and insects, the *preparation* of the best remedies, and the *best time for the application* of the remedies. It should be remembered that prevention of fungus disease is possible, but their cure is hardly practicable.

DISEASES.

Diseases of plants, for convenience of consideration, may be grouped as follows: First, those caused by (a) insects and other animals, (b) fungi, (c) bacteria, (d) slime moulds, and (e) flowering plants; and, second, the unfavorable action of soil, drought, heat, wind, lightning, frost, and sun scald. Sometimes two or more of these causes may operate to bring about a diseased condition of the plant. In particular we may note that plants which have been rendered unhealthy by excessive moisture, excessive dryness, or imperfect access of light and air, are more liable to attack from insects and fungi. It is not always easy to tell when a plant is in a diseased condition, for the condition of a healthy plant varies between fixed limits, and it is only when these limits are exceeded in either direction that the life of the plant is threatened, and there is disease instead of health. We sometimes group the causes which bring about diseases in plants as external and internal, but it is very probable that the so-called internal causes will be found to be nothing more than external causes acting in an indirect manner.

Young plants are, as a rule, more liable to attack by fungi and insects than older plants, because their tissues are softer and their cuticle thinner.

In the following pages attention will be given only to those diseases in plants which are caused by insects, fungi, and slime moulds.

The losses produced every year by the action of insects and fungi on vegetable crops are very large, amounting in Ontario to probably one-half million dollars. While it may be true that some of these losses cannot be averted, yet it is also true that a large percentage of them can be prevented by proper treatment. On account of the low prices prevailing in the vegetable markets, the method becomes a very important factor in the control of these pests. In some cases the cost of treatment would amount to as much as the market price of the vegetable. It is our object in the following pages to recommend treatments as have been found effective and practicable in vegetable crops cultivated on a commercial basis.

A few words about the habits of fungi are in order. Fungi are a group of lower plants (without green-coloring matter) that produce spores instead of seeds. The body of a fungus may be very simple, composed of a few threads, or it may be more complex, composed of many threads matted together. The fungus derives its nourishment from the cells of the plant which it attacks. Sometimes the threads live on the surface of the plant (*e.g.*, the Powdery Mildews), but more frequently they live within the plant, either between or within the cells. Fungi produce, roughly speaking, two kinds of spores—*summer* spores, capable of developing threads as soon as they are set free; and *resting*, or *winter* spores, requiring a period of rest before germinating. Spores are carried by such agencies as wind and water, and, coming into contact with a suitable host plant, they develop threads which may enter through wounds.

or through the skin of the plant. Once within, the mass of threads grows rapidly at the expense of the cells of the host plant, and a diseased condition ensues. Every fungus produces its own characteristic disease and injury, so that it is possible to diagnose the causes of most plant diseases from the external appearances.

The best method of dealing with fungous diseases is along the line of *prevention of infection*. Careful attention to all wounds, when spores may find entrance; the rotation of crops, so that the resting spores of one crop may not infect the succeeding ones; careful attention to the destruction of weeds that may be diseased and infect useful plants; the use of old rather than fresh manures; the selection of plump, healthy, and disease-resisting seeds; and the timely and early application of fungicides, are some of the methods usually employed to prevent infection.

Insects do fully as much harm as parasitic fungi, and some are also very difficult to control. Wire-worms, White Grubs, and Root-maggots pass their grub or larval stage in the ground, and feed on the roots of plants. Potato "Bugs," asparagus beetles, and grubs, squash-bugs, and plant lice, feed on the stems and leaves, and are more readily treated.

For the practical grower, it is important to know that insects are divided into two classes: the *biting* insects, that chew their food, and the *sucking* insects. The former can be poisoned by arsenical poisons, but the latter cannot, and must be treated by substances that kill by contact, such as soaps, kerosene emulsions, and tobacco washes. It is also very important to know the life-histories of the most injurious insects, so that they may be attacked during the most vulnerable period of their life.

Much can be done by such *cultural* methods as rotation of crops, high culture, careful removal and burning of rubbish and weeds, and plowing. Short rotations, for example, furnish unfavorable conditions for white grubs, wire-worms, and root-lice. The general plan is to change the crop so frequently that it becomes impossible for any insect to pass through its life stages without being seriously disturbed, and its food supply destroyed. Deep fall-plowing is also an excellent method of controlling wire-worms and white-grubs, and is effective against grasshoppers and cutworms. As for High Culture, it may be said that vigorous, healthy-growing plants are far less liable to attack, and are far more likely to recover from injury, than those that are in any way weakened in vitality from lack of fertility or by neglect. Therefore, if a farmer and gardener gives special attention to the fertility and drainage of his land, procures the best seed, and by proper planting and cultivation secures vigorous plants from the start, and by proper care endeavours to keep them in this condition until the product is matured, he will have accomplished more in preventing loss from insect depredations than he would accomplish by the best remedies applied to half-starved, neglected plants.

Asparagus.

(Insects.)

COMMON ASPARAGUS BEETLE (*Crioceris asparagi*): A small, bright-colored beetle, about one-fourth of an inch in length; head, legs, and wing covers of a bright bluish-black color. There are six cream-colored markings on the back of the thorax, and margins of the wing covers are of a light reddish-brown.

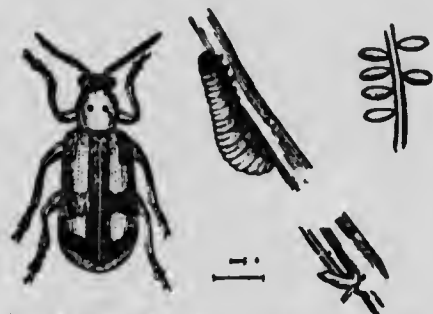
The brown-colored eggs are deposited on the stalks early in May and from these hatch dull gray-colored larvæ. When the larvæ are full grown, they pass into the ground and change to pupæ, and about ten days later, emerge as adults.

The life-cycle, therefore, only lasts about a month. There are several broods each season, and we usually find eggs, grubs, and adults upon the plants from May until autumn. The winter is passed in the adult stage, under stones or beneath the bark of trees.

Remedies: Ridge the earth to protect the young shoots, and dust the plants every few days with air-slaked lime in the morning while the dew is on the plant; when the cutting season is over the plants should be sprayed with Paris green or arsenate of lead. This will kill both larvæ and adults. When practicable, turn the chickens into feed on the larvæ and beetles.



The Twelve-spotted Asparagus Beetle enlarged.



ASPARAGUS BEETLE.—(*Crioceris asparagi*, Linn.)

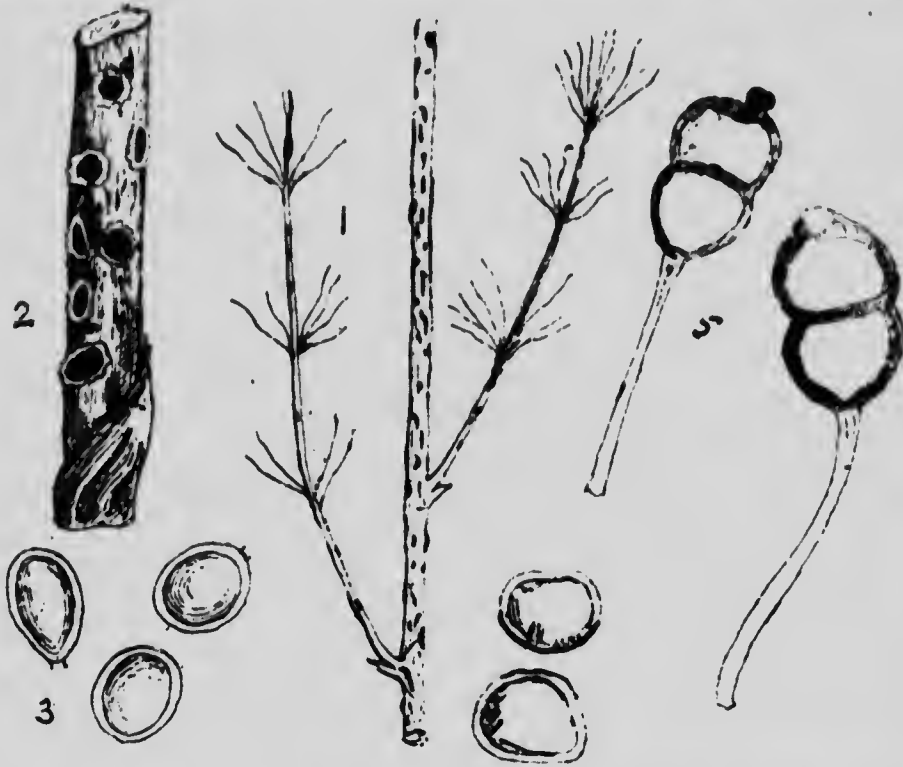
TWELVE-SPOTTED ASPARAGUS BEETLE (*Crioceris 12-punctata*):—The beetles are of a uniform reddish-orange color, with six black spots on each wing cover. They are about the same size as the Common Asparagus beetle. The habits of this beetle are much the same as the last

Remedies: Same as for Common Asparagus beetle.

(Fungus).

RUST (*Puccinia asparagi*): Very numerous in some plantations. Numerous brown or black oval spore-producing postules break through:

the skin of the stem. Three kinds of spores are produced, viz., cluster-cup spores, red summer spores, and black winter spores, all on the same plant.



ASPARAGUS RUST. 1, a diseased stem; 2, the cluster-cup stage on early plants; 3, spores of cluster-cup; 4, spores of summer stage (uredospores); 5, spores of the winter, or teliospore stage.

Remedies: Spray with resin-bordeaux from July to September at intervals of ten days or two weeks; dust liberally with flowers of sulphur; cut and burn the dead stems in autumn; plant resistant varieties, such as Palmetto and Argenteuil.

Beans.

(Fungi).

ANTHRACNOSE (*Collectotrichum linlemuthianum*): This disease occurs mainly on the pods, but sometimes on the leaves, as roundish black, sunken spots, bordered with purple. The spores are produced at the ends of minute threads, massed together at points on the diseased spots.

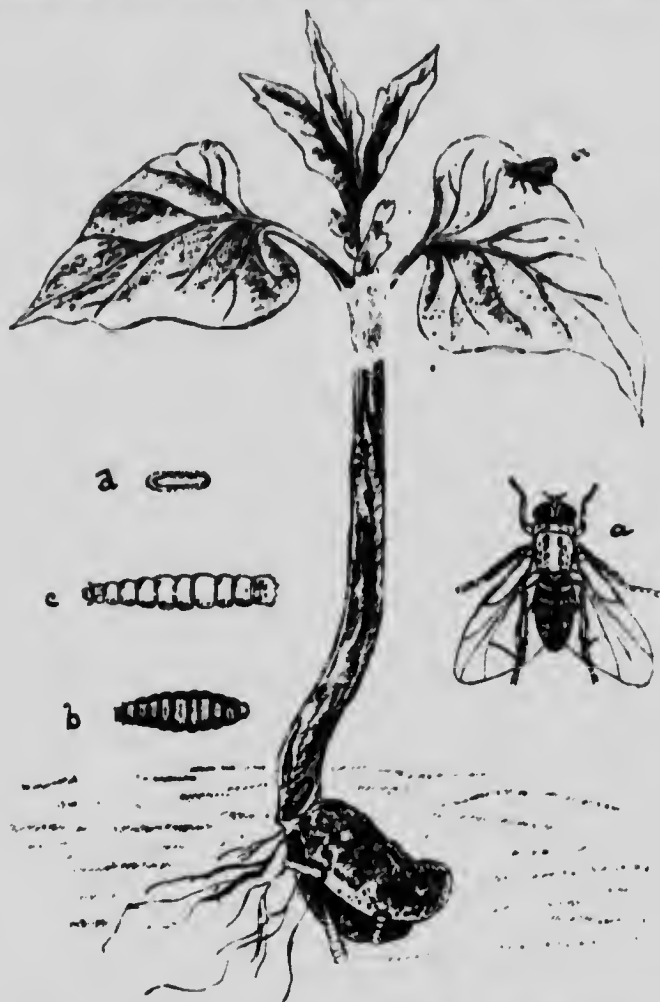
Remedies: Spray with Bordeaux at intervals of two weeks, beginning when the plants are quite small, and continuing into September or October. Soak the seed beans for two hours in formalin solution, made



PINK ROT ON BEAN ANTHRACNOSE. *a.* spores and spore-threads of the Pink Rot, showing the shape, and arrangement of the spores. (After Cornell Bull. 207); *b.* bean pods attacked by anthracnose.

by dissolving one-half pint in fifteen gallons of water. Destroy infected seedlings and leaves when first observed.

RUST (*Uromyces appendiculatus*): Bean rust is occasionally injurious on some varieties, and is readily recognized by the small brown or black pustules on both sides of the leaf.



BEAN FLY. a. adult flies; b. pupa case in ground; c. maggot; d. an egg. After Luggar.

Remedies: Burn the stalks and rubbish containing the spores, and plant varieties that are more or less rust-resistant.

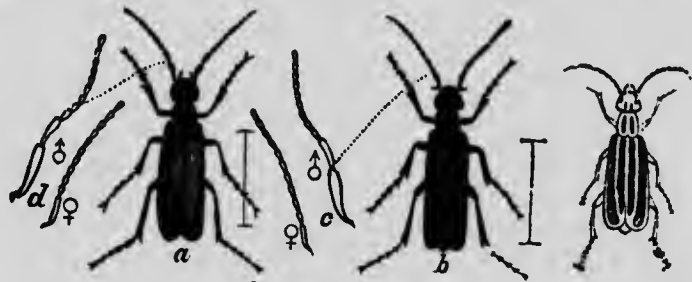
Beet.

(Insects).

OLD-FASHIONED POTATO BEETLE (*Epicauta vittata*) ASH-GRAY BLISTER BEETLE (*Macrobasis unicolor*), and **BLACK BLISTER BEETLE (*Epicauta***

pennsylvanica: All three species of Blister beetles are injurious in the adult stage. They are about half an inch long, with long legs, and soft, flexible wing covers. The Old-Fashioned form is striped yellow and black. The Black and Gray forms look much alike, except for color.

In the larval stage these insects are beneficial, living upon the eggs of locusts.



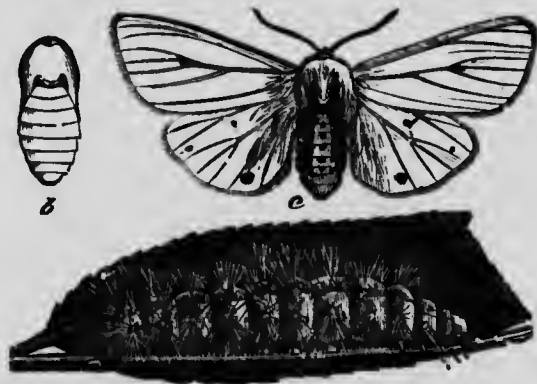
BLISTERING BEETLES.

Remedies: Spray with arsenical poisons. On account of their beneficial nature, it is not advisable to spray unless they are very abundant.

BEE-LEAF MINER (*Pegomya vicina*): The larvæ mine inside the leaf. At first the mines are small, but later, large blotches appear on the upper side of the leaf. The green tissue of the leaf is devoured, and the function of the leaf is destroyed.

Remedies: Gathering and destroying infected leaves; crushing the maggot inside the leaf.

WOOLLY-BEAR (*Spilosoma virginica*): Large caterpillars, about one and one-fourth inches in length. The color varies from pale yellow to



COMMON YELLOW BEAR.—(*Spilosoma virginica*) Fab.: *a*, caterpillar; *b*, pupa; *c*, adult. After Riley.

straw color. The adult is a snowy white moth, marked with a few black dots. The larvæ feeds on the leaves of the beet.

Remedies: Hand picking; Paris green in Bordeaux.

LEAF-HOPPERS (*Jassidae*): Small, elongated insects, usually pale green in color. They are very active and jump quickly when disturbed. They are provided with sharp sucking beaks, which extract the juices from the surface of the leaf. When present in large numbers, they cause a gradual decline of the plant, and in some cases death.

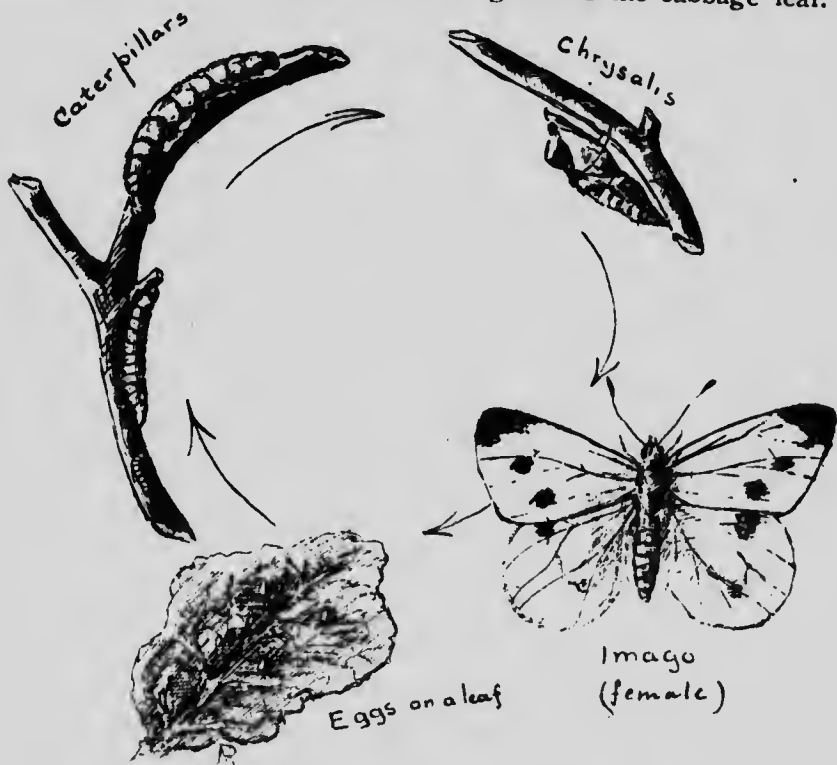
They pass the winter in the adult state, under boards, stones, leaves, etc.

Remedies: Collect and burn all rubbish before winter sets in. Contact poisons have not proved very satisfactory.

Cabbage.

(Insects).

CABBAGE-WORM (*Pieris Rapæ*): The common green worm of the cabbage. It is about the same color of green as the cabbage leaf. Its



CABBAGE BUTTERFLY. The four stages in the butterfly's life history are represented: eggs, larvæ or caterpillars, chrysalis, and wings. The body is covered with fine short hairs, and when mature it is about one and a half inches in length. The adult is the common white Cabbage butterfly.

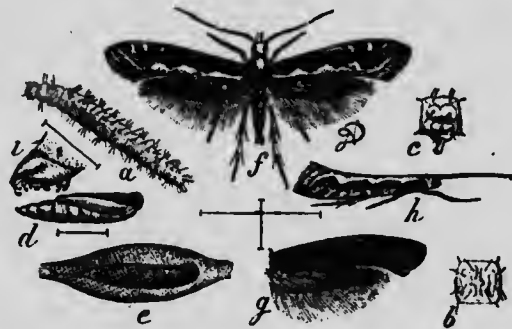
Remedies : Spray with Paris green, using one pound of Paris green to every 100 gallons of water, and adding a little hard or soft soap to prevent the liquid rolling off the cabbage leaves; hellebore dusted over the cabbage leaves in early morning.

Hellebore is poisonous to insects, although harmless to man. It is more expensive than Paris green.

CABBAGE-ROOT MAGGOT (*Phorbia brassicæ*): This pest is well known to the vegetable growers of Ontario. The eggs are laid by a small fly in the soil near the root of the cabbage. In two or three days the eggs hatch, and the small white maggots find their way to the root of the cabbage or cauliflower. The young maggot tunnels into the root and the affected plant soon withers and dies.

The winter is passed, for the most part, in the pupal condition.

Remedies : Carbolic acid emulsion (diluted about thirty times with water) using one-half teacupful to each plant and pouring it about the root with a sprinkler the day after setting and repeated every ten days, until the end of May; tobacco dust placed around the stem of the plant; pads of tarred paper about 2 and 2½ inches in diameter, placed about the plants shortly after setting time; destroy diseased plants.

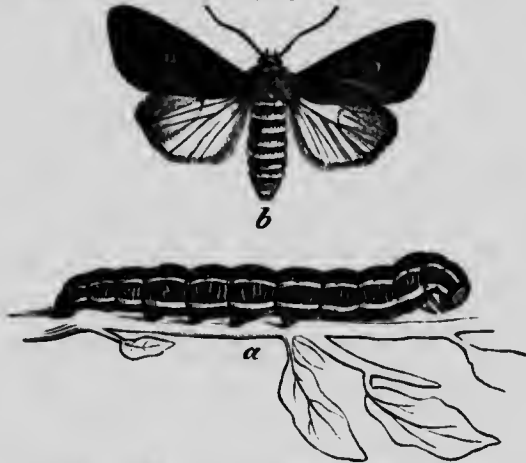


THE DIAMOND-BACK MOTH : a, caterpillar ; d, pupa ; e, cocoon ; f, moth—enlarged.

DIAMOND BACK MOTH (*Plutella maculipennis*): Small green-colored caterpillars, about three-eighths of an inch in length. When disturbed they wriggle about and fall to the ground. Their presence is easily detected by the numerous small holes eaten through the leaf. The larval stage lasts about a month, and then they spin small cocoons on the under side of the leaf. About two weeks later the adult moth emerges. There are, at least, two broods in a season.

Remedies : Dust or spray the infected plants with the usual Paris green mixtures or solutions, as for Cabbage-worm. Induce vigorous growth by light dressings of nitrate of soda.

ZEBRA CATERPILLAR (*Mamestra picta*): Very bright-colored caterpillars, velvety black on the back, and with bright yellow stripes on each side of the body. They attack many plants of the Cruciferae family, including Turnip, Rape, Cabbage, and Cauliflower. They seldom occur in such numbers as to do much injury.



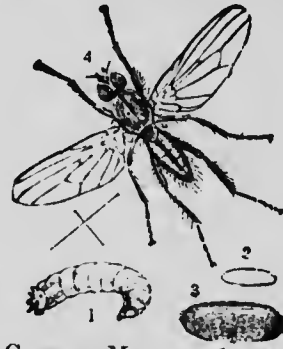
ZEBRA CATERPILLAR (*Mamestra picta*, Harris.)

Remedies: Dust plants with Paris green and some dry powder, or spray with Paris green solution.

CUTWORMS: The cutworms are large, dark-colored insects, about one and a quarter to one and a-half inches in length. They are smooth, naked, and present a greasy looking appearance. When disturbed they curl up



THE CABBAGE APHID male; 3 and 4, wingless female—2 and 4 enlarged.



CABBAGE MAGGOT; 1, maggot; 2, 3, pupa case; 4, fly—1, 3 and 4 enlarged.

at both ends. Some confine their ravages to the ground, and are known as ground cutworms. Others, which defoliate trees, are known as "Climbing cutworms." The pupal stage is passed in the ground, and the moths appear in midsummer.

They cut off the young plants just below the surface of the soil.

Remedies : Sprinkle poisoned bait between the rows (prepared according to the formula), but keep poultry away at such times. The cut-worms always bury themselves in the soil before they die.

APHIS (*Aphis brassicæ*): Minute, soft-bodied insects, covered with a coat of fine, waxy powder. They have sucking mouth parts, and extract the juices from beneath the surface of the leaf. They multiply very rapidly, and about mid-summer the under surface of the leaves becomes literally covered by them.

Remedies : Spray with whale-oil soap, prepared by dissolving one pound of the soap in from four to six gallons of the water, and apply as in the case of kerosene emulsion.

(Fungi).

CLUB ROOT (*Plasmodiophora brassicæ*): This disease is caused by a slime-fungus, and is characterized by irregular enlargements or galls on the roots, and by the spindling nature of the affected cabbage, which makes little or no head. The cells of the galls are abnormally large, and, before maturity, contain a grey or brown granular mass of protoplasm. At maturity this mass is converted into spores, which later are set free in the soil. Naked moving bits of protoplasm escape from the spores, and it is believed that they enter the plants by the root-hairs. Turnips, radish, mustard, shepherd's purse, and other members of the Cruciferæ are liable to this disease.

Treatment : As the spores may remain dormant for several years in the soil, infected fields should not be used for the same crop for several years; cabbage on soils rich in lime suffer but little from Club-Root, hence it is advisable to apply a coating of slaked lime (75 bushels to the acre); weeds, such as mustard and Shepherd's Purse, should be looked after carefully; on no account put Club-root refuse on the manure or compost heap, but burn it; "manure from cows fed with clubbed roots will easily infect crops."

BLACK ROT (*Pseudomonas campestris*): This is a bacterial disease of cabbage, cauliflower, rape, and Swede turnip, and spreads rapidly in low, damp soils during rainy, moist weather. The lower leaves are usually first attacked, where the veins turn black and the leaves wilt.

Treatment : Remove and destroy diseased plants; avoid low, damp soils, and rotate the crops.

SOFT ROT (*Bacillus oleraceæ*), is another bacterial disease of cabbage and cauliflower. (See O.A.C. Bulletin 136.)

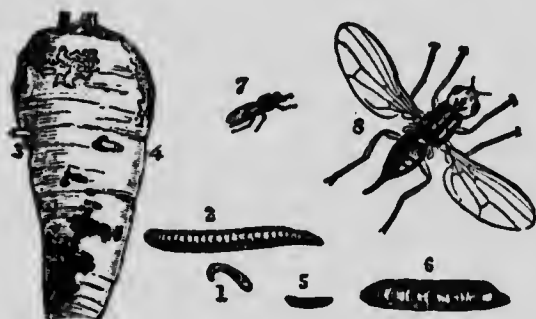
Carrots.

(Insects).

THE CARROT RUST FLY (*Psila rosæ*): Semi-transparent, yellowish maggots, about one-fourth of an inch long, blunt at the tail end, but

tapering toward the head; frequently injure the roots of carrots. The mature insects are a species of small fly.

The leaves of the young carrots turn reddish, and the roots become minutely furrowed and blotched with rusty patches. The carrots when stored for winter use, although sometimes not showing much injury on the outside, may be found to be perforated in every direction by dirty brown burrows.



CARROT RUST-FLY—natural size (1, 5, 7), and enlarged (2, 6, 8).

Remedies: Sow late to escape the flies; spray with kerosene emulsion solution (one part of the ordinary emulsion to nine of water); dust rows with lime, land plaster, or ashes, to which a little coal-oil has been mixed. One application a week should be made through June and into July. Rotation of crops.

Celery.

(Insects).

CELERY CATERPILLAR (*Papilio asterias*): The adult is a very handsome swallow-tailed butterfly. The larva when full-grown is about one and one-fourth inches long; is pale-green, and marked cross-wise with yellow and black lines. Just behind the head is a pair of horn-like structures, which can emit an unpleasant odor.

Remedy: Hand-picking is usually sufficient to control the caterpillars.

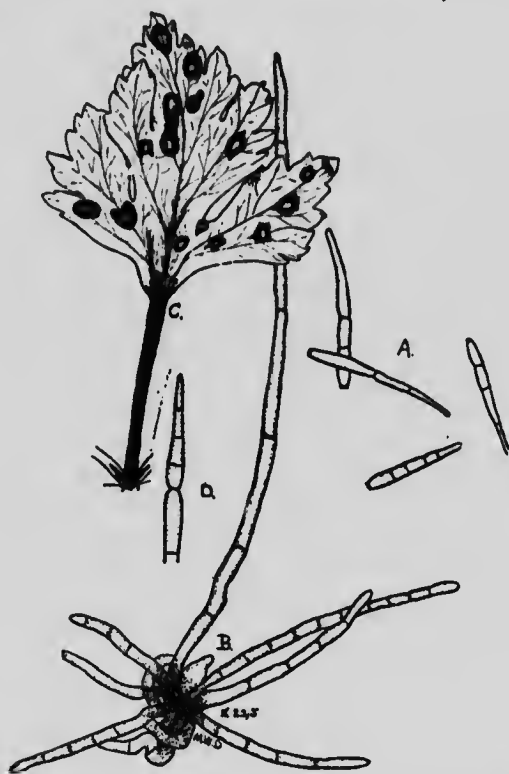
(Fungus)

LEAF BLIGHT (*Cercospora apii*): This fungus disease is sometimes known as "rust," and appears on the leaves first as light spots, which later become brown, and finally yellow. The spots soon increase in size and become irregular in shape, and the plants are seriously injured. The spores can be readily found on the diseased areas.

Remedies: Spray with Bordeaux while the young plants are in the frames before transplanting, and repeat at intervals of ten days. It is

recommended to use the Ammoniacal-copper carbonate solution in the later sprayings.

LEAF SPOT (*Septoria petroselini*, var *apii*): Brown spots, studded with minute black spots, appear on the leaves.



CELERY BLIGHT. (*Cercospora Apii*.)—A, spores through the agency of which the disease spreads; B, tuft of aerial protruding through a breathing-pore of a leaf; C, a diseased leaf, showing the brown.

Remedies : Same as for leaf blight above.

Corn.

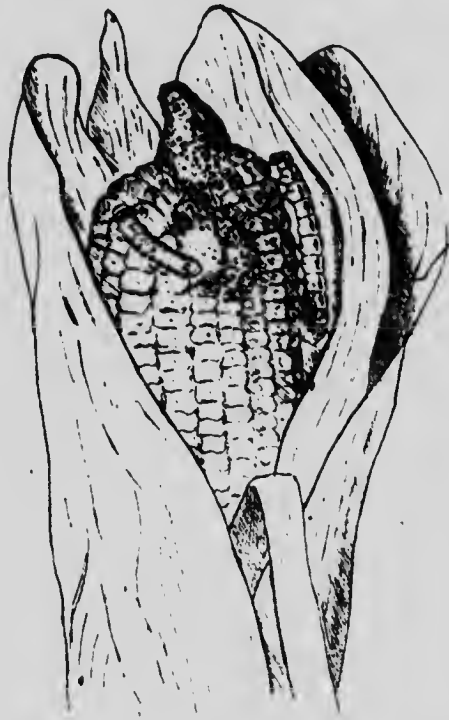
(Insects).

CORN-STALK BORER (*Papaipema nitela*): The larvæ which belong to the Cutworms bore into the stalks of the young corn plant. The leaves turn yellow, and the stalks die prematurely. It is a general feeder, and attacks potatoes, tomatoes, and many species of weed.

Remedy : Destroy the diseased shoots.

JUNE BEETLE or WHITE GRUB (*Lachnosterna fusca*): The larva is a large, soft, white grub, about an inch and a half long, and usually curled at the posterior end. The pupa stage is passed in the ground. The adult is a large, plump, brown beetle, known as the June "bug." It takes two or three years to develop, and is sometimes very destructive to garden crops.

Remedies: Late fall plowing destroys the pupæ, and exposes them to their enemies and the weather; rotation of crops prevents the development of the insect; shaking the adults from trees upon sheets.



CORN WORM. An ear of corn affected by corn worm. Caterpillars are very variable in their markings.

CORN EAR-WORM or COTTON BOLL-WORM (*Heliothis armiger*): The larvæ are striped, and may be greenish or reddish in color, and when full-grown about one and one-fourth inches long. The larvæ feed on the ears of the sweet corn, and the affected ears are unsightly and unfit for table use.

It has never been very troublesome to Ontario corn-growers. It also feeds on the fruit of the Tomato.

Remedy: Late fall plowing destroys the pupæ.

GRASSHOPPERS AND LOCUSTS: Large jumping insects, with biting mouth parts. They feed on asparagus, beet, sweet corn, and many other kinds of garden plants.

Remedy: Spray with Paris green solution, arsenical Bordeaux, use poison bait.



MAY BEETLE. *Ichnosterna fusco*, Fröhl. From Riley.

WIREWORM OR CLICK BEETLE: Slender, yellowish-brown worms, with six legs on the front segments of the body. They are hard and wire-like, and when full grown are about an inch long. They require from three to five years to pass through their life-stages.

The adults are dark gray click beetles, for when they are placed on their backs they turn over with a click.



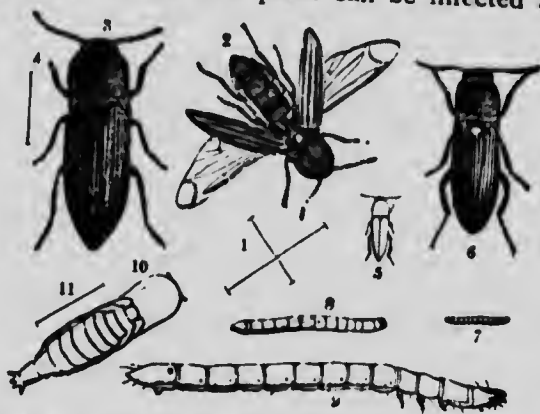
A GRASSHOPPER OR LOCUST.

Remedies: We have no satisfactory remedy for wire-worms. Poisoned baits, such as sliced potato and clover soaked in Paris green, placed under boards, have given the best results for garden plants; rotation of crops, and late plowing are helpful.

(Fungi).

SMUT (*Ustilago maydis*): Sometimes the cobs of corn become greatly enlarged, and the leaves and staminate tassels have tumor-like growths.

These are produced by a fungus called Corn Smut. The growths are filled with black spores, which rest over winter, germinate in the spring, and produce multitudes of secondary spores. These are carried by the wind to new corn plants, which become infected. It has been shown that only young parts of the corn plant can be infected and attacked.



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

Treatment: Avoid fresh manure; remove and burn all the smut growths as soon as discovered. Seed treatment is not effective.

RUST (*Puccinia sorghi*): Reddish or blackish elongated pustles occur on both sides of the leaf. The injury is not often serious.

Cucumber.

(Insects).

STRIPED CUCUMBER-BEETLE (*Diabrotica vittata*): This beetle is well known to the vegetable grower. It is light yellow, with four black lines down the back, and is a little more than two-fifths of an inch in length. The eggs are laid on the stems just below the surface, and when hatched bore into the stem or root. The winter is passed in the adult stage, under any rubbish which will afford shelter. In the spring, as soon as the young cucumbers appear above the ground, the beetles leave their hibernating quarters and devour the foliage of the seedlings. It feeds also upon the squash and melon, and is a very difficult insect to overcome.

Remedies: Spray with arsenical Bordeaux as soon as plants appear above ground, and repeat ten days later; dust the young plants with Paris green, and land plaster, ashes or lime (one to fifty), or with dry slaked lime and sulphur, and repeat ten days later; keep the young vines covered with cheese-cloth, fixed to frames; clean up refuse in the fall.

SQUASH-BUG (*Anasa tristis*): The adult insect is a rusty-brown, flat bug, yellow on the under side. It is about three-fifths of an inch in length

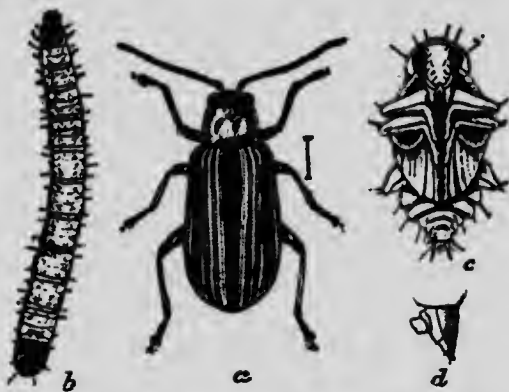
and has a very offensive odor. It winters in the adult form underneath leaves, boards, etc. The eggs are reddish-brown, and are laid on the under side of the leaves.

Remedies: Hand-pick the insects morning and evening, when they are least active; collect and destroy the egg masses; spray the vines thoroughly with kerosene emulsion or soap solution to kill the young



Portion of a cucumber vine showing natural infection with *B. tracheiphilus*. Note the wilted appearance of the leaves.

bugs; protect the young plants with cheese-cloth screens; trap with shingles and pieces of board, under which the bugs will gather, or with early squash plants.



STRIPED CUCUMBER BEETLE (*Diabrotica vittata*).
From Chittenden.

TWELVE-SPOTTED CUCUMBER BEETLE (*Diabrotica 12-punctata*): A greenish-yellow beetle, with twelve black spots on its wing covers. It

is about the same size as the striped cucumber beetle, and attacks the same plant.

Remedies: Same as for Striped Cucumber Beetle.

(Fungi).

DOWNY MILDEW (*Plasmopara cubensis*): This disease is also common on musk melons. Large yellow spots appear on the leaves, and cause them to shrivel up. The disease is most serious during muggy weather. The spores are borne on peculiar stalks on the under side of the leaf, and are borne to unaffected leaves by wind. As the body of the fungus lives within the tissues of the leaf, it is impossible to effect a cure after the leaf is inoculated.

Treatment: Spray with Bordeaux every ten days after the middle of July, giving attention to the under sides of the leaves. This treatment will at least keep the fungus in check.

WILT (*Bacillus tracheiphilus*): A bacterial disease of cucumber, squash, and pumpkin. The leaves of affected vines suddenly wilt, and in a few days shrivel and turn brown. The disease progresses in the vine in the direction of growth, and kills the leaves in succession.

Lettuce.

(Fungi).

DOWNY MILDEW (*Bremia lactuæ*): Greyish, mouldy areas occur on the under side of the diseased leaves, which show yellowish-brown patches. This fungus thrives well in moist situations. The spores are borne on peculiar branching stalks, constituting the mould.

Treatment: Care in draining, watering, and ventilating will do much to control this disease.

THE GREY MOULD (*Botrytis vulgaris*): This is very common in greenhouses. It causes a rotting of the leaves, upon which it appears as a greyish mould. In rotting leaves are found also minute black bodies (sclerotia), which carry a leaf-rot disease, (*Sclerotinia libertiana*) called the Drop, over from one crop to another. It may be that the Gray Mould is the summer stage of the Drop disease.

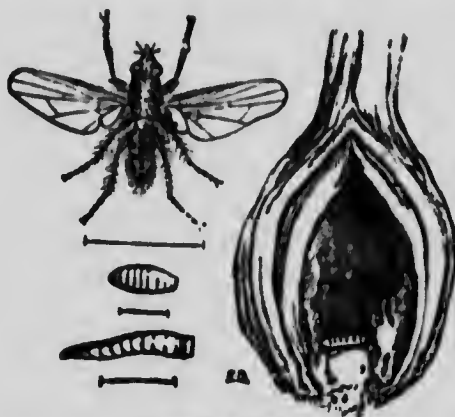
Treatment: Care in draining and ventilation; sterilize the soil with hot water, or add a coating of sterilized sand or earth; apply coatings of coal ashes, or sulphur and charcoal.

Onion.

(Insects).

ONION-MAGGOT (*Phorbia ceparum*): The adult is a small fly, about half the size of the common house fly. The eggs are laid on the young plants in early spring, and hatch in a few days, when the larvæ burrow into the bulbs. When full-grown, they pass into the soil and become

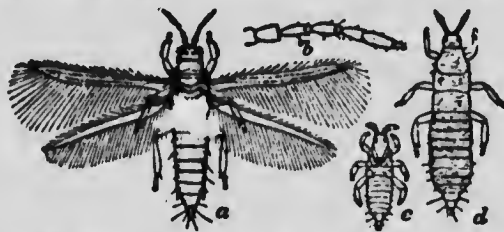
pupæ, and the adult flies emerge a little later. There are several broods in a season.



ONION MAGGOT.

Remedies: Crude Carbolic Emulsion, as for the Cabbage root maggot, sprinkle along the rows of the plants once a week; horse-hoe a furrow away from the plants, in which nitrate of soda is distributed, and cover with earth; remove diseased plants, and destroy maggots; white hellebore dusted along the rows once a week from the time the young plants appear above ground; fresh gas lime broadcasted between rows of onions at the rate of two hundred weight to the acre.

THRIPS (*Thrips tabaci*): Very minute insects, about one-twenty-fifth of an inch in length, of a pale yellow color, with darker-colored wings.



ONION THRIPS (*Thrips tabaci*). a. adult female; b. antenna of same; c. young larva or nymph; d. full grown larva. All enlarged.
(After Howard, Division of Entomology, U.S. Dept. of Agriculture, Yearbook for 1898.)

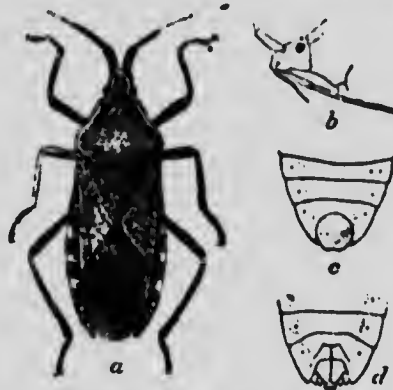
They occur in very large numbers, and the injury is visible in the form of small yellow spots, increasing in size until the tips of the leaves become yellow or brown; the whole stalk finally having a whitish appearance, and, if the weather is wet, the leaves decay.

Remedy: Spray with kerosene emulsion, used at the rate of one part of the emulsion to ten of water.

(Fungi).

DOWNY MILDEW (*Peronospora schleidenii*): This is a common disease of onions. The leaf first shows yellow patches, covered with a greyish mould. Later, the patches increase in size and numbers, and the leaf shrivels and dies. Two kinds of spores are produced, viz., thin-walled summer spores, on the minute branched stalks forming the greyish mould, and thick-walled winter spores (oospores), in the tissues of the leaves killed by the fungus. The summer spores are scattered by the wind during summer, and are the agents in the spread of the disease.

Treatment: Rotation of crops is necessary, especially when winter spores are in the infected soil; removal and burning of diseased plants; spray with Bordeaux or potassium sulphide (1 ounce to 2 gallons of water); dusting the plants with powdered quicklime and sulphur (2 to 1).



TRUE SQUASH BUG. (*Anasa tristis*, De G.) a. mature female; b. side view of head, showing beak; c. abdominal segments of male; d. same of female;—a. twice natural size; b., c., d., slightly more enlarged. After Chittenden, Div. of Entomology, Dep. of Agriculture.

SMUT (*Urocystis Cepula*): This disease is often troublesome to control. Early in the season leaves of onions may show the black smut masses arranged more or less in lines. The onions are only infected during their seeding stage from the spores, either attached to the seed or lying in the soil, hence the danger of planting onions in smut-infested soil.

Treatment: Destroy and burn diseased plants; when soil is smut-infested grow seedlings in smut-free soil, then transplant; in infested soil "apply in the drills, per acre, one hundred pounds of sulphur thoroughly mixed with fifty pounds of air-slaked lime; sprinkle seed with formalin solution (1 pound to 30 gallons of water) to kill the attached spores."

BLACK MOULD (*Macrosporium parasiticum*): This fungus is usually found associated with the Downy Mildew, but it is supposed to be respon-

sible for injury to the leaves. The diseased areas are covered with a thick black growth of the fungus. The spores are many-celled and dusky-colored.

Treatment: Spray with Bordeaux.

Garden Peas.

(Insects).

PEE-WEEVIL (*Bruchus pisorum*): The eggs are laid on the young pods as soon as they are formed. The larvæ when hatched bore into the pod and destroy the seeds. The winter is passed in the adult stage.

Remedies: Sow only seed peas that have been fumigated with carbon bisulphide.



PEA WEEVIL.—(a) The grub ;
(b) the pupa, under surface ;
(c) the pupa, upper surface ;
(d) the adult weevil.

PEA MOTH.—(a) A full grown "worm" or caterpillar (enlarged); (b) adult moth with wings expanded (enlarged); (c) adult moth with wings closed; (d) a group of five peas injured by the caterpillar of the pea moth.

PEA-APHIS (*Nectarophora pisi*): It is a large, soft-bodied, green louse, either with or without wings. Besides the Pea, it feeds on clover, vetches, and, probably, many other leguminous plants.

Remedies: Spray with kerosene emulsion or with whale oil soap wash.

PEA MOTH (*Semasia nigricana*): Hairy white caterpillars—when full-grown nearly one-half an inch long. The small adult moth lays its eggs on the pods in the latter part of June or early in July. The caterpillar attacks the peas and renders them unfit for table use.

Remedies: Rotation of crops, sow early to escape the moth.

(Fungi).

PEA MILDEW (*Erysiphe martii*): Sometimes leaves and vines show a fine growth of mould-like threads, followed later by many small dark bodies which bear the resting spores. The summer spores are borne in erect chains on the fine white threads. Affected leaves are small, the vines are weak, and the pods are small and shrivelled.

Treatment: Spray with Bordeaux when the Mildew makes its appearance, but it is not often necessary to resort to this treatment.

LEAF-SPOT (*Ascochyta pisi*): The lower leaves show yellow blotches, and soon fall off. Occasionally the vines and fruit are attacked. The spores are small, and are borne in little sacs on the blotches.

Potato.

(Insects).

COLORADO POTATO BEETLE (*Septinotarsa 10-lineata*): This very familiar pest spends the winter in the ground. They leave their hibernating quarters about the middle of May, and commence mating at once. The eggs are laid on the under surface of the leaf, and hatch a few days later. When full-grown, the larvæ pass down to the ground, where they change to orange-colored pupæ, about three inches below the surface. There are three broods in a season.

Remedies: Spray with Paris green-Bordeaux (formula 4-4-40½) or the arsenate-of-lead-Bordeaux, when plants are 2 to 4 inches high, and repeat every ten days or two weeks, and after rains.

FLEA-BEETLE (*Epitrix cucumeris*): Very small black beetle, about one-sixteenth of an inch in length. The hind legs are very highly developed, and fitted for leaping. They riddle the leaves of the potato and tomato with little round holes. It is through these holes that the spores of the Early Blight enters the plant.

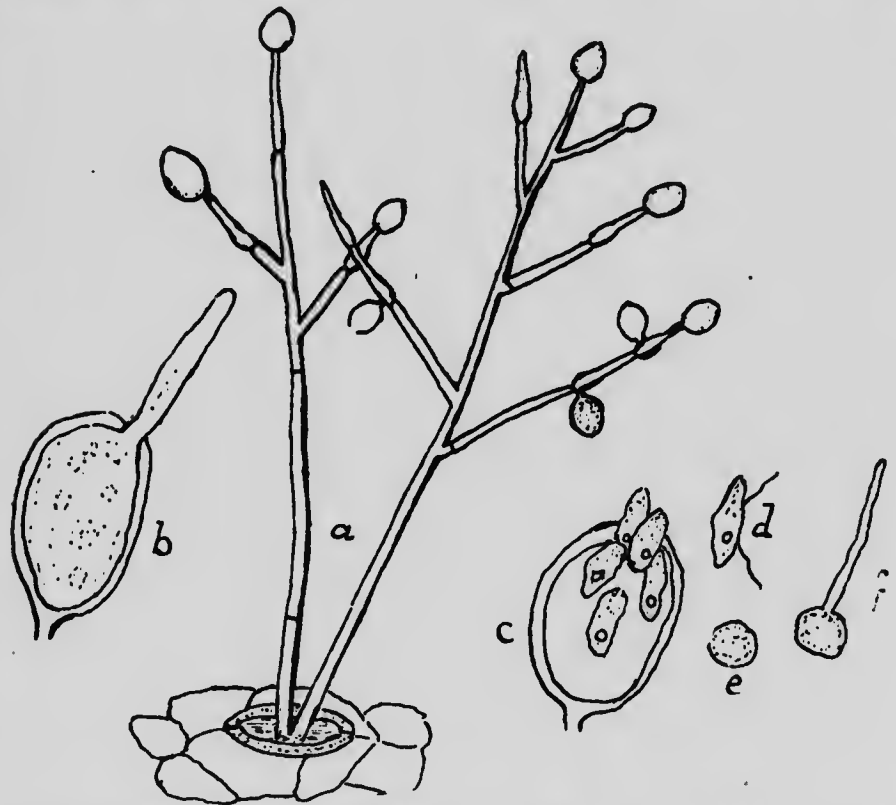
Remedies: Spraying with arsenical Bordeaux; destroy hibernating quarters by clean culture.

STALK-WEEVIL (*Trichobaris trinotata*): Small, white, legless, grubs, about one-fifth of an inch long. They bore in the stem of the potato and cause the leaves to turn yellow and the stem to die prematurely. The grubs change to pupæ within the stems, and a little later the adults emerge from their pupæ and remain in the stalks until the following spring.

Remedies : Gather and burn all the stalks in the fall, and the beetles will be destroyed.

APHIS (*Aphis sp.*) : Small, green, soft-bodied plant lice, about one-sixteenth of an inch long. They have sucking mouth parts, and are usually found on the under side of the leaves. They extract the juices from the leaf, causing the leaves to curl up.

Remedies : Tobacco water or dilute whale oil soap in the Paris green-Bordeaux.



THE FRUITING ORGANS OF LATE BLIGHT : (a) The branching stalks which issue from a breathing pore of the leaf, and the spores; (b) a simple spore or conidium germinating; (c) a sporangium with contained zoospores; (d) a zoospore with its two whips; (e) a zoospore after losing its whips; (f) a zoospore germinating.

FOUR-LINED LEAF-BUG (*Poecilopsus lineatus*) : A yellow sucking insect, with its wing covers marked with black. It is a little more than one-fourth of an inch in length, and feeds on the foliage of many garden plants. The affected leaves turn brown and curl.

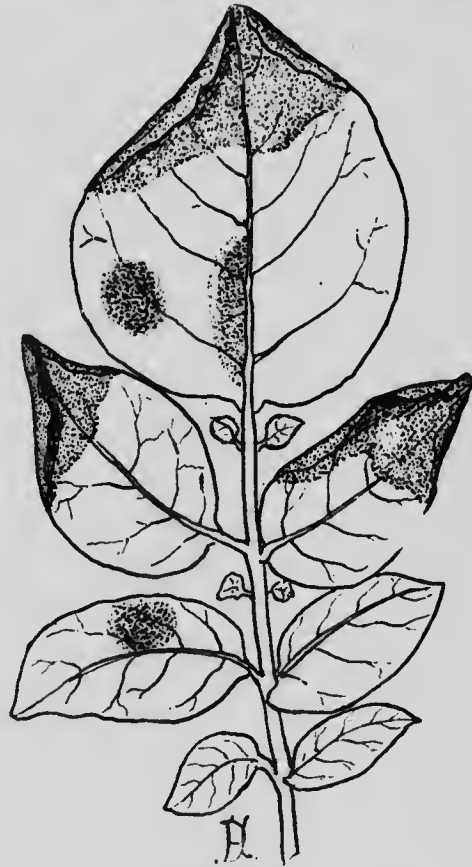
Remedies : Spray the young bugs with kerosene emulsion; add a little whale oil soap to the Bordeaux.

(Fungi).

LATE BLIGHT OR DOWNY MILDEW (*Phytophthora infestans*): This fungus disease is often very destructive in late summer to the potato crop. The margins of the leaves are usually the first portions to become diseased, probably because in periods of excessive moisture the edges are kept longer moist than the inner parts. There is a sharp line of demarcation between the affected and the unaffected areas; and in moist, warm



EARLY BLIGHT.



LATE BLIGHT.

weather, when the affected areas are enlarging rapidly, there is between the two areas a narrow whitish ring of mildew, which is producing spores in large numbers. The diseased leaves first turn brown, then darker, and finally black. Complete decay of the leaves soon occurs, accompanied by an offensive, yet characteristic, odor.

It is usually supposed that the fungus attacks the tubers as well as the stalks and leaves, producing a brown rot, but the mode of infection

has not been definitely proven. As no winter spores have yet been observed, it is believed that the threads of the fungus live over winter in the affected dormant tubers, and from these the following season make their way back to the stalks and leaves. It is probable that the soft rot of potatoes is mainly of bacterial origin.



COLORADO POTATO BEETLE (*L. pygmaea decem-lineata*, Say.)

Treatment: Spray with Bordeaux, every two weeks, beginning about July 10th, and continuing well into September; plant the more resistant varieties, and avoid wet soil, if possible.

EARLY BLIGHT (*Macrosporium solani*): Attacks early potatoes. The plants ripen prematurely, and the tubers are small. The affected leaves become gradually discolored; have many yellow areas, which are small



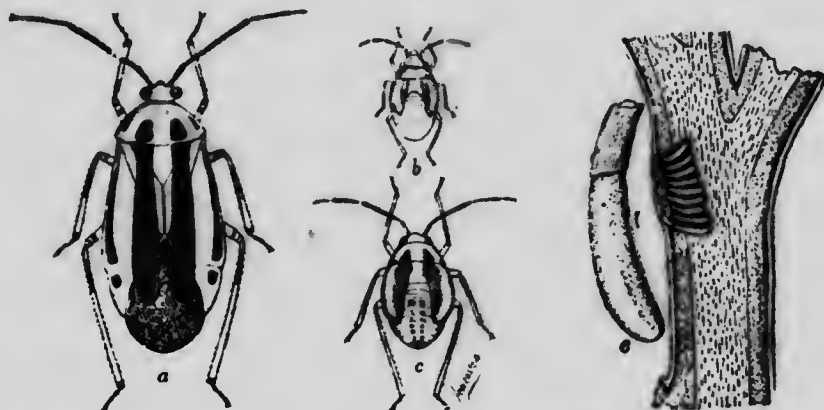
POTATO STALK WEEVIL. Larva, beetle, and pupa—enlarged.

CUCUMBER AND POTATO FLEA-BEETLE.

and circular, except where several have run together; and have a strong tendency to curl. During the later stages of the disease the leaves gradually become brown and shrivelled; and the stems become yellowish-

brown and dry. It is believed that flea-beetles are responsible to some extent for the spread of the disease.

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.



FOUR-LINED LEAF BUG. (*Pezomachus lineatus*, Fab). a. adult; b., c. immature. Luggar. Eggs after Slingerland.

DRY ROT (*Fusarium oxysporum*): This disease produces a wilt of the stalks, and a rot of the tuber, characterized by a blackening of the ring of fibres and an end-rot. These injuries usually follow the blight; and the rotting is frequently in market potatoes, which may appear quite sound on the outside, but on cutting them open show black or brown spots or parts of rings.

Treatment: By spraying to prevent Blight, and selecting seed potatoes carefully, the injuries may be reduced.

WET ROT (*Bacillus* sp.): A common bacterial disease of potatoes, producing soft rot.

Radish.

(Insects.)

RADISH-MAGGOT (*Phorbia brassicæ*): These are the same maggots that work in Cabbage roots, and for further information concerning appearance and life-history of this insect, see insects affecting the cabbage.

Remedies: Sprinkle carbolic acid emulsion solution along the rows about once a week; light frames, two or three feet high, enclosed on all sides with cheese cloth, placed over the beds; dust white hellebore along the rows once a week; slight applications of nitrate of soda between the rows. (See Onion Maggot.)

(Fungi).

WHITE RUST (*Albugo candida*): Small, white blisters form on the under side of the leaves; and when these blisters rupture the summer spores are set free as a white powder. Winter spores are also formed within the leaf, and are liberated the following spring on the decay of the tissues. This fungous disease, although not a serious one, is quite common, and is found on cress, turnip, cabbage, Shepherd's Purse, and mustard.

Treatment: Destroy all diseased plants.

DOWNY MILDEW (*Peronospora parasitica*): This disease occurs also on cabbage, turnip, and other Cruciferous plants. It is found along with the white Rust as whitish, filmy patches on the under surface of the leaf and discolored brownish-yellow spots on the upper surface. Both summer and winter spores are formed, the latter within the leaf.

Treatment: Destroy all diseased plants.

DAMPING-OFF (*Pythium debaryanum*): Damping-Off is a very common disease, affecting the seedling stage of many plants, more especially Cruciferous plants, such as radish, mustard, cabbage, and stock. The affected parts topple over near the surface of the soil, and the stem at that point is shrivelled, weak and black. The disease spreads rapidly in moist situations, and much difficulty is experienced sometimes in growing the plants. Besides summer spores, resting spores are formed, which may remain dormant in the soil for many months.

Treatment: Avoid excessive watering of seed-bed, and sow thinly; avoid shade for the seed-bed; burn all diseased plants; never use soil that has borne plants diseased with *Damping-Off*; in gardens bury the upper layers deeply with the plow.

Squash.

(See insects affecting the Cucumber.)

Tomato.

(Insects.)

TOMATO-WORM (*Phlegethontius celeus*): The larva is about three inches long and has a horn-like structure on the last segment. The general color is light green with oblique whitish bands on each side. The eggs are deposited on the leaves of the tomato and potato. The pupa has a long tongue case, and is passed in the ground.

Remedy: Hand picking, spray with arsenical poisons.

CUTWORMS: For description of habits and life-history, see insects affecting the cabbage.

Remedy: Poisoned bran, sweetened with a little molasses and made into moist balls the size of a plum. Do not use this treatment unless stock and poultry are excluded.



TOMATO WORM (*Sphinx quinquemaculata*, Hub.)

CORN-EAR WORM: Sometimes found feeding on the fruit of tomato. (For description of larva, see insects affecting corn.)

FLEA-BEETLES (*Epitrix cucumeris*): This is the same flea-beetle that causes injury to the potato. It riddles the leaves of the tomato with little holes, and injures the expansion of the leaf.

For further description of this pest and treatment, see insects affecting the potato.

(Fungi.)

BLACK ROT (*Macrosporium tomato*): This fungus produces roundish, black velvety areas on the fruit of the tomato. The spores are many-celled, and sooty-colored, and are borne on threads covering the diseased spots. Sometimes the leaves and stems are also affected.

Treatment: Spray with Bordeaux, beginning when the flowers open, and repeat at intervals of ten days or two weeks.



CUT WORMS (*Agrotis ypsilon*). After Riley.

BLIGHT (*Bacillus solanacearum*): This is a bacterial disease and causes the death of the leaves. The bundles of the potatoes and stems become brown or black. The disease is apparently spread to some extent by insects.

Treatment: Keep potato beetles and flea-beetles in check with Bordeaux and Paris green.

LEAF SPOT (*Septoria lycopersici*): Attacks the leaves, stem, and sometimes the fruit. Angular spots containing minute black fruits appear on the leaves and do considerable injury.

Treatment: Spray with Bordeaux a week after transplanting, and again at intervals of two weeks.

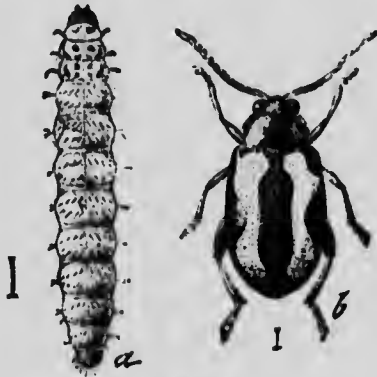
SCAB (*Cladosporium fulvum*): Olive-brown, felt-like areas occur on the under side of the leaves and brown discolorations on the upper surface. In severe cases the leaves turn black, shrivel up, and die. Tawny-colored, two-celled spores are produced on the clustered stalks of the fungus of the under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

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

Turnip.

(Insects.)

TURNIP FLEA-BEETLE (*Phyllotreta vittata*): A small, shining, black beetle, with a yellowish, wavy stripe on each wing cover, and about 1/16 of an inch in length. It feeds upon the leaves, not only of the radish, but also of the turnip, cabbage, and many other Cruciferous plants.



TURNIP FLEA BEETLE. (Enlarged 8 times.)

Remedies: Spray with arsenical poisons; Paris green, mixed with 25 parts of flour, dusted on the plants while the dew is on; Bordeaux acts as a repellent, and is recommended.

 FUNGICIDES AND INSECTICIDES.

FORMULÆ.

I. Bordeaux Mixture.

Copper sulphate (blue stone)	4 pounds.
Fresh stone lime	4 pounds.
Water	40 gallons.

- (1) Make a stock solution of bluestone by dissolving 40 pounds in warm water in a barrel and add water to make up to 40 gallons. Every gallon of this solution in first barrel contains one pound of bluestone.
- (2) Into a second barrel put 40 pounds of fresh stone lime, and add with stirring small quantities of water to slake it. When fully slaked make up to 40 gallons by adding water. Every gallon of milk of lime in this second barrel contains one pound of lime.

To prepare the Bordeaux, empty four gallons of bluestone solution into the spray tank or barrel, which already should have 25 or 30 gallons of water in it; stir the milk of lime thoroughly and empty four gallons of it through the strainer into the spray barrel with constant stirring; then add water to make up to 40 gallons.

Any one of several arsenical compounds may be used along with the Bordeaux to form a combination insecticide and fungicide. The following are among the best:

- (a) *Paris Green*. Add four to six ounces to 40 gallons of Bordeaux.
- (b) *Arsenite of Soda*. Boil together for 15 minutes one pound white arsenic, four pounds sal soda, and two gallons water, until a clear solution is obtained. Add one to one and one-half quarts to 40 gallons of Bordeaux.
- (c) *Arsenite of Lime*. Boil together for 45 minutes one pound arsenic, two pounds fresh lime, and one gallon of water. Add one quart of this solution to 40 gallons of Bordeaux.
- (d) *Arsenate of Lead*. Put four ounces of arsenate of soda in two quarts of water in a wooden pail and eleven ounces acetate of lead in two quarts of water in another pail. When dissolved mix together and add to 40 gallons of Bordeaux.
- (3) *Never mix the concentrated stock solutions together*. If the milk of lime and bluestone are mixed in the concentrated form, just as they are taken from the stock solution, a precipitate of a flaky nature will soon settle out, and either fall to the bottom or clog the nozzle.
- (4) *Test the Bordeaux to find out whether sufficient milk of lime has been added*. This is most easily done by means of the ferrocyanide test. A saturated solution of this substance can be purchased at any druggists for a few cents. In testing, place some of the Bordeaux, which has been thoroughly stirred, into a saucer, and add a few drops of the ferrocyanide. If sufficient lime has been used, no discoloration will appear, but if insufficient, a deep dark brown color will be produced.
- (5) *Always strain the milk of lime to prevent gritty particles from clogging the nozzles*.
- (6) *Use a fine nozzle*; do not soak or drench the plants.
- (7) *The stock solutions will keep*, but the Bordeaux mixture becomes useless after standing for two or three days.

II. Resin-Bordeaux Mixture.

Pulverized resin	5 pounds.
Concentrated lye	1 pound.
Fish oil	1 pint.
Water	5 gallons.

Place the oil, resin and one gallon hot water in an iron kettle and heat till resin softens, add the lye and stir thoroughly; then add

four gallons hot water and boil till a little will mix with cold water and give a clear, amber-colored liquid. Add water to make up five gallons. Keep this as stock solution. For resin-Bordeaux, add ten gallons water to two gallons of stock solution, then mix this with 40 gallons Bordeaux.

This mixture is very adhesive to smooth leaves; has been used successfully against asparagus rust.

III. Ammoniacal-Copper Carbonate Solution.

Copper carbonate	5 ounces.
Strong ammonia, sufficient to dissolve the copper carbonate, usually about	3 pints.
Water	40 gallons.

Mix the copper carbonate into a paste with a little water, add the ammonia, and when the copper carbonate is completely dissolved pour the deep blue solution into the water.

Recommended for late spraying against fungi to prevent disfiguration of fruit or leaves.

IV. Potassium Sulphide (Liver of Sulphur.)

(Used to control Mildews.)

Dissolve four ounces in eight gallons of water.

V. Flowers of Sulphur.

(Used in California against Asparagus rust.)

VI. Formalin (40 per cent. Formaldehyde.)

Put one-half pint into 15 gallons of water.

Used for prevention of bean anthracnose, potato scab.

VII. 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.

VIII. Paris Green Mixture. (Liquid.) (For Leaf-eating Insects.)

Paris green	1 pound.
Water	150 gallons.
Lime, freshly slacked	2 pounds.

Or,

Paris Green Mixture. (Dry.)

Paris green	1 pound.
Flour or dust	100 pounds.

IX. Poison Bait. (For Cutworms, Wireworms and Grasshoppers in gardens and cornfields.)

Wheat bran	50 pounds.
Molasses (any kind)	2 quarts.
Paris green(good grade)	1 pound.
Water	(Enough to make a thick mash.)

Handfuls of the bait are scattered about the garden at the base of the plants and among the corn rows in the evening.

Poisoned clover, slices of potato, etc., may be used effectively.

X. Hellebore.

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

XI. 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 box, then dust on plants through cheese-cloth.

XII. Kerosene Emulsion (for Bark-lice and Plant lice.)

Hard soap, half-pound, or soft soap.....	1 quart.
Boiling water (soft)	1 gallon.
Coal oil	2 gallons.

After dissolving the soap in the water, add the coal oil and stir well for five to ten minutes. When properly mixed, it will adhere to glass without oiliness. A syringe or pump will aid much in this work. In using, dilute with from nine to fifteen parts of water.

XIII. Tobacco Decoction.

Refuse tobacco	2 pounds.
Water	5 gallons.

Boil the mixture for 30 minutes or more, until a dark brown tea-colored solution is obtained. Keep it covered until cool. It may then be used undiluted for spraying infested plants. The addition of one pound of whale-oil soap to each 50 gallons increases the effectiveness.

XIV. Whale Oil Soap.

For plant lice, one pound in seven gallons hot water.

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