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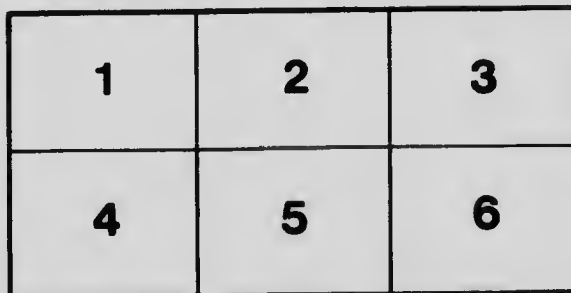
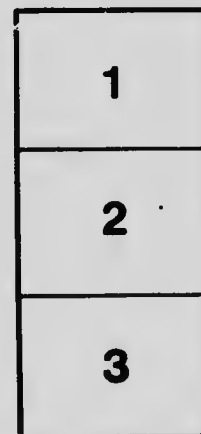
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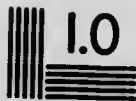
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The More Important Fruit Tree Diseases of Ontario

J. E. HOWITT AND LAWSON CAESAR.

INTRODUCTION.

The object of this bulletin is to furnish all who are interested in fruit growing with information which will enable them to identify the more common diseases of fruit trees and to apply successfully the treatments which experiments and observations extending over a period of eight years have shown to be the most effective in each case.

WHAT FUNGUS DISEASES ARE.

The majority of the diseases of fruit trees are what are known as fungus diseases. It is important that those having to deal with them should understand fully the causes of such diseases, in order that they may apply intelligently remedies for their control. Fungus diseases are caused by plants known as fungi. These plants, unlike ordinary flowering plants, have no green colouring matter (chlorophyll), and are unable therefore to manufacture their own food. All their nourishment 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 very fine, delicate, thread-like structures (hyphae), some of which become modified and produce reproductive bodies called 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 growing season and thick-walled resting or winter spores, which serve to 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 (germ-tubes), which enter the plant through the breathing pores on the leaves (stomata), through the skin or through wounds. Once within

the plant 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. Once a fungus is within the plant nothing can be done to destroy it. Spraying with lime-sulphur, Bordeaux mixture or other fungicide is not done to cure but to prevent disease. In other words, the object of spraying is to cover the surface of the leaves, fruits or other parts of the plant with a substance poisonous to the spores of fungi, in which they cannot grow and penetrate the plant. Spraying, therefore, in order to be effective, must be timely and thorough. The spray mixture must be on the tree before the spores reach it and the surface of the leaves, fruit and other parts of the plant must be completely covered so that there is not the smallest space on which a spore can germinate.

SPRAY OUTFITS.

Those who purpose buying a spray outfit and spray materials can find the addresses of the various manufacturers by looking over the advertisements in the *Canadian Horticulturist* and the various agricultural journals.

If there are only a few trees to spray, such as one finds in a back yard in a town or village, a small hand-pump, holding about five gallons of liquid, will suffice. This should be equipped with about twenty-five feet of good hose, a leakless stop-cock, an eight or ten-foot rod and a good disc angle-nozzle. Some companies manufacture a special rod and nozzle, so that by adjusting the latter the spray may be shot to the top of even a very high tree. A machine of this character with all the necessary accessories costs about \$20.

For more than about a dozen large trees this small outfit is much too slow. If the orchard consists of not more than about six acres of large apple trees or of about ten acres of trees the size of a moderately large plum, cherry or pear tree, a barrel-sprayer will suffice. This, fully equipped, will cost from \$20 to \$40.

A double-action or duplex type of pump gives considerably more power than a single-action or barrel pump, and so will enable a person to cover more trees each day, especially if the pump is installed in a 120 or 160-gallon tank. This type of outfit without tank will cost from \$40 to \$65.

For all apple orchards larger than those mentioned above a power outfit is almost essential for good work. A power outfit of this type with a tank and trucks costs between \$250 and \$400.

Good care with any of these outfits will more than double the amount of usefulness. Any kind of machine should be washed out each evening after spraying, and when the season's work is over should be well cleaned, oiled and put away in a dry place.

SOME SUGGESTIONS ON SPRAYING.

All trees should, of course, be pruned before they are sprayed, and large apple trees should be headed back to a reasonable height, care being taken in doing so to give them a symmetrical, umbrella shape. If San José Scale is present, the rough, loose bark should be removed from apple trees.

Good spraying continued year after year should usually result in from ninety per cent. to ninety-nine per cent. of absolutely clean, sound fruit. Unfortunately, not many of our fruit growers are good sprayers. The following are some of the chief reasons for this: First, their outfits are not kept in good condition to do

rapid, thorough work; often the pump needs repacking or the hose is too short, or the nozzles worn out or are the wrong kind. Second, they do not study the nature of the disease or insect they have to combat, and so do not recognize the importance of promptly spraying at the special times indicated in the spray calendar. A spray applied a few days too early or too late will often mean complete failure. Moreover, the omission of one or more of the regular applications will often mean cull fruit. Third, in many cases not nearly sufficient material per tree is used, frequently only about one-third of the proper amount. It is absurd to expect the spray to keep all of an apple free from scab if only half of its surface is covered by the mixture, or to kill all the San José Scale on a tree unless every particle of the bark is wet with the liquid. Fourth, the spray mixtures are sometimes not used at the strength recommended. Fifth, many men foolishly experiment with new mixtures instead of waiting until these have first been thoroughly tested by unprejudiced experimenters.

Before beginning to spray the machine must be put into good condition so that it will give good pressure and not leak. If two lines of hose are used, the one for the man on the ground should be from thirty to forty feet long, the other twelve to fifteen feet. The most satisfactory nozzles at the present time are those of the angle disc type. When the plates of these become much worn they should be replaced by new ones. If two nozzles are used on a T or a V they should not be set at a wide angle of divergence, but should be made to supplement each other and thus give a dense spray that will quickly wet the part being treated. Bamboo poles with aluminum rods inside are light and satisfactory if not roughly handled. A ten foot pole is about the right length for the man on the tower, and a six or eight foot one for the man on the ground. To prevent the drip running down the pole, a small rubber or leather disc about three or four inches in diameter, cut out of an old shoe or rubber, is helpful. It should be placed at the top of the rod just below the nozzle. Good pressure is necessary for speed and thoroughness. It should never be less than 100 pounds. With gasoline outfits about 150 to 200 pounds is high enough. Higher than 200 is more liable to cause leaf injury. The mixture in the tank must, of course, be kept well agitated to prevent settling.

When spraying, especially in the first application, it is desirable to take advantage of the wind. A strong wind is a great help, as it carries the spray right through the tree. If the wind is weak and the trees are wide apple trees, it is necessary that the man on the ground go in underneath the tree to the far side, and shoot the spray up upon the branches and twigs or foliage and fruit, and gradually work his way back to the outside. This is the only way in the case of large trees to make sure that the inner surface of upright twigs and small branches and later of the young fruits will be thoroughly covered, for they will not be reached from the other side when the wind changes, except where the wind is very strong. It is on this inner side of young fruits that the scab nearly always first develops, hence the need of the step just indicated. In the case of San José Scale great care must also be taken not to miss the tip of the branches. This is a very common fault with many sprayers.

In many instances there is too short a period to justify a person's waiting for a change of wind; hence under such circumstances the best method is to drive the team facing the wind and shoot the spray in at right angles to the row. This is a little slower, but if care is exercised is satisfactory. Moreover, by coming back and going up the other side, also against the wind, it enables a person to finish the trees the same day.

Thorough spraying requires great care and constant study. One should follow always some system with each tree, otherwise he will be missing parts here and there. Sometimes the best way is to take the tree branch by branch. At other times it is better to move the rod slowly up and down and work gradually from left to right or right to left, seeing that everything is covered as one goes. The angle on the nozzles permits the spray being directed first in one way then back in the opposite way, so that both sides of a branch or of fruits may be more easily covered. Often both sides of the branch may be covered by holding the nozzles against the wind and allowing it to drive the spray back. An apple tree capable of bearing five or six barrels of fruit will usually require from eight to ten gallons of spray, especially for the Codling Moth or for San José Scale.

DUSTING TREES FOR INSECTS AND DISEASES.



Dusting fruit trees for insects and diseases. (Original.)

During the last few years considerable success has been obtained, especially in New York State, in treating trees with dust instead of liquid sprays. The dust used consisted of from 85 per cent. to 90 per cent. of very finely ground sulphur and 10 per cent. to 15 per cent. of the powder form of arsenate of lead. It is applied by means of a blower driven by a gasoline engine. (See figure.) This is a very rapid and clean way of treating trees. At least twenty acres of large apple trees can be done in one day. The above substances, however, are useless against San José Scale, and also against Aphids and Pear Psylla. Other dust materials to combat these are being manufactured, but their success is still uncertain. We ourselves have had only two years' trial of dusting, and are unable therefore to speak with certainty as to its merits.

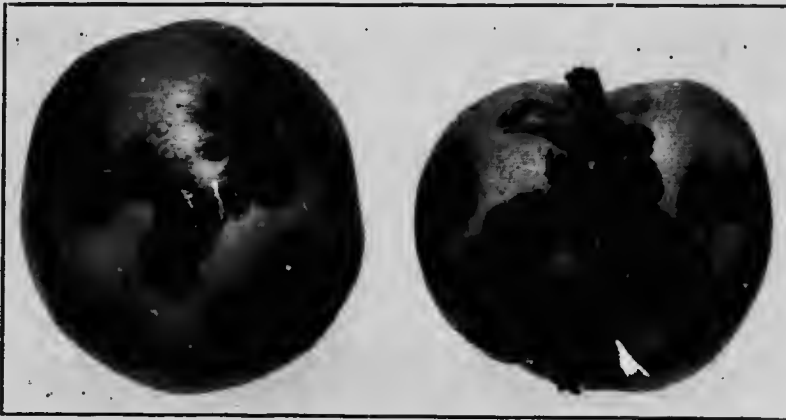
SPRAY CALENDARS.

From time to time improved methods of combating insect pests and plant diseases are discovered. These new methods are incorporated in the Spray Calen-

dar from year to year. Hence every fruit grower should write each spring to the Fruit Branch, Toronto, and request a copy of the latest Spray Calendar, so that he may have the most up-to-date information available.

APPLE SCAB (*Venturia pomi*, (Fr.) Wint.)

This is the most common and most serious disease of apples in Ontario. It occurs wherever apples are grown, and the scab spots on the fruit and leaves are familiar to almost every fruit grower. In wet seasons it causes a financial loss of many thousands of dollars to the fruit growers of the Province. This is to a large extent a needless loss, for Apple Scab can almost always be prevented, no matter how wet the season may be, by thorough, timely and intelligent spraying. Such spraying, however, can only be done when the fruit growers understand the nature of the disease and how it is spread, and know the climatic conditions which favour the development of the fungus which causes it. Such knowledge is invaluable in the control of Apple Scab. It makes clear the necessity for thorough and timely spraying, and prevents the waste of time and material, which frequently occurs



Apple Scab on fruit. (Original.)

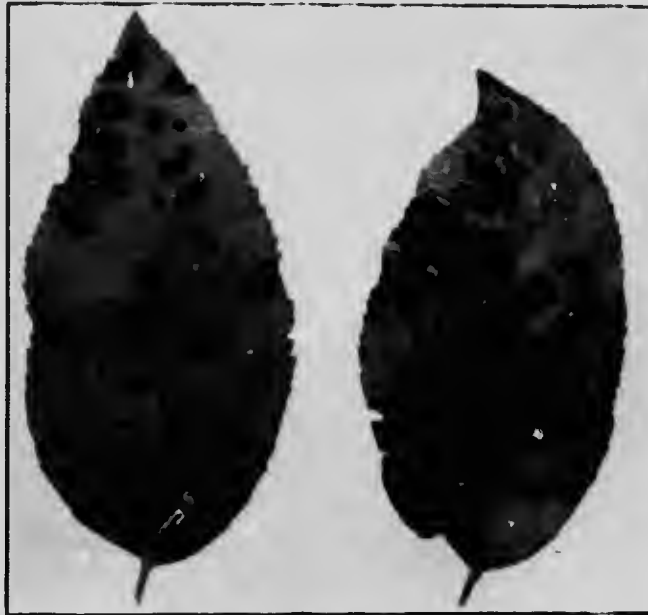
through spraying when climatic conditions are such that there is no danger of scab developing.

Symptoms. Apple Scab affects the blossoms, fruit, leaves and sometimes twigs. It is most conspicuous on and does most damage to the fruit and leaves. Scab may appear on the fruit during any stage of its development, provided climatic conditions are such as to render possible the spread and growth of the fungus which causes it. It may attack the stems of the very young fruits, causing them to drop and in this way very much reduce the crop. Frequently it attacks the base of the calyx of the blossom, and as this will become the fleshy part of the apple, an early infection of the blossoms causes the fruit to be scabby.

Frequently young fruits on which scab spots develop are stunted and misshapen. Mature fruit is rendered unsightly and unsaleable by the conspicuous black and brown scab spots, often bordered with a greyish rim. In severe attacks there is sometimes a cracking of the fruit, such as is so often seen when Pear Scab destroys Flemish Beauty pears. Not only does the scab render the fruit unsightly, but it also makes it very subject to rot when placed in storage. If scabby apples are packed during moist, warm weather, or kept in a moist condition, a pinkish-

white mould is very likely to develop around the edges of the spots. This soon causes a rotting, which markedly injures the fruit and makes it unpalatable. This is known as Pink Rot. Other rots such as the common storage rot, caused by blue moulds (*Penicillium*) and other fungi, also develop around scab spots on apples in storage. Such fruit is of course hard to market and can be sold only at a very much reduced price.

On the leaves Scab first appears as small, somewhat circular, olive-brown spots, on one or both surfaces. Under weather conditions favourable to the fungus, these increase in size, run into each other and become brown or black, so that a considerable portion of the leaf is destroyed. In severe attacks the leaves become crinkled and to some extent curled. Sometimes they fall, but more frequently they remain on the trees. The leaves are the food factories of the trees. The food



Apple Scab on leaves. (Original.)

manufactured by them is used for the growth of the fruit, stem and roots, and for the formation of fruit buds for next year. Hence severe injury to the leaves by Scab impairs the vitality of the trees and prevents the normal development of fruit buds and thus may reduce the crop below the average the following year.

twigs the Scab is very seldom noticed in Ontario. Sometimes, however, following a severe attack of Scab on the leaves and fruit the previous year, dead and blighted twigs may be seen in spring on some of the trees. On the surface of such twigs elongated cracks or fissures filled with a brownish-black powdery substance can be observed.

Varieties of apples differ very much in regard to their freedom from Scab. It is a great help in controlling Scab to know something regarding the susceptibility of the different varieties, as the Scab is very much harder to control on varieties which are very susceptible to it than on those which are not. Common varieties of apples which are (a) very subject to Scab—Snow, McIntosh, Graven-

stein, Early Harvest and St. Lawrence; (b) moderately subject to Scab—Spy, Rhode Island Greening, King, Baldwin and Ben Davis; (c) slightly subject to Scab—Duchess of Oldenburgh, Blenheim Pippin, Yellow Transparent, Tolman Sweet and Golden Russet.

Life History. The fungus which causes Scab passes the winter chiefly on the fallen leaves beneath the trees. If these are examined in the spring, small black dots or pimples will be seen projecting above the skin of the leaf on one or both sides. They vary in size from a mere speck to a pin head. Each is a fruiting body (perithecium) of the fungus, and contains numerous loculi sac-like structures (asci), (See Illustration), each of which in turn contains eight two-celled spores (ascospores). When mature the fruiting bodies (perithecia) open by means of a minute pore, through which the spores are shot out from the sacs by a peculiar pop-gun-like arrangement. Moisture is necessary for the discharge of the spores, which takes place chiefly during the spring rains from about the time the leaf buds burst until the blossoms are opening. Some, however, are discharged much later than this. The spores which are shot up for a short distance from the leaf are extremely light, and are scattered here and there by the wind. Some of them reach the unfolding leaves or blossoms, and here, if there is rain or heavy mist for about two days, they germinate and send out a tiny thread-like structure (germ-tube), which penetrates beneath the skin of the leaf or the calyx of the blossom, which afterwards becomes the flesh of the apple. Moisture is essential not only for the germination of the spore but also for the further development and penetration of the germ-tube. It is, therefore, only when we have a period of two or three days' rain



Section of Fruiting Body (Perithecium) of the Apple Scab fungus, showing the discharge of the spring spores (ascospores). (After Wallace.)

or heavy fog that the fungus can gain entrance to the leaves and fruit. About ten days or two weeks after the spores from the fallen leaves have germinated and the germ-tube has penetrated beneath the skin of the leaf or young fruit the first scab spots of the season are observed. These if examined with a microscope are found to be composed chiefly of spores and fungus threads. The spores are right on the surface of the scab spots, the fungus having developed under and pushed off the outer layer (cuticle) of the skin of the fruit or leaf. The spores are thus readily scattered through the orchard by wind, rain or insects. If the weather is dry and warm they can do no harm, but if a period of wet weather comes those that are on the leaves or fruits germinate and the germ-tube penetrates the leaf or fruit, and in ten days or two weeks another crop of scab spots is developed. The spores from these may in turn give rise to more scab spots containing spores, so that there may be several successive generations of spores during the season. By means of these spores the scab is spread through the orchard during wet weather. A single shower is not sufficient to cause the spores to germinate and penetrate the leaf or fruit. Observations indicate that it requires two days of wet weather—

rain, heavy fog or mist—for the spores to germinate and the germ-tube to get under the outer layer of the skin of the leaf or fruit. Frequently the fruit grower thinks that the scab spots have all developed in a day or two, not realizing that the fungus must have been living in the leaf or fruit for nearly ten days or more before the scab spots appeared on the surface.

Moisture being essential to the development and spread of the scab fungus, it can be easily understood that it is during the spring of the year that there is the greatest danger of infection. At this season wet weather is frequent, and often prolonged. The days are short, the nights long and cool, so that the leaves and fruit may remain covered with moisture for a long time after each rain. The fruits at this time are small and covered with hairs which hold moisture much more readily than the smooth skin of the more mature apples. Such conditions favor the development and spread of the fungus, and so there is great danger of scab becoming prevalent at this time. In seasons of average weather conditions for Ontario, the period when most infection occurs is from the time when the blossoms are showing pink until about two weeks after the petals fall. Sometimes, however, serious infection occurs earlier than this time, when the leaves are unfolding, or again it may be later, about the end of June. So May and June are nearly always the months when there is the greatest danger of scab becoming serious. During July and most of August the scab fungus can rarely develop, because at this time there is not sufficient moisture, as prolonged wet periods seldom occur and the days are long and the nights short and warm, so that the leaves and fruit are quickly dried even after heavy showers. In late August and in September, however, prolonged cool, wet weather may occur, and at this time there is danger of late infections.

Prevention. Apple Scab can be prevented by timely and thorough spraying in combination with the proper pruning of the trees. Spraying must be done at the right time. The spray mixture must be on the leaves and fruit before the spores reach them. We have already learned that the spores only develop during wet weather. The times of the year, therefore, when we get our wet weather are the times we have to spray if we are going to prevent Scab. One spraying with either lime-sulphur or Bordeaux mixture is not sufficient to prevent Scab, as the rain gradually washes the spray off and as the leaves and fruit by growing larger develop more surface to cover. In order to be sure of preventing the disease, we must spray from three to six times during the season, the number of sprayings depending upon whether the weather is wet or dry. The first spraying should be done just as or soon after the leaf buds burst. For this application concentrated lime-sulphur at the regular strength recommended for the dormant wood spray, namely, specific gravity 1.035 (=1 gallon commercial to 7 gallons of water) should be used unless the grower is certain that there is no San José Scale in the orchard and very little Oyster Shell Scale. If he is sure as to this, a weaker solution may be used, of the strength 1.020 specific gravity (=1 gallon commercial lime-sulphur diluted to about 15 gallons with water). There is little danger of burning the foliage with either of these strengths of lime-sulphur provided the spraying is all completed before the little leaves have reached the size of a ten-cent piece.

The second spraying should be given just before the blossoms open, that is, just when they are showing pink, using concentrated lime-sulphur, strength 1.010 or 1.009 specific gravity (=1 gallon commercial to from 30 to 35 gallons of water), or Bordeaux mixture, 4.4.40 formula.

In average seasons the third application should be given immediately after the blossoms have all or nearly all fallen, with a concentrated lime-sulphur solution,

strength 1.009 or 1.008 specific gravity (=1 gallon commercial to from 33 to 40 gallons of water). This is generally the most important spray for the control of Apple Scab and always for Codling Moth, and it must be promptly applied, as a delay of a day or two may make all the difference between success and failure.

In some years there is a long period of cold wet weather between the date when the blossoms begin to burst and that when they fall. Sometimes the length of this period is three or four weeks. In such cases it is necessary to give an intermediate spraying between the second and third. Hence if the grower finds at the end of twelve days or two weeks after he has applied the second spray that the weather is still cold and wet, and development of the blossoms is very slow, another spraying should be given at once to protect the young blossoms and foliage. This should be of the same strength as for what is ordinarily the third application, but poison should be omitted because of the bees. It is very important to observe carefully the weather conditions and apply this spray when necessary. Failure to do so may result in the apples being scabby in spite of the regular sprayings being given.

If June is cold and wet another spraying about ten days or two weeks after the third regular spraying will be necessary. The solution for this application should be of the same strength as that for the third, or slightly weaker, for example, 1 gallon of the commercial to not more than 40 gallons of water. No poison is necessary unless the Codling Moth or the Plum Curculio is specially troublesome. Bordeaux mixture is also satisfactory for this application.

Spraying in early August is an insurance against late infection of Apple Scab and Sooty Fungus. In wet autumns such spraying is necessary to prevent late attacks of Scab, especially with varieties such as McIntosh Red and Snows, which are very susceptible to Scab. For this application use a weak lime-sulphur solution, such as concentrated lime-sulphur, strength specific gravity 1.008 or 1.007, which equals commercial lime-sulphur 1 gallon to 40 or 45 gallons of water, or Bordeaux mixture. No poison should be used at this time. Often if the spraying is done later than the first or second week in August there is a chance of the fruit being discoloured at picking time. Should the dust method prove satisfactory it could be used at any time in the fall without danger of staining the fruit. If the early sprayings are thoroughly done, and the fall is not extremely wet, usually the crop will remain clean without this last application. Hence every man will have to use his own judgment in regard to it.

Thoroughness in Spraying. Very few men spray thoroughly enough to get the best results. The object of spraying is to cover the surfaces of the leaves and fruits with a good fungicide (a substance which destroys the spores of fungi), such as lime-sulphur or Bordeaux mixture, so that when a spore reaches leaf or fruit it is destroyed and cannot grow and cause Scab. We see therefore that if spraying is to accomplish its object it must be very thoroughly done; every fruit and leaf must be completely covered with the fungicide so that there is not the least space on which a spore can germinate. Thorough spraying necessitates the liberal use of the spray mixture. A large apple tree will require from six to ten gallons or more to cover it properly. Care must be taken to reach every side of the young forming fruit or (in other words) of the calyces or flower cups which develop into the fruits. If a tree is examined for Scab before the fruit is an inch in diameter, nearly all of it will be found on the more sheltered side, that is, the side facing the centre of the tree, because that is the side most protected from wind and sun, and hence the side which retains the moisture the longest. Later when the fruit grows larger it bends over and these Scab spots will thus be seen on the outer side. This fact emphasizes the necessity of being sure to spray thoroughly the centres as well as the outsides

of the trees. In order to do this it is necessary, except in the case of small trees, to send the man on the ground in underneath the trees, so that he may shoot the spray up into them from beneath as well as do all the lower outer parts.

Pruning. Good pruning before spraying makes it easier in three important ways to control Apple Scab. First, it is almost impossible to spray thoroughly a large tree with numerous, thickly clustered branches, because the superfluous branches interfere with the mixture reaching all sides of the fruit and foliage; second, it costs less to spray a well pruned tree, because fewer gallons of mixture are necessary; third, well pruned trees let in the light and allow a free circulation of air much better than unpruned trees, and thus the moisture which is so favorable to the development of the Scab fungus will dry off more quickly. Scab and Sooty Blotch for this reason will almost always be worse on unpruned trees.

BLACK ROT CANKER, BLACK ROT AND LEAF SPOT (*Physalospora cydoniae*, Arnaud).



Black Rot Canker on branch.
(Original.)

This disease is found in most parts of the Province, and is worst generally in poorly cared for and neglected orchards. In the apple growing districts east of Toronto it has caused serious injury to apple trees and much alarm to the growers. In that part of the Province, however, it is not by any means confined to neglected orchards. Observations and experiments show that the fungus causing Black Rot Canker is unable to penetrate healthy bark, and can gain entrance and produce cankers only through wounds due to various causes, such as winter injury, sunscald, carelessness in cultivation, pruning and picking of the fruit. Varieties of apples which are most susceptible to Black Rot Cankers are those which are too tender for the district and so suffer severely from winter injury and sunscald.

The fungus which causes Black Rot Canker is not confined to the apple. It is recorded as affecting pear, quince and other trees, but the writers have not observed it at least to any appreciable extent in Ontario on any host but the apple.

Symptoms. This disease attacks the trunk, branches, leaves, fruit and sometimes the twigs, but causes most damage by the cankers produced on the trunk and larger limbs. On the leaves circular spots from one-eighth to one-quarter of an inch in diameter are produced. These are brown in the centre, with a distinct purplish margin. Towards the centre of these spots the minute black fruiting bodies (pycnidia) of the fungus can often be seen by a careful

observer. The leaves are seldom severely injured by these spots, but frequently they are plentiful enough in unsprayed orchards to attract the attention of the grower.

On the fruit a small brown spot first appears. This gradually increases in size until the whole fruit becomes rotten, brown and later black. The surface becomes covered with minute black fruiting bodies (pycnidia), which helps to give to the rotted fruit a black appearance. For some time the infected fruits remain firm and retain their normal form, but finally shrivel. These black, shrivelled fruits are frequently seen hanging on the trees or lying on the ground beneath. In Ontario, the rotten fruit in the orchard is not abundant and is seldom noticed by the grower. In storage also, so far as our observations go, the Black Rot on the fruit attracts but little attention.

On the trunk and larger limbs discoloured areas appear on the bark. These may increase in size, forming large cankers, which with age become cracked, rough and black. These cankers may be only a few inches long, or they may be a yard or more in length. They are usually found on the south-west side of the trunk and on the upper side of the larger limbs, these being the parts of the tree that are most likely to suffer from sunscald and winter injury. In many cases the cankers gradually enlarge, extending completely around the trunk or branch, and penetrating through the bark to the wood, thus girdling the part attacked. The cankers in this way frequently destroy the larger limbs, and when they occur on the trunks, which they very often do, may cause the death of the whole tree. Sometimes the cankers remain small. Frequently even the larger ones do not penetrate deeply, and cause merely a superficial roughening of the bark, which in time may disappear. Embedded in the bark of the cankers small, black, pimple-like structures may be seen with the naked eye. These are the fruiting bodies (pycnidia) of the fungus.

Life History. The fungus causing this disease is carried over winter as fungus threads (mycelium) in the cankers, and also as numerous spores contained in the fruiting bodies (pycnidia), which are seen in abundance embedded in the skin of the rotted apples, the bark of the cankers, and to a less extent in the spots on the leaves. These spores are discharged from the fruiting bodies (pycnidia) during the spring and early summer. As has been stated before, observations and experiments show that infection can only take place through wounds, the spores being unable to infect sound and healthy tissue. Winter injury, sunscald, carelessness in cultivation, pruning and picking of the fruit, or other causes make wounds through which the fungus gains entrance to the bark and finally spreads and causes cankers. Varieties which suffer from winter injury and sunscald are very subject to Black Rot cankers, because it is chiefly through such wounds that the fungus gets a start in the healthy bar .

Treatment.—Plant only those varieties which are known to be hardy in the district where they are to be grown. Keep the trees thrifty by proper pruning and cultivation. In districts subject to extreme cold during the winter months, do not cultivate later than the middle of June, then sow a cover crop. Such treatment will check the growth of the trees and cause the wood to harden for winter. Cut out all cankers on the trunk and larger limbs, except those that are merely superficial. Use a draw-knife for this purpose and cut back to healthy bark, taking care to leave the edges of the wound smooth, even and perpendicular. Wash the wounds thoroughly with concentrated lime-sulphur or with bluestone, one pound to ten gallons of water, and paint over with coal tar or white lead mixed with

linseed oil without turpentine. White lead checks and cracks, and if it is used the wounds will have to be painted over two or three times. Coal tar does not check or crack, but slightly discolours the bark around the edges of the wounds. The writers, however, have never noticed any serious injury to the bark from the use of coal tar on apple trees. Badly cankered trees, which would be dead in a year or two if neglected, can in many cases be saved by cutting and treating the cankers as described above. In pruning it is often advisable to cut out and burn large limbs which are badly cankered, if this can be done without causing too much injury to the tree. Sometimes, when it is necessary to remove a badly cankered main limb, a sucker nearby can be left to grow and take its place. Proper spraying is also of importance in controlling this disease. Spray at the regular times indicated in the Spray Calendar for the apple. The first or so-called dormant wood spray with concentrated lime-sulphur, specific gravity 1.030 to 1.035 (=1 gallon to 7 to 9 gallons of water), is especially important in the prevention of cankers, and care should be taken to see that the trunk and main limbs are all thoroughly covered at this time. This application, combined with the other sprayings when the trees are in leaf, will completely prevent the spotting of the leaves.

SOOTY BLOTCH AND FLY SPECK (*Leptothyrium pomi*, Mont. & Fr. Sacc.).

This disease frequently disfigures apples, and by so doing much reduces their market value. It does not usually appear until late summer or early fall, and only becomes prevalent enough to cause serious disfigurement of the fruit when the weather is specially damp at this time of the year.



Sooty Blotch. (Original.)

Symptoms. This disease is easily recognized by the characteristic irregular sooty blotches which the fungus causes upon the fruit. These may be few and scattered or numerous, and often coalescing so as to give a sooty appearance to a considerable area of the surface of the apple. This form of the disease is

known as Sooty Blotch. The other form, commonly called Fly Speck, is recognized by the small, black, shining specks on the surface of the fruit. These are frequently very numerous and clustered together in large groups so that they noticeably disfigure the skin of the apple. Both forms of the disease may be present on the same fruit. Affected apples are disfigured and rendered unattractive, but the flesh is not injured as the fungus does not penetrate below the skin.

Prevention. Prune the trees to let in plenty of light and air, as the disease is always worse where too dense foliage keeps the fruit damp for a long time after every shower and heavy dew. Spray the trees in the spring as recommended for the prevention of Apple Scab and spray again the first or second week in August. For this last spraying use concentrated lime-sulphur, strength specific gravity 1.008 or 1.007 (=1 gallon of commercial lime-sulphur to 40 or 45 gallons of water). No poison should be used with this application.

STIPPEN, BALDWIN SPOT, OR BITTER PIT.

This disease is frequently seen in Ontario. The Baldwin and Spy are particularly subject to it, but it is by no means confined to these varieties.

Symptoms. Small, sunken, dark spots, from one-sixth to one-quarter of an inch in diameter are seen on the surface of the fruit. The skin of the spot is usually unbroken. The flesh beneath is dead and brown, and frequently similar brown spots and streaks are scattered through the interior of the fruit. Very often apples may be badly affected in this way without showing the characteristic



Stippen or Bitter Pit. (After McAlpine.)



Internal Stippen. (Original.)

pits on the surface. This form of the disease may be referred to as internal stippen. So far as one can judge, it occurs early in the growing season and is mistaken frequently for the work of the Apple Maggot, which it resembles to some extent. Occasionally fruits may be deformed, due to the extreme development of internal stippen. Frequently, apples apparently sound when picked develop the external form of the disease in storage.

No fungus has been found to account for this disease. Though a great deal has been written about it there appears to be very little exact knowledge concerning its cause and prevention. It is thought to be due to extreme variations in the water supply to the trees during the growing season, which tend to check and stimulate alternately the growth of the fruit. Internal stippen appears to be worse in seasons when there is plenty of rain during the spring and early summer, followed by a sudden and severe drouth. On the other hand, the typical surface stippen appears to be worse when we have severe drouth in July and August, followed by heavy rains. Probably the water-holding capacity of the soil has an important bearing on the occurrence of the disease. Sometimes a few trees in an orchard develop stippen year after year, while others of the same variety remain free from it. It appears in certain orchards to a greater or less extent every year, while other orchards in the same district and containing the same variety of apples apparently remain free from it.

Prevention. So far as is known, very little can be done to prevent this disease beyond adopting those horticultural practices which tend to an even, normal



Pink Rot following Apple Scab. (Original.)

development of the fruit throughout the season. Such practices include the thorough under-draining of the orchard, proper fertilizers, as may be required, good cultivation during the spring and early summer, cover crop sown not later than the end of June, at least in the colder districts, thorough and timely spraying and careful pruning. Trees that are subject to stippen year after year might with advantage be mulched with barnyard manure about the first of June. This will conserve the moisture and insure an even and steady development of the fruit.

PINK ROT (*Cephalothecium roseum* (Cda.))

Pink Rot is chiefly a storage trouble, succeeding Apple Scab. It is found on scabby apples which have been packed during moist weather or stored in a damp place. The fungus which causes this rot cannot penetrate the sound skin of the apple, and can gain entrance to the flesh only through scab spots or other wounds. Greenings and Snows are particularly subject to Pink Rot.

Symptoms. A whitish mould sometimes with a distinct pinkish tinge develops around or upon the scab spots. This is followed by a brown rotting around the spots, which markedly disfigures the fruit and renders it unpalatable.

Prevention. Spray thoroughly to prevent Apple Scab. Pink Rot never causes serious injury except to scabby apples. In packing, discard any fruits showing signs of white mould. Store the fruit in a cool dry place as soon after picking as can be done. If possible pick and pack when the weather is cool and dry.

PEAR BLIGHT (*Bacillus amylovorus*, Burrill).

This destructive disease is usually known by the above name, but fruit growers speak of it also as Blight, Fire Blight, Twig Blight, Blossom Blight, and, when it infests the trunk, as Body Blight.

It attacks not only pears, but also apples, crab apples, quince, mountain ash, hawthorn and junberry. The last three are rarely much affected, but pears,



Young pear orchard in early spring, showing blighted branches. The presence of the leaves indicates where the disease is. (Original.)

apples, crabs and quince suffer severely in seasons favourable for the development of the organism. So destructive is the Blight to pears that many good orchards have been almost totally destroyed by it: in fact so great has been the loss that in many districts fruit growers have given up pear growing in the belief that they cannot successfully cope with the disease. Apples do not suffer so severely as pears, yet some varieties, even the large, bearing trees, are much injured, and young, rapidly growing trees of very susceptible varieties are not infrequently killed. All varieties of quince are much damaged by the killing of branches and twigs, though trees themselves are not often killed.

The disease is found in nurseries as well as in orchards.

In pears and apples there is a considerable amount of difference in the susceptibility to attack of the different varieties. It is generally agreed that Clapp's Favorite is the most susceptible pear, and that Bartlett and Flemish Beauty are also very subject to attack, whereas Kieffer is least susceptible and Seckel is usually not severely injured. Of apples, Tolman, Gravenstein, Rhode Island Greening, Alexander and King are among the most susceptible, while Spy, Duchess and Ben

Davis are among those least attacked. No variety, however, either of apples or pears, is entirely immune, especially to infection through the blossoms, even Kieffer pears often being attacked in this way.

Symptoms. The disease manifests itself in many forms. (1) In June we often find numerous wilted and dying young fruits with their enveloping leaves. After a few days these leaves turn brown on apples and nearly black on pears and become very conspicuous. There may be hundreds of such dead little twigs and fruit spurs on a single apple or pear tree. In all or almost all such cases the organism was introduced by insects into the blossoms and by working back through the



Blighted twigs on pear trunk. The disease runs down such twigs and enters the trunks or branches. (Original.)



Main limbs of a Flemish Beauty pear tree, O.A.C. orchard, in which the blight is rapidly spreading. The limb to the right is practically dead. Notice the cracking and blistering of the bark, especially on the middle limb. All the disease above the crotch developed this season from the cankered area below the crotch. It spread throughout the bark very rapidly during June, July and August. Photo taken in September. (After Jones.)

fruit stems into the twigs killed both fruit and twigs. This blossom inoculation is the greatest source of infection and largely accounts for later troubles.

(2) Throughout the remainder of the season the twigs, suckers, water-sprouts and branches die, their leaves remaining attached instead of dropping to the ground. The death of these parts is caused by the organism working down from the fruit spurs and twigs that had been previously infected, through the blossom or through fresh infections introduced by sucking or other insects.

(3) Not infrequently the trunks and main branches become infected as the result of the disease continuing down from smaller branches or from getting into a water-sprout and running down into the trunk or as the result of direct inoculation by some bark or wood infesting insect. Roots of trees may also become inoculated through infected suckers. On these diseased branches and trunks, especially on rapidly growing pear trees, the bark in many cases becomes swollen, spongy, and after a time shows on its surface drops or little masses of a gummy exudate which is at first nearly colorless, but soon turns brown. This liquid substance is sticky, contains millions of the disease organisms, and by being visited by various kinds of insects, to the legs, mouth parts or other structures of which it becomes attached, serves as a great source of contagion for the rest of the orchard. Exudate may occur also on twigs or any other infested part. If affected bark is cut with a knife it will usually be seen to be streaked beneath the surface with brown or reddish-brown. After a time the diseased bark dies, shrinks and cracks away from the neighbouring bark. In the case of pears, if the organism once becomes established in a large branch or in the trunk, it will usually continue to develop until it kills the tree if not treated; but in the case of apples, even though it may pass down a water-sprout or branch into the trunk or larger branches and kill areas of the bark there which may be several inches in diameter, it will in most cases ultimately die without killing the tree itself. The dead areas or "Blight Cankers" as they are called, may later be invaded by the Black Rot fungus, increase in size and result in considerable damage to the tree.

(4) Occasionally the fruit is attacked at any time throughout the growing season and killed.

Cause. The disease is caused by a very tiny organism, a bacterium, known as *Bacillus amylovorus*. This is so small that at least 10,000 individuals could find room on the head of a pin. These germs work chiefly in the tender tissues of the bark and have marvellous powers of multiplying. Millions may be produced from a single one in a day. They feed on the food substances found in the living bark and soon kill the part affected. Warm, moist weather, which causes rapid growth and abundance of sap, favours greatly their development, whereas drought soon checks them and may even cause their death. As the bark tissue in apple trees is harder and less succulent than in pears this seems to explain why the disease usually dies out in the larger branches and trunks of apples, so that most injury to apples is due to the blossom infection destroying the young fruits, twigs and smaller branches.

Means of Distribution. As stated above, insects serve as the chief means of distribution. During the winter the organism lives in the healthy bark that bounds the dead areas. In spring with the rise of the sap the germs multiply, clog the tissues of the bark and cause a gummy exudate on badly infested trees, though this is often not easy to find. Ants are very fond of this exudate and by feeding upon it cause their legs and mouth parts to become infested with germs. They are also very fond of the nectar of the blossoms; and hence can readily inoculate them on a diseased tree. Bees and other insects also visit the inoculated blossoms and in turn carry the organism to blossoms on other trees. Doubtless other insects besides ants may serve as the direct original inoculators of the blossoms, but none seem to be so fond of the exudate as they.

Later in the season the exudate is much more abundant on the various twigs and other affected portions, so that sucking or bark infesting insects are much more liable then to become contaminated and act as carriers to healthy trees.

Methods of Control. It requires a careful, observant man to keep Pear Blight in control, so that this work should never be entrusted to anyone else. The first step is to go carefully through the orchard after the foliage has fallen in autumn, or at least before there is any movement of sap in spring, and cut out all diseased branches, cutting always when practicable several inches below the dead portion. If there are diseased areas on the trunk, these can in many cases be removed successfully by a drawknife and stout pocket knife or chisel, care being taken to remove all bark until the healthy bark with no brown or reddish streaks in it is reached. Often dead looking areas on the trunks and larger branches are not caused by Blight, but are due either to a natural dying of the outer bark or to winter injury or some other cause. By cutting through these it will usually be seen that the inner bark and cambium are alive, and thus one can see that they are not blighted. If these doubtful areas are left until many trees have been studied the operator will soon learn in most instances to diagnose the case correctly. The orchard should again be inspected carefully about the first week in April or a little earlier to see that no diseased parts have been overlooked. Any cuts made at this time of the year or later should always be disinfected with corrosive sublimate, 1 part to 1,000 parts of water, or 1 tablet in 1 pint of water. This can be applied by means of a bottle with a little piece of sponge instead of a cork in the opening. The pruning implement must also be disinfected after each cut. (*Remember that corrosive sublimate if taken internally is very poisonous.*) All prunings should be removed promptly and burned lest they act as a source of contamination. *The great object of this early inspection is to remove all traces of Blight so that insects will not be contaminated and spread it to the blossoms in the spring.*

The next step in control is to watch for the first signs of the wilting of the young fruits and leaves on twigs and fruit spurs after the blossoms have fallen. Prompt attention here is very essential, for upon the rapid destruction either by breaking off or cutting out of these infested twigs before the disease can pass down them into the larger branches, depends the success of the later steps. Much of this work can be most readily done from a dray driven along close to the trees. The trees for a week or two at this time of the year will have to be inspected every day or two until all traces of the Blight have been removed. After this in good growing weather a weekly inspection is desirable or in very dry weather a bi-weekly inspection. In cutting out any of these twigs or branches it is very important to cut a foot or eighteen inches below where the disease shows on the bark, otherwise in many cases the germs will not all be removed. Usually it will require only a very short time if the Blossom Blight has been thoroughly removed, to make the later inspections. One man can sometimes inspect ten acres of pears in a few hours.

Young apple trees, crabs and quince should receive the same attention as pears, but on large apple trees it is often impracticable to remove Blossom Blight. On these, however, it will usually be found that the disease soon dies out without running more than a few inches down the stem. On very susceptible varieties, if the larger branches are being attacked, the disease should be cut out as on pears.

As a very succulent condition of the bark favours the Blight, it is usually not desirable to prune pear trees heavily or to cultivate more than is necessary to give fair-sized fruit.

Suckers and water-sprouts on the trunk and main branches of pears and young apples should be promptly removed to prevent the disease getting into these and passing down into the older portions or to the roots.

Though no variety is entirely immune, it is not wise to plant Clapp's Favorite, as these trees are so extremely susceptible to attack and so favourable to the rapid growth of the organism that it is very difficult to save them.

The plan of planting Kieffers and later budding or grafting Bartletts or other desirable varieties on the branches of these seems a rational one; for in such cases even if the organism attacks the twigs or branches it is not likely to kill the tree, because of the resistant nature of the Kieffer trunk and main branches.

As a rule control of blight on pears will be simplified by planting the pears at a considerable distance from other pear, apple or quince orchards.

PEAR SCAB (*Venturia pyrina*, Aderh.)

Pear Scab is similar in nearly every respect to Apple Scab. In Ontario only the Flemish Beauty and a few of the less valuable and often unnamed varieties of



Pear Scab on fruit. (Original.)



Leaf Spot on pear. (After V. B. Stewart.)

pears are very subject to it. Scab is a great drawback to the otherwise valuable variety, Flemish Beauty. When the fruit is badly affected it is cracked open and rendered almost valueless for commercial purposes.

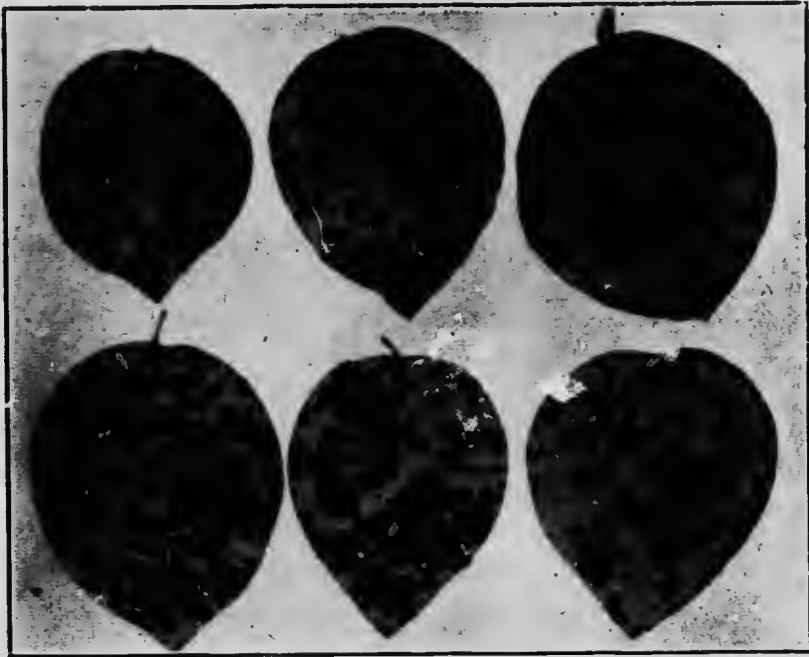
Prevention. Prune and spray as recommended for Apple Scab, taking special care with the first spray to see that the tips of the twigs are thoroughly covered, and always give a fourth application about ten days after the third.

LEAF SPOT OF THE PEAR (*Mycosphaerella sentina* (Fckl.))

This disease is frequently seen in Ontario, though it seldom causes any appreciable harm except in badly neglected orchards or to trees growing wild on roadsides or in fence corners. It is sometimes observed in nurseries and occasionally result: ...ature defoliation which checks the growth of the young trees.

Symptoms. This disease is confined to the leaves, on which are seen small, somewhat angular spots, usually with grey centres and brownish or purplish-brown borders; but sometimes the whole spot is dark in colour, with no distinct grey central area. In the centre of the spots as they mature, small black specks, the fruiting bodies (pycnidia) of the fungus, appear. The size of the spots appear to vary with the variety and the season. When the disease is severe the spots may be so numerous as to injure the leaves markedly.

Life History. The tiny black specks or fruiting bodies (pycnidia) are filled with minute, slender, thread-like spores, which are discharged from a small opening at the tip of the fruiting body (pycnidium). They are scattered through the orchard by wind and rain, and serve to spread the Leaf Spot during the summer months. Moisture is essential for the germination of these spores and for the



Leaf Blight of quince. (V. B. Stewart.)

penetration of the leaf by the germ-tube. Hence it is that the Leaf Spot is always most prevalent in a wet season. The fungus lives over the winter in the fallen leaves. In these another form of spores (ascospores) are developed in a special kind of fruiting body (perithecium). These are discharged in the spring of the year and some of them are blown by the wind to the newly developed leaves on which in a short time they produce the characteristic spots and the first generation of summer fruiting bodies (pycnidia).

Prevention. The sprayings which are given for Scab appear to control completely Leaf Spot. To control it on nursery stock spraying with Bordeaux mixture or with commercial lime-sulphur 1 gallon to 40 gallons of water is recommended. The first application should be made just as soon as the trees come into full leaf in the spring, the second about two or three weeks later. In very wet seasons one or two more sprayings at intervals of about two weeks may be necessary.

LEAF BLIGHT OF PEAR AND QUINCE (*Fabrea maculata*), (Lev.) Atk.)

This is another disease of comparatively little importance in Ontario. It is seen on both pear and quince, but is usually more noticeable on the latter. It is chiefly a leaf spot disease, but the fruit is sometimes also affected. The spots on the leaves are small and circular, dull red or brown in the centre with darker borders. One or more black pimples, fruiting bodies (pycnidia), of the fungus can be seen in the centre of each spot. In severe attacks the spots may be so numerous that the leaves turn yellow or brown and fall. Red and brown spots are sometimes also seen on the fruit. On the quince the disease is sometimes so severe as to cause a premature defoliation.

Prevention. In orchards the sprayings as ordinarily given for Scab appear to prevent completely this disease on pears. On quince it may be prevented by spraying with lime-sulphur or with Bordeaux mixture. An early dormant wood spray should be given with concentrated lime-sulphur, strength specific gravity 1.030. This should be followed by a second spraying shortly before the blossoms appear and another soon after they fall. Concentrated lime-sulphur specific gravity 1.008 or Bordeaux mixture may be used. In wet seasons a fourth spraying may be required about ten days later.

PEACH LEAF-CURL (*Exoascus deformans*) (Berk.) (Fckl.)

This is the most common and most injurious fungus disease of peaches. It is familiar to every peach grower and very frequently seriously impairs the vitality of his trees.

Symptoms. Blossoms, young fruits and twigs are sometimes affected, but it is by the destruction of the leaves that the chief injury is done. The leaves are infected as they expand in the spring and become distorted, curled, thickened, and yellowish-white, pinkish or purplish in colour. A little later in the season they turn brown and fall. The disease may spread from the leaves into the shoots and destroy them. In severe attacks of Peach Leaf-Curl the trees are almost completely defoliated, the fruit is stunted or drops to the ground, and the vitality of the trees is so impaired that they are likely to be severely injured by the cold the following winter. The proper development of fruit buds is also prevented. Young trees may be killed the first year they are set out if they are defoliated before they have recovered from the shock of transplanting. Peach Leaf-Curl is always more severe in cold wet springs.

Life History. On the surface of the affected leaves numerous spores are produced and the fungus which causes Peach Leaf-Curl is thought to be carried over the winter by some of these spores adhering on or between the bud scales. In the spring, when the buds begin to swell with warmth and moisture, the spores germinate and infect the unfolding leaves. Hence the necessity for early and thorough spraying. In cold wet springs the opening of the buds is retarded, while the germination of the spores and the development of the fungus is favoured by the excessive moisture and not retarded by the cold. Thus the fungus has plenty of time to get established in the tender tissues of the developing leaf. This explains why Peach Leaf-Curl is always worse in cold wet springs.

Prevention. Spray with lime-sulphur, using the strength recommended for San José Scale, namely, concentrated lime-sulphur strength 1.035 specific gravity (=1 gallon commercial lime-sulphur to 7 gallons of water). Spraying must be

done early in spring before the buds have started to swell, and care must be taken to see that every bud is thoroughly covered. Success depends upon early and thorough spraying, as can be understood from a consideration of the life history of the fungus. Somewhat weaker solutions of lime-sulphur or Bordeaux mixture will prevent the Leaf-Curl, but will not kill San José Scale, which is apt to be found wherever peaches are grown, and therefore it is advisable to use the strong solution of concentrated lime-sulphur as recommended above. Fall spraying for the prevention of Peach Leaf-Curl has been tried in New York State and satisfactory results obtained. The results of experiments in Ontario in the fall of 1915 and again in 1916 point to the same conclusion.



Peach Leaf-curl.

PEACH YELLOWS AND LITTLE PEACH.

These two diseases are so closely associated in the orchard and seem to be so nearly related that they may be discussed together. They are both very destructive and are much feared by all peach growers who have had an opportunity to see the damage they can do. From about the year 1909 to 1913 these diseases were so prevalent in the Niagara district that there was something like a panic among the growers lest the peach industry might soon be ruined. At that time the writers saw several otherwise excellent orchards varying in size from 500 to 1,000 trees, in which almost every tree was diseased and thus worthless; for there is no cure for a tree once it is diseased. Some of these orchards were not more than eight years of age, and so had not reached their prime. Fortunately, a better knowledge

of the symptoms of the disease and better inspection has since brought both diseases under control.

Symptoms of Peach Yellows. On a diseased tree some of the fruit will usually ripen from a few days to two or three weeks prematurely. Such fruit is more highly coloured than normal, is blotched outside with red, streaked inside with the same colour and has the flesh around the pit abnormally red. Sometimes only one branch or even one twig will show these symptoms and all the rest of the tree bear quite normal fruit. The first year the diseased fruit is either normal in size or a little larger, but the next year it is smaller than normal. The foliage on at least some of the branches is nearly always a sickly yellow colour and is often clustered and curled as described below for Little Peach. Sometimes we find arising from the main branches little upright tufts of much-branched twigs with narrow, yellow-



Branch of tree affected with Little Peach just beginning to show the clustering and curling of the leaves near the base as indicated by the arrows. (Original.)

ish leaves. This symptom, however, is not common except on trees in which the disease is in an advanced stage.

Symptoms of Little Peach. The fruit on a typical diseased tree or part of a tree ripens later than usual, is smaller than normal, but has no peculiar colour markings. In many cases, however, we find trees on which the fruit ripens at the usual time and is about normal in size, and yet the foliage shows clearly that the trees are diseased. The symptoms on the foliage are the curling and clustering of the leaves, especially on the inner parts of the tree, and the sickly yellowish or sometimes reddish-yellow colour they assume. On some varieties the leaves cluster much more than on others. Curling and clustering of leaves apart from the yellowish colour is not a symptom of disease. On young diseased trees the leaves on the outer branches will usually remain quite green for a long time after those on the

inner or central portion have begun to show the disease. If the centre of the tree looks healthy but the outer branches because of a reddish-yellow colour look diseased, it will nearly always be found that such trees are not affected by Little Peach or Yellows, but are suffering from lack of nourishment. Care must of course be taken both with Yellows and Little Peach not to confuse the foliage symptoms of these diseases with those caused by winter injury or by borers at the base of the tree or by cankers on a branch or elsewhere. A little study and experience will soon enable a person to recognize injuries from these causes. It is also worth remembering that the foliage on the Crawford type of trees differs from that on the Elberta, and the latter again from that on the Smock or Triumph or St. John; so that to study Yellows and Little Peach one should first familiarize himself with the different kinds of foliage to be found on the different varieties. This is especially important as the amount of curling and clustering due to the diseases depends largely upon the sort of leaf characteristic of the particular tree affected.



Leaves from Little Peach tree, showing the characteristic flattening and curling. (Original.)

Cause. The cause of Yellows or of Little Peach has not been discovered. There are, of course, several theories, but none are satisfactory. No organism, whether bacterial or fungus, so far as the microscope or as cultures are able to reveal it is present.

It has been shown both in our own experiments and in those of several investigators in the United States, that the disease can be produced in healthy trees by budding them with buds from diseased trees. We have done this in many cases, both on large and small trees, and in the majority of instances, though not in all, the disease has developed. In all but one case in our experiments it required two years from the time the buds were inserted before the symptoms could be detected on the foliage or fruit. Hence it is clear that in the tree itself development of the disease is very slow.

It has been claimed by several writers that pits from diseased trees will not grow. In our experiments this was true only of pits from badly diseased trees, but not of those from trees which had shown symptoms of the disease only for a month or so. Of these, as high as eight per cent. of the pits germinated and grew.

It has also been claimed by certain writers that if the pit from a diseased tree grows, the tree thus produced will be diseased. We have had several hundred such pits grow and at the end of three years they showed no sign of disease. So that it would appear as if the danger from pits from diseased trees was not an important factor.

There is good reason to believe that whatever be the cause of Yellows and Little Peach, there is much danger in some mysterious way of the disease passing from one tree to another in the orchard. It is true that for several years this may not happen, and the explanation may possibly lie in the nature of the weather, some years compared with others. In any case we can see no other explanation of the great increase of the disease in the past in orchards where infected trees were not removed than that infected trees spread the disease to healthy trees.

Methods of Control. There is just one method of control, and that is to encourage the local inspector to mark every clearly diseased and suspicious tree or to mark them oneself, take them out and burn them promptly. This has resulted already in a very rapid decrease in the diseases. In 1911, 60,000 trees were marked and destroyed in the Niagara district; in 1912 this was reduced to 25,000, in 1913 to 7,000, and in 1914 to 3,000. Since that date there has been a tendency to over-confidence on the part of the growers in some localities, with the result that the figures for 1915 and 1916 are practically the same or slightly higher than for 1914.

Nurserymen also can help to keep down the disease by special precautions not to take bud sticks from a diseased tree or even from any orchard where considerable disease has appeared at any time during the preceding three years.

BROWN ROT OF STONE FRUITS (*Sclerotinia cinerea* (Bon.) Wor.).

This, as the name implies, is a disease of peaches, cherries, plums and apricots. It is to be seen in Ontario to a greater or less extent every year, and in some seasons causes very serious damage, especially to certain susceptible varieties of peaches, to sweet cherries, and several varieties of European plums.

Symptoms. Blossoms, fruits, leaves (sweet cherries), and twigs are affected. It is by the destruction of the fruit that the chief loss is caused. On the fruit the disease first appears as a small brown spot, which gradually increases in size until the whole fruit becomes soft, brown and rotten. These rotten fruits retain their form for a time, but finally they dry out and become shrivelled, hard and wrinkled, and are known as "mummies." These are frequently seen hanging on the trees or lying on the ground underneath. On the surface of the rotten fruits greyish-brown velvety spore pustules are easily seen with the naked eye. They look like small pimples. The fruit does not usually begin to rot until about half grown, and becomes more subject to rot as it approaches ripeness. Sometimes, however, the young green fruits are destroyed by the disease. The blossoms also are sometimes attacked. They turn brown and fall. Destruction of the blossoms by this disease has not often been noted in Ontario. Sometimes the fungus which causes the rotting of the fruit grows back into the twigs and girdles them, and thus causes a twig blight. This is most frequently seen in the case of the peach, but

is not uncommon on plums. On sweet cherry leaves brown, dead areas, due to this disease, are common when the rot is bad on the fruit.

Life History. The fungus which causes the disease is spread during the summer months by means of spores produced in great numbers on the surface of the rotting fruits. These are scattered by rain, wind, insects and other agencies. In warm, muggy weather the rot is spread by them very rapidly, especially when the fruits are close together and the foliage so thick as to keep out light and prevent the free circulation of the air.

The fungus which causes the disease is carried over the winter in various ways:—

1. By means of the mummied fruits hanging on the trees or lying on the ground beneath. In these the mycelium of the fungus remains alive all winter, and in the spring, when they are soaked by rains, the fungus threads may grow again and produce fresh crops of spores (conidia) on the surface. From some of the mummied fruits lying on the ground underneath the trees partly covered by



Mummified plums and peach, due to Brown Rot. About one-half natural size. (Original.)

the earth, about blossoming time little trumpet-shaped growths (apothecia), are produced. These contain immense numbers of another kind of spores (ascospore), which are discharged into the air and may be blown up into the trees, where, if weather conditions are favourable, they may infect the blossoms or young fruit and cause them to rot. These trumpet-shaped growths (apothecia) have been observed in Ontario every year since 1912, and probably play an important part in initiating the disease in the spring.

2. By means of spores produced during the summer adhering to the mummied fruits and probably to bark and bud scales. These retain their vitality and are capable of causing infection and producing disease again in the spring.

3. To a slight extent by means of dormant fungus threads (mycelium) in the blighted twigs.

It will be seen from the above account of the life history of the fungus, that the mummied fruits are chiefly instrumental in perpetuating the disease from year to year.

Prevention. Prune the trees so as to let in light and air and facilitate spraying. Spray thoroughly and at the proper times. Peaches should be sprayed with concentrated lime-sulphur, strength specific gravity 1.035 (=1 gallon commercial lime-sulphur to 7 gallons of water) early in the spring before the buds begin to swell. A second spray should be given about a month after the fruit is set with self-boiled lime-sulphur. In wet seasons, when rot is likely to be bad, it is advisable to spray again with self-boiled lime-sulphur about a month before the fruit ripens. Sulphur dust could probably be substituted for the liquid and could be applied about two weeks before picking, as it would not stain the fruit. Thin peaches so that they do not touch each other. This helps to prevent the rot spreading.

Spray plums and cherries, first, just before the buds burst, with concentrated lime-sulphur, strength specific gravity 1.035 or 1.030 (=1 gallon of commercial to 7 or 9 gallons of water); second, just after the fruit is set and the calyces have fallen with concentrated lime-sulphur, strength specific gravity 1.009 or 1.008 (=1 gallon commercial lime-sulphur to from 35 to 40 gallons of water) or with Bordeaux mixture; third, about ten days or two weeks later, depending upon the weather, with concentrated lime-sulphur, strength specific gravity 1.008 (=1 gallon commercial lime-sulphur to about 40 gallons of water) or with Bordeaux mixture. All varieties subject to rot should receive an application just when the fruit begins to colour, which is about as late as is safe, to avoid staining the fruit, with lime-sulphur, strength specific gravity 1.008 (=1 gallon commercial lime-sulphur to 40 gallons of water). Poison is not necessary at this time except where Cherry Fruit Flies are present. Dusting cherries and plums two or three days before picking with finely-ground sulphur, free from poison, promises to be very valuable, especially in saving sweet cherries.



Spring stage of the Brown Rot fungus on a peach, buried just at the surface of the ground. (After McCubbin.)

The mummied fruits, being so important in carrying the fungus which causes the disease over from year to year, should, if practicable, be destroyed. Knock them off the trees in the fall and gather and burn them, or plow them under early in the spring. Gathering the mummies and burning them is the most effective method, as plowing may not turn all of them under deep enough to prevent their being sources of infection.

PEACH SCAB OR BLACK SPOT (*Cladosporium carpophilum*, Thum.).

This disease is seldom destructive in Ontario. It is, however, frequently seen, especially on the white-fleshed varieties.

Symptoms. Small, circular, sooty-black spots are seen on the surface of the fruits. These may be scattered all over the surface or may be more or less confined to certain areas. In severe infections the spots may be so numerous as to disfigure



Peach Scab—a very severe infection.
(Original.)

about a month after the fruit is set. Probably dusting with sulphur would give equally good results.

POWDERY MILDEW (*Sphaerotheca pannosa* (Wallr.) Lev.).

This Mildew attacks both the roses and the peach. It is most commonly seen on young peach trees which have not yet come into bearing, and frequently injures



Powdery Mildew on young peach twigs in nursery. Note the distorted, slender leaves, almost white with the fungus spore masses. (After Duggar.)

nursery stock severely. It does, however, sometimes occur on older trees. Certain varieties are said to be particularly susceptible to it.

Symptoms. The Mildew is seen on the leaves, young shoots and sometimes on the fruit. The leaves become distorted, stunted, curled, pale, sickly, more or less

folded lengthwise and covered with a dense powdery white substance, which extends over unto the twigs on which the leaves are borne. The Mildew is easily recognized by this dense white powdery covering on the affected leaves and shoots. It develops most vigorously in warm, moist weather, and is usually most abundant in late summer and autumn.

Prevention. At the first sign of the Mildew, dust with flowers of sulphur and repeat at intervals of ten days as often as may be required to hold the disease in check. Spraying with self-boiled lime-sulphur is also recommended. It is sometimes advisable to discard very susceptible varieties.

CROWN GALL (Pseudomonas tumefaciens (Erw.) Smith & Townsend).

This is a bacterial disease which affects peaches, apples, plums, cherries, raspberries and many other plants. It is easily recognized by the woody, knot-like swellings seen on the trunk and roots. These galls vary in size. Some are not as large as a walnut, while some may be as large or much larger than a man's fist. When these galls are on the trunk they are usually at or just below the ground. The extent of injury done to the tree by Crown Gall is an open question. Many affected trees continue to grow and appear to thrive normally. There is no doubt, however, that some trees are weakened and stunted, if not killed by the presence of the galls. Hairy Root of apples, often seen in nursery stock and easily recognized by the tufts of thread-like rootlets replacing the branches on the main root, is caused by the same organism.

Prevention. In order to be on the safe side do not plant any trees showing any indication of Crown Gall. Such trees should be returned to the nurseryman with a request for healthy trees to take their place. It is not advisable to plant fruit trees where raspberries have been grown, as raspberries are very subject to this disease.



Crown Gall on Apple. (Original.)

CANKER OR GUMMOSIS OF PEACH TREES.

In certain localities in the Niagara district, especially at Queenston, Niagara-on-the-Lake, St. Catharines, and in several orchards at Winona and Grimsby, it is a common thing to see large, black, gum-covered cankers, chiefly on the upper side of large branches. These cankers do not heal over but continue to widen out and enlarge until finally the whole branch dies. This usually takes several years.

The cankers have been attributed to various causes. Mr. W. A. McCubbin, of the Dominion Laboratory, who has made a special study of Peach Cankers, writes as follows concerning their origin:—

- *“ 1. A very small percentage arise from holes made by borer larvæ.
 “ 2. They may come as an after-effect from small cracks in the trunks or limbs. The percentage thus formed is also very small.
 “ 3. A small number start from gum blisters under the bark.
 “ 4. A few arise at the bases of twigs killed by Brown Rot. The Brown Rot fungus works back from the rotten fruit into the twig and then starts a canker in the larger limb.
 “ 5. Wounds made by scraping the limbs, etc., are accountable for a small number.



Small cankers on peach branches. Natural size.
 (Original.)

- “ 6. Quite a few cankers start at pruning wounds.
 “ 7. By far the greatest proportion of cankers are formed on the limbs at the bases of dead twigs. There is presumably a fungus concerned here which, after establishing itself in the dead twig, runs back into the larger limb and there starts a canker.”

Field observations made by the writers, incline them to think that heavy pruning and heavy fertilizing, in combination with wet weather early in the growing season, may also have some effect in inducing the formation of cankers.

Means of Control. Mr. W. A. McCubbin, after conducting many experiments on the healing of Peach Cankers, makes the following recommendation in regard

*Bull. 24, Dominion Department of Agriculture, "Fruit Tree Diseases of Southern Ontario."

to their prevention and control: Removal of the dead twigs from the main limbs, since it is found that these twigs are the starting point of the disease in such a large number of cases; destruction of Brown Rot mummies; painting of all the larger pruning wounds; removal of small limbs showing cankers, and the treatment of cankers on trunk or large limbs by cleaning out the cankers immediately after rain when the bark and gum are soft, and disinfecting the wounds with formalin diluted one to ten, or corrosive sublimate, one in a thousand, and coating them with lead paint free from turpentine.

The field observations of the writers recorded above indicate that care should be taken not to over-prune or over-fertilize peach trees, as such treatment apparently tends to induce the formation of cankers.

BLACK KNOT OF PLUMS AND CHERRIES (*Plowrightia morbosa* (Shw.) Sacc.).

This is an extremely destructive disease, and in localities in Ontario where no special efforts have been made to control it, it has destroyed numerous cherry and plum trees. In well-cared-for orchards, it is kept under control and seldom causes serious injury. This is particularly true of orchards in the fruit-growing sections where spraying is generally practised and where the law requiring the cutting out of Black Knot is enforced.



Black Knot on plum twigs.
(Original.)

Symptoms. The knots usually appear first in the spring of the year. The swellings are at the start slight, but gradually increase in size. The surface becomes cracked and covered with a light green coating consisting of numerous fungus threads (mycelium) and spores. The swellings are often spindle-shaped and usually confined more or less to one side of the twig. Later in the season, as the knots mature, they lose their green colour and become dry, hard, black and cracked, with the surface studded with minute black pimples which are the fruiting bodies (perithecia) of the fungus. The knots are most abundant on the twigs and smaller limbs, but are sometimes found on the larger limbs, especially in the crotches. Occasionally they occur on the trunks.

Life History. From late spring until mid-summer numerous spores are produced on the young, developing knots, so that each is a source of infection to healthy limbs on the same tree or on other trees in the neighbourhood.

During the fall and winter another form of spores (ascospores) develop in the black pimples (perithecia) on the surface of the mature knots. These spores are mature and are discharged from late winter until early spring, according to the locality and severity of the season. Many of the knots are also perennial, producing fresh crops of spores each year.

Prevention. Cut out and burn the knots, taking care to cut well below the diseased area. This should be thoroughly done at least twice a year, in the fall or early winter and in late spring.

Spray plums and cherries as recommended for Brown Rot. The early dormant wood spray with concentrated lime-sulphur, strength specific gravity 1.030 or 1.035 appears to be particularly effective in the prevention of Black Knot, and care should be taken to see that it is very thoroughly applied. The branches, main limbs and trunks should be completely covered with the solution. Black Knot attacks wild cherries and plums, and there is a possibility of its spreading from these to those under cultivation. It is advisable, therefore, to destroy wild plums and cherries in the neighbourhood of the orchard if they are affected with Black Knot. The enforcement of the clauses of the "Fruit Pests Act," regarding the cutting out of Black Knot, should make it much easier for fruit growers to keep Knot out of their orchards.

PLUM POCKETS (BLADDER PLUMS) (*Eroascus pruni*).

This disease is common in Ontario on wild plums and on cultivated plums of the American varieties (*Prunus americana*). It is recorded also as sometimes



Plum Pockets or Bladder Plums. The fruit on the left is healthy, that on the right is diseased. (Original.)

occurring on the common or European plums (*Prunus domestica*). It is most prevalent in cold, wet springs. It cannot, however, be regarded as a disease of any great economic importance.

Symptoms. Soon after the fruit is set it becomes swollen, hollow, without a pit or stone, and often distorted in shape. These light, hollow, bladder-like fruits have suggested the common name "Bladder Plums."

In the early stages, affected fruits are yellowish or reddish in colour. Later they become covered with a whitish bloom. This is due to the production of numerous spore sacs (asci) on the surface. These sacs (asci) contain ascospores. After these are discharged the fruit turns dark brown in colour and falls off.

Life History. The fungus which causes Plum Pockets appears to live over winter as spores, adhering on or between the bud scales. These germinate and produce infection of the young ovaries when the buds are bursting in the spring.

Prevention. Spraying as recommended for Peach Leaf-Curl appears to prevent this disease entirely.

PLUM RUST (*Puccinia pruni spinosae*, Pers.).

This disease is occasionally observed in Ontario orchards, but has never been recorded as doing any serious damage.

It produces small, dark brown pustules on the under surface of the leaves. In severe attacks premature defoliation may be caused.

LEAF SPOT, SHOT-HOLE FUNGUS, YELLOW LEAF DISEASE OF CHERRIES AND PLUMS.

This is a very common disease in Ontario on wild and cultivated cherries and plums. It is to be seen nearly every year and in wet seasons may very seriously injure cherry trees. Both sweet and sour cherries are frequently completely defoliated in wet summers. In the years 1915 and 1916, it was particularly



Leaf Spot or Shot-hole Fungus on cherry and plum. (Original.)

bad. It is usually recorded as being worst on sweet cherries, but here in Ontario it has been just as destructive, if not more so, to sour cherries.

The disease on the different species of cultivated and wild cherries and plums is not all caused by the same fungus. Three closely related species of fungi, each confined to certain species of cherries or plums, have been found to cause it. *Coccomyces hiemalis*, Higgins, causes the disease on sweet and sour cultivated cherries and on the wild pin cherry, *C. pruniphorae*, H. on cultivated plums of the European and American varieties and on two species of wild plum, *C. lutescens*, H. on wild black cherry, choke cherry, and perfumed cherry.

Symptoms. These vary with different hosts. On the leaves of plums and wild cherries brown spots are produced, which soon fall out, leaving little holes,

which give the leaf a "shot-hole" appearance. On cherries the spots on the leaves do not as a rule drop out so readily and are smaller. They are reddish-brown in colour and may be very numerous, so that nearly the whole surface of the leaf may be covered by them. Badly affected leaves turn yellow and drop. Cherry trees are frequently completely defoliated early in the summer. Such defoliation prevents the proper ripening of the wood and renders the tree very subject to winter killing. In the spring and summer of 1916, numerous instances were recorded of cherry trees not surviving the winter. When inquiries were made, it was found in nearly every case that the trees which were winter killed had been defoliated by Leaf Spot the previous summer.

Life History. On the surface of the spots on the leaves numerous spores are produced. These can often be seen as little white, velvety pustules in the spots, usually on the under side of the leaf. These spores serve to spread the disease during periods of wet weather in the summer. Moisture is necessary for its spread. It is only in wet seasons that it causes serious injury. The fungus which causes the disease is carried over the winter in the fallen leaves. In these it produces fruiting bodies (apothecia). These contain another form of spores (ascospores). During wet weather in the spring, about the time the new leaves are developing, these spores are discharged from the fruiting bodies in great numbers. Some of them are carried by the wind to the young leaves, where they produce the first infection of the season, from which the characteristic spots develop a week or two weeks later.

Prevention. Leaf Spot usually can be prevented by giving the three regular sprayings recommended for the control of the Brown Rot and an additional application just after the cherries are picked, with Bordeaux mixture or concentrated lime-sulphur, strength 1.009 or 1.008 specific gravity (=1 gallon commercial to from 33 to 40 gallons of water). Bordeaux seems the better remedy.

POWDERY MILDEW OF CHERRY (*Podosphaera oxycantha* (D.C.) DeBary).

This Mildew is frequently noticed on cherries in Ontario. It does not usually injure old trees to any great extent. Young trees and nursery stock, however, are sometimes severely injured by it. Apples and plums are also affected by the same mildew, especially nursery stock.

Symptoms. The young shoots, tips of branches and leaves become covered with a white powdery mildew. On the leaves it is most abundant on the lower surface. In severe attacks shoots and twigs are distorted and stunted and the leaves curled. Early in the season the mildew is white and more or less powdery, especially on young shoots and twigs. Later it becomes darker in colour. If the mildew on the lower surface of a leaf is examined at this time, numerous dark specks will be seen scattered among the white threads. These impart the darker colour to the mildewed areas.

Life History. On the surface of the leaves and shoots the white threads of the fungus (mycelium) can be seen with a hand lens. During the early summer from these white threads stalks are sent up which bear chains of spores (conidia). These spores are so numerous that they give to the mildew the characteristic powdery appearance. They serve to spread the disease during the summer months. Towards autumn minute specks are seen among the fungus threads. These are at first yellow, later black in colour. They are fruiting bodies (perithecia), and each contains one large spore sac (ascus) with eight spores (ascospores) inside. These spores serve to carry the fungus over the winter. In the spring they are liberated,

and some of them are blown by the wind to cherry leaves or shoots where, if there is plenty of moisture, they germinate and produce the first infection of the summer. The chains of summer spores (conidia) soon develop and new infections occur.

Prevention. Good results have been obtained in New York State by the use of commercial lime-sulphur, 1 gallon to 40 gallons of water. *"The addition of 3 pounds of iron sulphate to 40 gallons of the mixture tends to reduce the possible injury to the foliage and also increases its sticking quality. The first application should be made as soon as the disease appears. From three to five sprayings will be required in order to keep the Mildew in check." It is possible that the new dust method of preventing plant diseases would prove satisfactory with this trouble.

INJURIES DUE TO WINTER OR TO LOW TEMPERATURES.

In this province, which is subject to cold winters and great extremes of temperature, winter injury or injuries caused at other times of the year by low temperatures, are common and very important. Hence every fruit grower should have a knowledge of the forms which such injuries take and of the simple means by which some of the worst of them may be prevented.

It is impossible to go into a full account of this subject, so that the following deals only with the more common or more important types of injuries. We have already referred to the winter killing of cherry trees as a result of early defoliation brought about by the Leaf Spot or Shot-hole Fungus disease. Hence this will not be dealt with here.

SUNSCALD.

This is the most common form of winter injury. It occurs all over the province, but is worse in the colder portions. Thousands of apples, plums and cherries in almost every fruit-growing county are affected. The injury consists in the killing of the bark, often over an area three or four feet or even more in length, on the south or south-west side of the trunks, and also in the case of apples on the upper side of large branches. The death of the bark is caused by its being heated up by the sun's rays on cold, bright days, especially in February and March, and then after sunset cooling off very quickly. The great drop in the temperature thus taking place in a few hours is very injurious to the tissues of the bark, and if frequently repeated kills them. To make matters worse, the dead sunscalded area on apple trees is commonly invaded by the Black Rot fungus, which gradually extends the injury and in many cases girdles the trunk or branch and kills all the parts above. A great many of the Black Rot cankers start in this way from Sunscald. On plums and cherries it is chiefly the trunks that are affected and here, too, the injury may be increased by fungi or by borers working around the margins of the dead bark. Sunscalded trees, of course, often live for many years, and may bear almost as well as if the bark on the affected area had not been killed.

Methods of Control. (1) When setting out new orchards incline the trees a little to the south-west and head them low. This helps to shelter the trunks from the sun.

(2) In dehorning or pruning apple trees, never remove all the centre, thus exposing large branches to the direct rays of the sun. Such open centres are not only unsightly, but lessen the bearing capacity of the tree.

*Bull. 358, Cornell University, Agricultural Experiment Station of the College of Agriculture.

(3) The trunks and branches of Transcendent or Martha Crab apples are very resistant to Sunscald and the roots to root-killing, hence if these were planted and the desired variety of apples grafted or budded on their branches, much of the danger of Sunscald, Root-killing and Collar Rot would be avoided.

(4) All dead sunscalded areas, especially on the trunks, should have the bark removed with a drawknife, and the wound painted with white lead or with coal tar. This will keep out the Black Rot and other fungi.



Effect of Sunscald on the southwest side of the trunk of a European plum tree. Most of the bark on the injured area has been killed and fallen off. (Original.)

(5) The trunks may be protected against the sun's rays by various devices, such as wrapping them with white building paper, or using vincer, or corn stalks, or even by tacking a board up against the south side. Whitewashing the trunk heavily about the end of January also helps. If building paper is used and is put on in late autumn and a little earth thrown up around the base, it will also keep off mice. Any form of protection against Sunscald should always be applied not later than about the middle of January.

CROWN ROT OR COLLAR ROT.

This is the name commonly given to that form of injury which consists in the death of the bark around the base of the trunk of trees. The girdling may be either complete (and in such cases the whole tree soon dies) or may be partial, only one side or portions here and there being girdled. In the latter cases, the branch or branches just above the dead bark may die, but often the whole tree may remain alive and healthy. There is a great tendency, however, for these semi-girdled trees to become completely girdled after a few years. Crown Rot is fairly common in apple orchards in most parts of the province, and is by no means limited to the colder districts. King of Tompkins is specially subject to it, but many other varieties also suffer.

There are several theories as to the cause of this Collar Rot, but the writers are convinced that the chief cause is low temperatures acting upon succulent tissues which have not been properly hardened up for winter. The bark at the crown is much more tender than that higher up on the trunk, and hence where trees have been over-fertilized and cultivated too late this is the part that is most likely to be killed, especially if not protected by snow.

The death of the bark around the base of the trunk of peach trees and also of sweet and sour cherries, sometimes extending a short distance below the ground, is probably very closely allied in nature to the Collar or Crown Rot of apples. It is usually found where the trees are in exposed situations or where wind currents sweep through the orchard, especially if the trees were very thrifty the previous summer.

Methods of Control. (1) Do not plant on their own stock King of Tompkins or any other variety known to be very subject to this disease. If these varieties are desired, they should be grafted on immune or nearly immune stock, such as Tolman Sweet or Transcendent or Martha Crab.

(2) Do not over-fertilize or cultivate so late that the trees will not have their wood and bark hardened up for winter. Cultivation, even in the warmer districts, should usually close about July 1st, and a week or two earlier in the colder districts. A cover crop should be sown as soon as cultivation is finished. This will help to hold the snow on the ground.

(3) Never plough away from the trees in autumn, but see to it that the soil around the trunk is high enough so that no water will remain there.

(4) It is very probable that on exposed positions peach trees could be saved from this trouble and also from root-killing by first banking up a little earth around the trunk and then placing about six inches deep of manure around this for a width of two or three feet. It is better not to have the manure in contact with the trunk itself.

(5) Where trees are only partially girdled, especially apple trees, it is a good plan to remove the dead bark and cover with coal tar the wood thus exposed. Rotten bark favours the entrance of fungi, hence the reason for its removal.

BLACK-HEART.

After a very cold winter or after sudden extremes of temperature many apple, pear and peach trees will, on examination, be found to have their wood killed and darkened, even though the bark and cambium are still alive. Young trees, including nursery stock, are more subject than old trees to this trouble, but the branches even of old trees may be affected. Where the injury occurs in the same tree a couple of years in succession, or where rot-producing fungi get entrance through

some wound into the wood, the tree may become so brittle and weak that it will break off as a result of any slight strain. Such trees are, of course, worthless. Very often, however, trees, especially bearing trees, may be black-hearted, and yet live and bear good crops, though there is a great tendency on such trees for large branches to die from time to time. Some varieties of apples and pears are much more subject than others to Black-Heart; in fact the more tender the variety the more subject it seems to be to this disease. Peach trees, owing to the rapidity with which they make new wood, recover more fully from Black-Heart than apples or pears.

Methods of Control. (1) Do not plant any variety that experience shows is too tender for your district. Baldwins especially should not be planted in the colder portions of the province or in counties subjected to great extremes of weather. Some of the hardiest good varieties of apples are Duchess, Yellow Transparent, Wealthy, McIntosh, Fameuse and Tolman.

(2) Avoid late cultivation and over-fertilizing, (see under Collar or Crown Rot), yet on the other hand the trees must not be weakened by starvation and neglect. A golden mean is what is desired.

BARK SPLITTING ON TRUNK.

This is moderately common. Fruit growers used to believe that it was due to trees being as they called it "hidebound," but it is now known to be caused by a great sudden drop of the temperature which contracts the bark much more rapidly than the sapwood, with the result that it gives way at some one or more places, and once a rupture occurs the splitting readily extends up and down with the grain of the bark. Deciduous shade trees are also subject to bark splitting. Sometimes the splitting extends into the wood for some distance, but usually it is only the bark that is affected. In some cases the bark is not only split, but is also torn away from the wood for an inch or more on each side of the split.

Methods of Control. (1) Trees that have made a very great growth and are not hardened for winter seem to be more subject to splitting; hence the remarks above on avoiding late cultivation apply here.

(2) If the bark has separated from the wood it will be well to remove it back to where the union is intact and to paint the exposed wood with white lead. Cracks may be filled with grafting wax to keep out water. Trees are not often killed by this form of winter injury.

CROTCH INJURY.

In the colder portions of the province many trees are injured during winter at the crotch or fork, the bark at this part being killed. Bark at crotches is apparently more tender than on trunks or branches. If this dead bark is allowed to remain, and if there is not good drainage to carry off moisture, it will not be long until rot-producing fungi will gain entrance and cause the wood itself to decay, with the result that one or more large branches may break off or the whole tree be ruined.

Methods of Control. (1) Hardy varieties are not nearly so subject as tender varieties to this injury, hence in the colder districts too great care cannot be taken to set out only varieties that will be suited to the climate.

(2) When forming the head of young trees, distribute the main branches so that they will not come out together and thus form a weak crotch. It is a good plan to have a central leader for the lower part of the head.

(3) Where crotch injury appears, remove the dead bark and paint the wound with white lead or cover with grafting wax. Never use cement in a crotch, as it will crack.

KILLING BACK OF NEW GROWTH.

It is a very common thing, especially after a severe winter, to find that numerous twigs, especially on peaches, have been killed by winter. The killing may extend two feet or more back from the tip. Trees that made a late growth in summer and autumn are usually the ones that suffer most.

Methods of Control. The general principles in regard to cultivation and fertilizing mentioned under Collar Rot apply here. If time permits the dead twigs should be cut out as soon as observed.

KILLING OF FRUIT BUDS.

Nearly every year many fruit buds on peaches are killed, though the leaf buds are uninjured. This is the chief reason that peaches require a mild climate. Cherry and plum buds are also subject to winter killing, but will stand much greater extremes than peaches. The killing of apple and pear buds is not common. If a dead peach bud is cut through with a sharp knife, the centre will be seen to be brown or black.

Bud killing seems to be due chiefly to a sudden great drop or drops of temperature. If the buds have become somewhat too advanced through the occurrence of very mild weather, such as we often have in January, their destruction seems to take place more readily.

Methods of Control. The presence of a large body of open water by moderating the climate helps to prevent this injury. Apart from the choice of situation, all that one can do would seem to be to follow the well-known good methods of cultivation, fertilizing and pruning. Good air circulation is also valuable; hence in choosing a site for an orchard avoid air pits or places where the air circulation may be expected to be poor. Air drainage is almost as important in an orchard as soil drainage.

KILLING OF BLOSSOMS AND YOUNG FRUITS.

Late frosts during bloom or soon after may destroy numerous blossoms or even young fruits. The latter seem to be just as tender as the blossoms. Sometimes enormous losses are caused by these late frosts. Orchard heaters are used in some countries to prevent this injury. They have not, however, been much tested in Ontario. The question of sites is also important here, as frost is always more destructive where air drainage is poor.

RUSSETING OF FRUIT AND CRINKLING AND RUPTURING OF LEAVES.

Late frosts, soon after or as the fruit is setting, may result in very conspicuous russet bands around apples and pears. These bands may be at the calyx end, or around the middle or nearer to the stem end. They are probably due to frost and moisture combined injuring the skin.

Some years the leaves are much crinkled and sometimes have the upper surfaces separated from the lower through spring frosts. There is apparently no practical method of preventing such injuries.

SPRAY CALENDAR

PLANT AND PESTS.	1ST APPLICATION.	2ND APPLICATION.	3RD APPLICATION.	REMARKS.
<p>APPLE.</p> <p>Scab or black spot, canker, leaf spot, codling moth and other biting insects, scale insects, mite and blister. (Consult bulletins 187, 194, 198 and 219).</p>	<p>Earlier before or soon after the leaf-buds burst, preferably the latter. Use A1 or B. For San José Scale prune severely, scrape off loose bark and drench the whole tree, paying special attention to outer twigs.</p>	<p>Just before the blossoms open. Use A2 or D, with 2 or 3 lbs. arsenate of lead to each 40 gals. of the liquid.</p>	<p>Immediately after the blossoms have all, or nearly all, fallen, and before the early ones close. Use A3 or D, with 2 lbs. arsenate of lead to each 40 gals. This is the application for codling moth.</p>	<p>For Scab, a 4th application about 10 days after the 3rd is necessary if June is wet, also an intermediate one between the 2nd and 3rd with A3, <i>without any poison</i>, if the interval, owing to cool damp weather, threatens to be long. Spraying with the weaker A3 early in August is an insurance against sooty fungus and late scab. If Aphids are annually troublesome, delay 1st application till buds begin to burst, then add Black Leaf 40 or nicotine-sulphate 40 per cent. to A1 or B and cover every bud. For Cankers cut out diseased bark, disinfect and cover with white-lead paint free from turpentine. For Blight on young trees keep suckers rubbed off trunk and main branches and cut out promptly any diseased branches or twigs well below the diseased bark. Always disinfect both cuts and tools with corrosive sublimate (1 to 1,000).</p>



Stage for 3rd application.

Stage for 2nd application.

Stage for 1st application.

PEAR.

Scab or cracking, blight, codling moth, other biting insects, scale insects, blister mite, psylla and slug. (Consult bulletins 176, 187 and 219.)

Shortly before or just after the blossoms open. Use A3 or D, with 2 or 3 lbs. arsenate of lead to 40 gals. of liquid. Just after blossoms have fallen. Use A3 or D, with 2 lbs. arsenate of lead to 40 gals.

PLUM AND CHERRY.

Black knot, brown rot, leaf blight or shot-hole fungus, curculio, slug, aphids and cherry fruit-flies (Consult bulletins 219, 226, 227 and 230.)

Just before or as the buds are bursting. Use A1 or B. For San José Scale see above under Apple. Soon after the fruit is set. Use A2 or D, with 3 lbs. arsenate of lead to 40 gals. Just before the cherries begin to color. Use A3 or D, with 3 lbs. arsenate of lead to 40 gals.

PEACH.

Leaf-curl, scab or black spot, yellows, little peach, curculio, borer, San José scale, shot-hole borer. (Consult bulletin 241.)

Before the buds begin to swell. (All must be done before any sign of bursting of buds.) Use A1 or B. This is usually the only spraying peach trees receive. Soon after fruit is set. Use 2 or 3 lbs. arsenate of lead and 1 or 2 lbs. freshly slaked lime dust with sulphur. To 40 gals. water for curculio. Omit if curculio is not troublesome. About one month after fruit is set. If troubled by Brown Rot use C or dust with sulphur. Good pruning and thinning the fruit help to control this disease.

Note.—A1=Concentrated lime-sulphur strength 1:035=1 gal. commercial to 7 gals. water.
A2=Concentrated lime-sulphur strength 1:010
A3=

B=The old home-boiled lime sulphur, 20.15 formula. C=Self-boiled lime-sulphur. D=Bordeaux mixture, 4.4.40 formula.
1:009 specific gravity=1 gal. Commercial to from 30 to 35 gals. water.
1:008 specific gravity=1 gal. Commercial to from 33 to 40 gals. water.
1:030=1 gal. commercial to 9 gals. water, and

pears subject to Scab should always receive a 4th application 10 days later than 3rd with same mixture. For Blight cut out carefully in winter all blighted branches and twigs, cutting several inches below the diseased part. Also remove and burn trees too severely blighted to save. Throughout growing season watch for and remove promptly in the same way all blighted twigs or branches. Disinfect at once tools and all cuts with corrosive sublimate (1 to 1,000). For Psylla delay in spraying with A1 or B until leaf buds have burst and add Black Leaf 40 or Nicotine-sulphate 40 per cent. to Codling Moth spray if necessary. Arsenate of lead will kill Slugs (3 lbs. to 40 gals.).

For Rot keep fruit well covered with A3 or D or sulphur dust in moist weather. May dust just before picking. For Cherry Fruit-flies (the cause of the little white headless maggots in cherries,) use 3 lbs. arsenate of lead to 40 gals. of water. Apply to all cherry trees just as Early Richmonds are getting a reddish blush, and again to only Montmorency and late varieties about 10 or 12 days later. Cut out and burn all Black Knots in winter and whenever seen in summer. For Slugs see under Pear above. For Aphids on Sweet Cherries postpone the 1st application until the buds are just bursting, and then add nicotine-sulphate 40 per cent. or Black Leaf 40. Good pruning with plenty of sunlight and air help against Rot.

If brown rot is likely to be troublesome use C again about one month before fruit ripens, or dust with sulphur. Destroy mummified fruit in autumn. Remove at once and burn any tree attacked by yellows or little peach and also all suspected trees. Dig out borers at base of tree with knife in May and again in October. For shot-hole borer cut down and burn before April all dead or dying trees or branches, and leave no brush heaps near orchard.

FORMULAE FOR INSECTICIDES

INSECTICIDES FOR BITING AND LAPPING INSECTS.

1. ARSENATE OF LEAD PASTE.

Use 2 to 3 lbs. to 40 gals. of water, or of lime-sulphur or of Bordeaux mixture.

2. ARSENATE OF LEAD POWDER.

Use 1 to 1½ lbs. to 40 gals. of water, or of lime-sulphur or of Bordeaux mixture.

3. ARSENATE OF LIME (Calcium arsenate).

Use ¾ to 1 lb. if in powder form to 40 gals of Bordeaux mixture. Double the amount if in paste form. (There is some doubt yet whether this poison is always safe with lime-sulphur. It is not safe alone).

4. PARIS GREEN.

Use ¼ to ½-lb. with 40 gals. of Bordeaux mixture. (This poison is not safe with lime-sulphur.)

FORMULAE FOR FUNGICIDES

I.—BORDEAUX MIXTURE.

Copper Sulphate (Bluestone) 4 lbs.
Unslaked Lime 4 lbs.
Water 40 gals.

Dissolve the copper sulphate in a wooden or brass vessel with hot water, pour into a barrel and add cold water to make 20 gals.; slake the lime, preferably with hot water; add cold water to make 20 gals. Stir both barrels well and pour lime into the copper sulphate barrel. (Never mix concentrated milk of lime and copper sulphate solutions).

A stock solution of each may be made and kept indefinitely if not mixed:—Dissolve 40 lbs. copper sulphate in 40 gals. of water by suspending just below the surface of the water in a coarse sack. Each gallon of the liquid will now contain 1 lb. copper sulphate. Slake any desired quantity of lime and put into a box or barrel in shaded place, or sunk in the ground. Keep covered with small amount of water to exclude the air. Calculate how much is required for 4 lbs. lime if well stirred.

To test Bordeaux mixture, let a drop of ferro-cyanide of potassium solution fall into a little of the mixture in a saucer. If this causes it to turn reddish brown, add more lime until no change takes place.

II.—LIME-SULPHUR WASH.

1. HOME BOILED (for use on dormant wood only):
Fresh stone lime 20 lbs.
Sulphur (flour or flowers) . . . 15 lbs.
Water 40 gals.

Slake 20 lbs. of lime in about 15 gals. or more of boiling water in a kettle or other boiling outfit. While slaking add the 15 lbs. sulphur made into paste by the addi-

240 divided by 30=8. This means that each gallon of such a wash must be diluted to 8 gals. with water to give us a strength of 1:030, the proper spring strength. For the second application 1:009 is about the right strength. To get it divide the 240 by 9, which gives 26½, or roughly speaking 27. This means that each gallon of a wash of the strength of 1:240 must be diluted to 26½ or 27 gals. to make the right strength for the second application. For the third application and any later ones 1:008 is about the right strength, and to get this we proceed in the same way and divide 240 by 8=30, so that each gallon must be diluted to 30 with water for this application. If the strength of the concentrated were 1:212 or any other number, you would in the same way divide the three figures to the right by 30, 9 and 8 respectively to get the proper dilutions for each spraying.

TABLE FOR CHANGING BEAUME READINGS INTO THEIR EQUIVALENT SPECIFIC GRAVITY READINGS.

Beaume.	Specific Gravity.	Beaume.	Specific Gravity.
18	= 1:141	27	= 1:230
19	= 1:150	28	= 1:240
20	= 1:159	29	= 1:250
21	= 1:168	30	= 1:260
22	= 1:178	31	= 1:271
23	= 1:188	32	= 1:282
24	= 1:198	33	= 1:293
25	= 1:208	34	= 1:305
26	= 1:219	35	= 1:317

Note.—Commercial lime-sulphur should be tested with the hydrometer and diluted according to the same rules as the home-made concentrated form.

INSECTICIDES FOR SUCKING INSECTS ONLY.

1. LIME-SULPHUR.

For scale insects, Blister Mites and Red Spider.

2. TOBACCO EXTRACTS.

For Aphids, Leaf-Hoppers, Peyllas, etc.

(a) BLACK-LEAF 40, strength to use is indicated on the cans.

(b) NICOTINE-SULPHATE 40%. Strength is indicated on the cans. (Practically same as Black Leaf 40).

(c) HOME-MADE EXTRACT. Soak 1 lb. tobacco refuse in 1 gal. water for 24 hrs. with occasional stirring, or steep 1 lb. in 1 gal. water for 1 hr. Make up for water that evaporates. Use at once without dilution: spoils in a few days if not used.

3. KEROSENE EMULSION.

Kerosene (Coal Oil) 2 gals.

Rain Water 1 gal.

Soap 1/2 lb.

Dissolve the soap in water by slicing and boiling; take from fire, and while hot pour in kerosene and churn vigorously for five minutes. For use dilute with 9 parts of water, so that the above 3 gals. of stock emulsion will make 30 gals. of spray mixture.

4. WHALE OIL SOAP.

For brown or black aphids, 1 lb. in 4 gals. rain water. For green aphids, thrip and leaf-hopper, 1 lb. in 6 gals. rain water.

tion of a little water. Boil vigorously, with stirring, for 1 hour. Dilute to 40 gals. with cold or hot water. Strain and apply as once.

2. COMMERCIAL LIME-SULPHUR. (Factory-made concentrated lime-sulphur).

This as purchased is usually about 1.290 specific gravity strength or 33° Baume.

3. HOME-MADE CONCENTRATED LIME-SULPHUR.

This may be used as a substitute for commercial lime-sulphur, but is only about % as strong as a rule.

Sulphur (a fine grade).....100 lbs.

Fresh stone lime, high in

percentage of calcium... 50 lbs.

Water.....40 or 50 gals.

Put about 10 gals. water in the boiling outfit, start fire, add sulphur, stir to make paste and break lumps, then add remaining water, and when near boiling put in lime. Stir frequently while slaking and until all the sulphur and lime are dissolved. Add water from time to time to keep up to 40 or 50 gal. mark. Boil 1 hour, then strain through a screen of 20 meshes to inch into storage barrels. Make enough at once for season's work. Cover well to keep out air, or pour oil of any kind over surface to depth of 1/2 inch for same purpose.

To determine how much to dilute for different applications use a hydrometer with specific gravity readings, and apply the following rule:

Put the hydrometer in the clear liquid when it is cold and the sediment has all been settled for a day or two. Note the number to which it sinks. Suppose this is 1:240. The strength for use before the buds burst should be 1:030 or stronger. To determine how much to dilute a strength of 1:240 to get 1:030, divide the three figures to the right in 1:240 by 30, that is

1. SELF-BOILED (chiefly for use on peach foliage).

Fresh stone lime 8 lbs.

Sulphur (flour or flowers) .. 8 lbs.

Water 40 gals.

Best prepared in quantities of 24 lbs. at a time to get sufficient heat. Place 24 lbs. lime in a half barrel, add enough cold water to start it slaking well and to keep the sulphur off the bottom. Dust the 24 lbs. sulphur over the lime, having first worked the sulphur through a screen to break lumps, then add whatever further amount of water is necessary to complete the slaking. Stir well with a hoe to prevent the lime caking on the bottom. As soon as the slaking is over, add enough cold water to cool the whole mass and prevent further combination. Strain into spray tank. Keep well agitated while spraying.

5. DUST.

For biting insects and fungus diseases the substances used now are 85 to 90% of sulphur and 10 to 15% of arsenate of lead powder. Dusting at this date (1917) is only in experimental stage.

III.—DISINFECTANTS (for pruning tools and for wounds on trees):—

1. CORROSIVE SUBLIMATE, 1 part to 1,000 by weight=1 tablet to 1 pint of water.

Apply with a swab on end of a stick.

Caution.—Corrosive sublimate is a deadly poison to man or beast if taken internally. It will also corrode iron or metal, so use in a glass or wooden vessel and be sure to wash these out very thoroughly when through using them.

2. LIME-SULPHUR about twice strength, or bluestone, 1 lb. dissolved in about 14 gals. water, may be used to disinfect wounds or cankers, but is not satisfactory in case of Pear Blight.

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