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Diseases of the Apple, Cherry, Peach, Pear and Plum; With Methods of Treatment.

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INTRODUCTION.

The rapid increase in the fruit growing industry in this State within recent years has made it necessary that more and more attention should be given to the diseases of these plants by the Experiment Staation and the fruit-growers themselves. A large number of letters reach this department during the year asking for information regarding these diseases and the best method of controlling them and these letters cannot in most cases be properly replied to by letter alone. They indicate also a growing interest in these matters and seem to indicate that the time has arrived to place before our people such information as is now available regarding these matters. To supply this evident need this Bulletin has been prepared.

We have thought it best to depart somewhat from the common method of presenting such matters and have made the attempt to arrange the facts and suggestions under such definite headings as will best serve to indicate what sort of information must be had before one can hope to successfully control diseases of cultivated plants. More than this we have looked upon the diseases from the standpoint of the diseased plant and have included, therefore, no statements regarding the organism causing the diseases where this would not conduce to a clearer understanding of the disease itself and particularly of the methods of treatment suggested. The science of plant pathology owes much to mycology but its future advance and recognition depends upon its rather more sharp differentiation from "economic mycology."

The plants are arranged in alphabetical order by their common names and under each are given, also in alphabetical order, the most important diseases of these

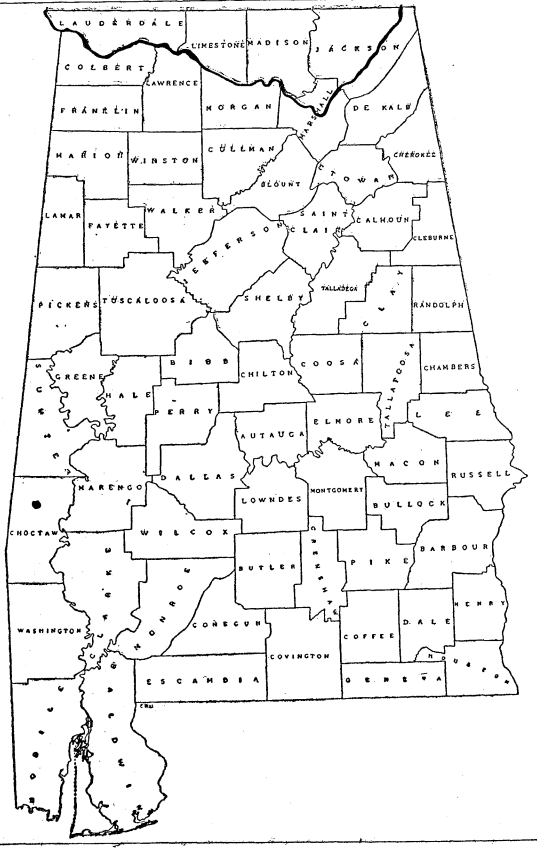
plants in our region. We have introduced no new common names for any of these diseases, but have employed the common names now in most common use or that are sanctioned by the leading authorities upon this subject. In cases where the same disease is known on more than one of the plants mentioned reference to the disease will be made under each, but its full description will be presented under the first plant mentioned or in connection with the plant in which the disease is here best known. If the disease shows specific differences in the different plants attacked mention of the facts will be recorded under each plant concerned. Methods of treatment are discussed under each disease and no "spray calendar" is given. It is believed the plan here adapted has several and peculiar advantages over the other method.

We have placed at the close of the discussion of each disease a bibliography of the disease. This bibliography is in no case complete, but is simply a select list of the more original and recent literature dealing with this subject. The majority of these references are to the literature of the State Experiment Stations and the Department of Agriculture. To these and other sources I am indebted for information here presented and the references to this literature are here included to show readers of this Bulletin that further reading and study of this matter of plant diseases may readily be made in the publications mentioned that may in most cases be had for the asking.

One of the principal purposes of this Bulletin is to enable fruit growers to recognize some of the common diseases of the plants mentioned in order that they may assist this department in securing data each year of the distribution and severity of the diseases in the various counties of the State. The method employed here in recording this information is well shown by the figures on pages 82 and 83. The first one shows the front and the last one the back of a record form so made as to be employed in a regular loose

leaf holder. We wish specimens and information regarding each disease from every county of the State where it is to be found and shall be glad to afford any who care to assist us in gathering this information any special directions they may desire. Specimens of diseased conditions of any plant are at all times desired and these and letters regarding such subjects should be directed to the Department of Plant Physiology and Pathology of the Experiment Station.

CROP DISEASE YEAR



(Devised by E. Mead Wilcox, 1904.)

NOTES.

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APPLE.

BITTER ROT.

History and Distribution.

The bitter rot of apples, known also as the ripe rot or anthracnose of the fruit, certainly made its appearance in America previous to 1867 and has attracted much attention from that time to date. In the United States the disease is found in practically every State east of and including Kansas, Oklahoma and Texas; the most serious outbreaks of the disease have occurred in Oklahoma, Indian Territory; southern Illinois, Ohio and Indiana; Kentucky, West Virginia, Virginia, eastern North Carolina, western New York; Delaware, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New Jersey and Alabama.

The fungus causing this disease may be fairly said to be found the world over wherever the apple is grown and, in addition to the apple, has been found on the following hosts: pear, tomato, grape, peach, nectarine, apricot, pepper, egg plant and squash. It remains to be determined whether the fungus occurring on these various hosts is identical.

Symptoms.

The bitter rot or ripe rot of apples is a fungus disease of the ripening fruit producing in another form a canker of the smaller limbs of the apple tree.

The first sign of the disease is to be found in the form of a small discoloration just beneath the skin of the apple. This spot, as it enlarges, becomes more and more sunken and the rotting of the apple proceeds towards the core. When the spots reach a size of about a half inch in diameter small blackish bodies appear in a circular arrangement beneath the skin of the apple (Plate I, Fig. 1.). These blackish

bodies are the fruiting bodies of the fungus and soon project from the surface of the diseased spot. As these fruiting bodies break through the surface of the apple the spores produced in them are allowed to escape. The spores are held together in the form of stringy pinkish masses which are quite conspicuous, particularly on dry quiet nights when the spore masses are oozing out.

As the disease progresses other rings of fruiting bodies will appear outside of the one first formed and in time there may be a half dozen or more of these concentric rings. If the climatic conditions are unfavorable to the rapid development of the fungus the rings of the fruiting bodies will not be so definite or may be absent entirely. From the original point of infection the fungus may grow out until the whole apple is rotted—though there is at all times a rather sharp line of separation between the healthy and diseased portions of the fruit. If infection occurs at more than one point the rings of fruiting bodies from the several infections will ultimately unite with one another.

The general effect of the fungus is to hasten the maturity of the apple and lead to the well known falling of the apples. This falling may occur at any stage in the development of the disease. In fact the premature falling of the fruit is one of the most conspicuous symptoms of this disease.

During the summer of 1902 a Mr. Simpson, of Illinois, a large fruit grower of that State, noticed that in many cases there was to be found a canker on the limb that he suspected of being the source of infection from the fact that the canker was often found at the top of an inverted cone formed by the diseased apples on the tree. A careful investigation of this matter by Blair and Burrill and by Von Schrenk and Spaulding has established this suspicion of Mr. Simpson as a fact. They were able to produce the typical bitter rot by inoculation of healthy apples with spores produced in these limb cankers and also to produce the limb canker through inoculation with spores obtained from dis-

eased apples. This very important discovery introduced into the treatment of the disease a new factor of immense importance.

These cankers appear most generally on the smaller limbs and their general appearance is well shown in Fig. 2 on Plate II. There are other cankers of apple trees and of other trees due to various causes, but whenever the bitter-rot of apples is found on trees on which cankers like those shown in the above figure occur the removal of the cankers would be advisable even in advance of a demonstration of the connection between the two troubles.

Relationship of Disease to Climatic Conditions.

The first appearance of the trouble on the apple may be expected during July in this latitude, though in the northern apple growing districts this is generally delayed until August. The exact time depends much upon the climatic conditions that prevail at the time and during the spring.

The green fruit is generally quite immune, a fact that may be due to the larger amount of malic acid in immature fruits as compared with ripe fruits. And it is this rapid destruction of the ripe fruit just when the owner is about ready to gather in the crop that makes the trouble so much dreaded!

Warm and sultry weather affords the best chance for the rapid development of the fungus and the appearance of a regular bitter rot epidemic. On the contrary in cool dry summers the trouble need not be much feared. Nights with much dew alternating with hot days will greatly promote the development of the fungus.

The time of first appearance of the trouble on the fruits may also be much influenced by the condition of the spores, as to ripeness, in the cankers and the mummies, to be described later. If a cold spring has delayed the formation of these spores then the rot will be late appearing on the fruit itself.

Economic Importance.

We cannot do better to emphasize the importance of this disease than to mention the statement of the President of the National Apple Shippers' Association who said, "the damage to the apple crop of the United States in 1900 from bitter rot was $10,000,000.00." The destruction of 75 per cent. of the crop by this disease is not very unusual and in many cases the owners of apple orchards have preferred to lease the orchard for a mere trifle than to run the risk of getting no returns at all. Von Schrenk and Spaulding say, in speaking of this disease, that "It has probably done more to discourage apple growing in many regions than all other troubles, including both fungus and insect diseases combined." In our State the disease has caused great losses in many places, but so far no very systematic attempt has been made to control the disease or to determine its exact distribution.

Aetiology.

The bitter rot of apples and the associated canker of apple limbs are produced by the fungus now known as *Glomerella rufomaculans* (Berk.) Spaulding and Von Schrenk.

Remedial Measures.

The treatment against this disease may, in the light of our present knowledge, be grouped under three headings: (1) removal and destruction of all diseased apples from the tree and from the ground, (2) removal of the cankered limbs, and (3) spraying with the regular Bordeaux mixture as directed below.

The spores formed on the apples that fall to the ground during the season and those on the apples that dry up to form mummies on the tree may live over the winter and thus constitute sources of new infection during the following spring. If only a few trees are infected it will cer-

tainly pay well to watch the spread of the disease and immediately pick and destroy by burning or burying in the ground every apple as soon as the disease appears upon it. In this way the further spread of the disease to other trees in the orchard will be largely prevented. And then all rotten apples on the ground should be gathered up and destroyed.

The limb cankers should be removed during the late fall or winter as they can then be seen more readily than they can when the trees are in leaf. If cankers are found on the smaller limbs as is generally the case, these limbs may be removed entire, but if found on the trunk or very large limbs it may be best to carefully cut out the cankered portion and paint over the wound carefully with white lead paint of tar. It seems certain now that the removal of all these cankers will do much to lessen the spread of the disease in the orchard by removing one of the sources of new infection.

In addition to the two above named precautions the trees should be carefully sprayed with Bordeaux mixture at least once before the buds open and then at intervals of ten days until the fruit is about ripe.

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*This Bulletin bears the date November, 1902, on its cover, but within contains the statement "Issued February 20, 1904."

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BLACK ROT.

This disease has been known for some time being reported from Illinois for example as early as 1878. It probably occurs in every apple orchard and is often confused with the bitter rot.

Symptoms.

Brownish decayed spots appear on the apple generally near the stem and often near the flower end. This rotted area soon turns black and the rotting proceeds towards the center of the apple. There is no such sharp demarkation between the rotten and healthy portions of the apple as exists in the case of the bitter rot and this is one method of distinguishing the two diseases from each other. The surface of the decayed spot becomes somewhat depressed.

Finally the apple shrivels up more or less and becomes a small and hard "mummy."

This disease does not occur as a rule on green apples except in cases of injury to the apple by wounds or insects. It is often abundant on "windfalls." It is also one of the chief causes of rotting of apples in the market.

On the leaves the same fungus often causes rather serious damage through the formation of rather large and irregular brownish spots.

The old dead twigs on unpruned trees may often become breeding places for this fungus from which spores may be scattered by the wind. The fungus was once thought to live on the twigs merely as a saprophyte but is now known to cause a serious canker of apple twigs. (See Canker of Apple on page 91.)

Aetiology.

It is produced by the fungus *Sphaeropsis malorum,* Berk. The fruiting stage consists of numerous rather small black pustules that develop on the surface of the diseased apple. The pustules develop as a rule only after the rotting is fairly well advanced.

These pustules are roundish conceptacles, with black or purplish walls, containing the spores. The spores ooze out as small white threads. The spores are at first white, but soon become deeply colored.

Treatment.

The disease may be controlled by spraying with Bordeaux mixture, making the first application before the leaves appear and subsequent ones at intervals of about two weeks. (See Fig. 6 on Plate II.) Decayed fruit should be removed from the trees and the ground and destroyed and "mummy" fruits should not be allowed to remain on the tree over winter.

Since the fungus causing this disease is also shown to

be the cause of a canker, care should be taken to remove or treat cankered limb as suggested under the bitter rot.

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CANKER.

History and Distribution.

This disease was first reported from New York State, but is now known to have a much wider distribution. The fact of its being caused by the fungus producing the well known black rot of the apple, pear and quince fruits would naturally lead one to suspect that the distribution of the canker would be coextensive with the black rot.

Symptoms.

In general a canker may be said to be the result of any "injury that destroys the bark and lays bare portions of wood." (Bull. 170 N. Y.) This particular canker is due to the action of a parasitic fungus that attacks principally the larger limbs. The trouble may be detected from the swollen appearance of the limbs and the rough dark colored bark. (Plate VII. Fig. 19.) Frequently in severe cases of canker the wood itself may be exposed and thus decay of the wood itself begins. The extent to which the canker affects the bark varies apparently with various conditions, but may be several feet.

The effect upon the tree is due to the interference with the circulation of the sap and the amount of injury will of course be in proportion to the surface area of the cankers. The tree may be simply weakened or may be killed outright.

Aetiology.

This canker is caused by the fungus *Sphaeropsis malorum* Pk.

Treatment.

Cankered limbs should, if possible, be removed and burned. Where the cankers are found on the trunk or very large limbs it may be advisable to cut out the diseased spot and paint over the wound with some sort of paint or wash.

When spraying with Bordeaux mixture for other apple diseases if canker be present it would be advisable to thoroughly cover the limbs with the spray mixture.

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FLY SPECK.

History and Distribution.

This disease, often referred to as "flies" and "blackbirds," was first reported in scientific literature in 1896 from Delaware. It is at present no doubt to be found practically wherever the apple is cultivated.

Symptoms.

This fruit disease is marked by the appearance upon the fruit of a number of small spots of specks (Plate II. Fig. 5.) in areas that may be 1-4 of an inch or more in diameter. The skin of the apple around this area may become rather cloudy in color and if many of the areas unite with each other the whole surface of the apple may become sooty in appearance. The effects of the fungus do not extend below the surface of the apple, but in the most severe cases the apple may become somewhat shrivelled owing to the action of the fungus causing the disease.

The claim is made that the disease will spread upon apples in storage.

Aetiology.

The disease is due to the fungus known as *Leptothyrium pomi* (Mont. & Fr.) Sacc.

Resistance of Varieties.

This disease appears in ordinary seasons most severely upon the fruit of trees planted in low damp situations. During a very wet season, however, all sorts of trees will be apt to be affected without reference to their situation or resistance. Rhode Island Greening, Rome Beauty and Peck's Pleasant are very frequently badly injured by this disease.

Treatment.

One thorough spraying with the ordinary Bordeaux mixture when the apples are half grown or less will prevent the injury from this disease. In the case of smooth skinned apples this spraying should be done somewhat earlier to prevent the so-called "russetting" of the apples caused by the fungicide itself. See also treatment for sooty blotch.

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HAIRY ROOT.

History and Distribution.

This disease was first reported by Stewart, Rolfs and Hall from Western New York in 1900, but is no doubt much more

widely distributed than our records in the literature show. We have here in Alabama a very similar if not identical disease of apple and peach.

Symptoms.

The affected trees have few or no large branch roots. The root system of the tree instead consists of a number of groups of hair-like fine roots springing from the main tap root. Fig. 16 on Plate VI shows one of the common forms of the disease.

Aetiology.

The cause of the disease is at present unknown. It may be associated with attacks of wooly aphis or with the crown gall, but may occur independent of both of these troubles. It does not seem with us to be found associated with any type of soil. Specimens of this disease are much wanted.

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RUST.

History and Distribution.

Apple rust is widely distributed and may be expected wherever apples and cedar trees are growing in close proximity to each other. In Alabama the rust is in many sections one of our most serious apple troubles.

Symptoms.

The disease may readily be detected by the circular yellowish spots (See Fig. 4 on Plate II.) that appear on the

leaves in May or June. Similar spots may also appear on the fruit.

Aetiology.

The apple rust here is produced by one stage of *Gymnosporangium macropus,* the other stage of which lives on the red cedar causing there the so-called "cedar apples, shown in Fig. 3 on Plate II. The spores produced in the gelatinous out growths from these gallls in early spring are the source of infection of apple leaves.

Treatment.

Spraying seems to be of no value in controlling this disease. Since cedar trees harber one stage of the fungus causing this disease it is of course advisable to remove the "cedar appless" or if possible the cedar trees themselves. A little attention to this matter will dispose of he rust problem in apple orchards.

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SCAB.

History and Distribution.

It has been known as a serious apple disease since the early part of the 19th century. For example Curtis recorded it as common on apples in North Carolina in 1867. In this country its greatest injury seems to be in the Mississippi Valley. In this State no definite attempt has ever been made to the writer's knowledge to control it by spraying and in fact it has never attracted any great attention.

Symptoms.

Scab first makes its appearance early in the spring soon after the first leaves begin to unfold. It is during this time that the greatest amount of infection occurs, though there is a second period of infection in the fall which is largely responsible for the production of the mature winter stage. The scab may often be seen on the leaves and fruit of the lower branches showing that the probable source of infection was to be found in the leaves on the ground on which the fungus had wintered over. The first spots on the leaves are often on the lower side near the midrib—this being the first part of the leaf to be exposed while the leaf is unfolding.

On the Leaves.

The scab here is found in the form of roundish spots about 1-4 inch in diameter. Frequently several of these spots may unite with one another—particularly if they are near a large vein or the midrib where the fungus seems to grow more rapidly than elsewhere on the leaf. The spots have an olive green color.

On the Fruit.

The scab spots are roundish 1-8 to 1-2 inch in diameter and of an olive green color—frequently with a lighter colored margin. These spots may coalesce to some extent if conditions are such as to favor the growth of the fungus. The scab fungus grows more rapidly on young fruits than on older ones—due no doubt to the fact that the cuticle of the younger apples is more delicate. Old fruits for the same reason are not very apt to become infected. The cuticle over the "scab" may later in the season become broken and flaked off, exposing the dead tissues of the apple and giving the scabbed area a reddish brown color. The fungus also frequently causes the formation of a considerable amount of corky tissue—which in turn protects the apple from becoming infected at the scab spot by other fungi.

Winter Stage.

When the diseased leaves fall to the ground in the fall the mycelium that during the summer was confined to the space just beneath the cuticle, grows down into the tissues of the leaf. The deeper penetration into the leaf is made possible by the death of the leaf and the consequent partial decay of its tissues. These hyphae take on a reddish olive color and the cells composing them are larger than those formed during the summer. The fruiting bodies, perethecia, of the fungus are formed within the leaf. The spores are ripe by April or May and ready to produce the spring infection. Perethecia are often formed near the small spots on leaves produced by the autumn infection. The pustules are scattered or more generally gathered together in groups on a grayish spot that may mark the spot of the summer's scab. This stage of the fungus is not found elsewhere but on the leaves.

TREATMENT.

The scab may be prevented by spraying with Bordeaux mixture as follows:

(1.) Spray with Bordeaux mixture just before the flower buds open.

(2.) Spray again just after the blossoms fall.

(3.) Spray 1, 2 or 3 more times at intervals of about 10 days.

The following results secured by Jones & Orton in Vermont, show the immense profits in spraying for the apple scab. They sprayed as follows:

1. April 27. Buds not open; with solution of copper sulfat 1 lb. to 20 gallons.

2. May 18. Leaves out—flowers not open; Bordeaux "1—10" to which was added 1-3 lb. paris green.

3. June 15. Blossoms fallen.

4. July 18.

5. August 3.

Comparison was made of trees sprayed five times and those sprayed three times (the last two sprayings being here omitted) and trees not sprayed at all. The following table shows the results clearly:

	Per cent. on the tree.	Per cent. fallen.	Total value of crop per tree.
Sprayed 5 times	60	40	$15.44
Sprayed 3 times	51	49	7.38
Not sprayed	33	67	2.15

When account is taken of the fact that the fungus causing the disease may winter over on the fallen leaves it appears advisable to rake up and burn fallen leaves at the close of the season.

The gain from spraying may fall into the following classes:

(1.) Actual gain in yield per tree.

(2.) An increased percentage of "selects" and No. 1." apples.

(3.) Prevention of falling due to scab .

(4.) Increase in vigor of the tree itself.

(5.) Reduction of the loss, often very serious, resulting from the attacks of various fungi causing a rotting about the scab spots of storred apples.

Influence of Weather.

The greatest injury from the scab may be expected during seasons having a cold damp spring. The amount of the injury in any given season is also no doubt in a measure dependent upon the amount of the mature *Venturia* stage produced on the fallen apple leaves—this in turn being influenced by the climatic conditions prevailing during the preceding fall and winter.

Aetiology.

Apple scab, a disease affecting the leaves and fruits of the apple, is caused by the parasitic, summer stage, *Fusicladium dendriticum,* of the fungus *Venturia inaequalis.*

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SOOTY BLOTCH.

History and Distribution.

This was first reported by Sturgis in Connecticut in 1898 on Rhode Island Greenings and Newton Pippins. It is now very widely distributed and together with the fly-speck disease, with which often associated, causes much damage to apples particularly during wet seasons or where trees are planted in low damp soil.

Symptoms.

The disease appears as irregular blotches (Plate II. Fig. 5.) upon the surface of the apple—these blotches are at first pale, but soon become sooty black in color and under a lens show a radiating appearance due to the manner of growth of the fungus causing the disease. No rotting of the fruit occurs since the fungus works entirely upon the surface of the fruit. It may with the fly-speck disease greatly reduce the market value of the fruit.

Treatment.

Both fly-speck and sooty blotch will be controlled by the

spraying against the scab. It may be necessary, however, to give one or two sprayings later in the season, say in July.

Aetiology.

The fungus causing this disease is generally referred to *Phyllachora pomigena,* though this matter demands further study.

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(In addition to the following consult the Bibliography given under Fly Speck.)

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CHERRY.

BLACK KNOT.

History and Distribution.

Black knot has long been known and the extent of its injuries has frequently been brought home to plum and cherry growers in no uncertain manner. The plum industry of the famous Hudson river valley (N. Y.) was practically wiped out by this disease. Farlow, 1876, was the first to determine its exact cause concerning which the most various opinions had previously been entertained.

Its most serious injury has frequently been to plums, but cherries are by no means exempt. DeSchweinitz mentions

an epidemic of this disease that destroyed the cherry trees about Bethlehem, Pa., in 1790.

Symptoms.

The black knot is a rough wart-like outgrowth (Plate VII. Fig. 18,) from the bark of twigs and branches in severe cases extending along the trunk for several feet. The first symptom is the swelling of the tissue just beneath the bark. This enlargement increases during the fall or growing season until the bark is ruptured. This exposed portion of the twig is soon covered with an olive green velvety coating composed of the reproductive hyphae of the fungus. A microscopical examination of the diseased portion at this time would show numerous erect hyphae bearing spores—the so-called summer spores. These are readily carried about by the wind and other agencies and serve to spread the disease during the growing season.

Later in the season the production of summer spores ceases and the velvety covering gradually disappears. The surface of the wart gradually becomes hardened and altered in color to a dark brown and finally to a dead black.

Pimples may be seen late in the fall covering the wart. In these are developed the winter spores called ascospores. These ascospores only develop during the winter and are capable of germination in February and March.

Aetiology.

The disease is due to the fungus *Plowrightia morbosa.*

Treatment.

The diseased twigs should be removed after leaf-fall or before the winter spores are formed. Twigs that show in the spring or early summer the beginning of a "knot" should be removed and burned to prevent the formation of the summer spores. If such knots are simply cut off and allowed

to remain on the ground the summer spores may ripen and then be scattered to other trees.

Co-operation of entire neighborhoods must be secured to render the campaign against the black knot effective. Legislation has been resorted to in several States, but a healthy and intelligent public opinion is necessary in this as in many cases.

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GUMMOSIS.

Among the stone fruits such as cherry, peach and plum a "gum-flow" or gummosis is frequent and may become a serious menace to the life of the trees affected. This disintegration of the tissues of the affected plant may be brought about by a variety of causes. Hence gummosis is a generic term applied to the condition here described whatever be the cause. Massee has described a gummosis of the common flowering almond (*Prunus japonica*) due to the action of a parasitic fungus, and this seems to be the only case of gummosis so far demonstrated to be due to a parasitic fungus.

Excessive gum flow frequently leads to the formation of a canker. (See plum canker, page —.) Reports of outbreaks of gummosis in any of the trees mentioned will be gladly received.

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LEAF SPOT.

History and District.

This disease occurs widely distributed on the leaves of cherry, plum and apricot and is frequently referred to as leaf blight.

Symptoms.

Minute spots at first appear soon after the first leaves are full grown and these are often only 1-6 inch or less in diameter. On cherry and plum leaves the spots may have a reddish margin. The spots enlarge to 1-8 inch or more in diameter, (See Fig. 21 on Plate VIII,) becoming at the same time dark and with a pale center. Often the diseased spots fall out of the leaf causing a shot-hole effect and then called "shot hole" disease. (See Plate VIII.)

The tree may become defoliated through the action of this disease and in that case may be much weakened so that it is more apt to be injured during the following winter. The damage in this direction is much greater if the defoliation occurs, as it is apt to in the plum, when the tree is in fruit.

Aetiology.

This disease is caused by *Cylindrosporium padi.*

Treatment.

The leaf spot may be controlled by the proper spraying with Bordeaux mixture, but in the case of the cherry the application of the spray at the time the tree is in fruit, the best time to control the disease, may cause the fruit to be stained with the spraying mixture so as to reduce its market value. However, it is well to apply Bordeaux just before the blossoms open and again just after they fall to partially control the leaf spot and fruit rot.

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PEACH.

BROWN ROT.

History and Distribution.

It has been known as a serious enemy of the peach in the United States for over 20 years and in Europe for even longer. Whenever peaches, plums or cherries are grown in this country the brown rot is a most serious pest. During certain years the loss is made most noticeable by favorable weather conditions. Thus in 1900 the loss to the peach crop in Georgia was estimated to be 40 per cent. or from $500,000 to $700,000. Similar losses are reported from other places. In Kentucky it has been reported as a rather serious disease of apples, but with us it seems to be confined to the peach, plum and cherry. It has also been reported on the pear, quince and apricot in addition to the above.

Symptoms.

On the Flowers.

Under favorable climatic conditions the disease may attack the flowers before or after the petals have fallen. At first a slight discoloration will appear on some part of the flower and soon this spreads so as to give the whole flower a brown and withered appearance. In Alabama during 1897 an epidemic of this disease of the peach flower appeared that practically destroyed the peach

crop for that season. Foggy, rainy and very warm weather were the conditions then prevailing that made possible the germination of an unusual number of the spores, derived, as usual, from the old diseased "mummy" fruits adhering to the trees. The spores formed on the diseased flowers were then sources of infection for any fruit that was later developed.

On the Twigs.

On the peach and plum, particularly the peach, the mycelium of the fungus may grow down into the twigs from the flowers or fruits that are infested. This condition of affairs is often referred to as the "twig-blight" of the peach. (See also canker of plum on page 131.) If only one or two peaches are found on a twig the twig is apt to become infected at only one point and thus be girdled by the fungus, resulting in the death of the uninfested terminal portion of the twig. If several infested fruits occur on the twig it may become infested throughout its entire length.

On the Fruit.

Small brown spots appear—these rapidly enlarge and whitish tufts of spore-bearing hyphae may appear. The peach may fall to the ground or simply shrivel up and remain attached to the tree. (See Plate III.)

In the case of the plum the fruit may be infected for some time before any external evidence appears. As the plum begins to ripen, however, the ash grey tufts of spore-bearing threads appear. This difficulty of distinguishing between infested and healthy plums leads in many cases to serious losses in shipping these fruits.

Peaches also often suffer en route to market from this rot—particularly if the refrigeration is not properly attended to.

Treatment.

The brown rot can be effectually controlled by two lines of treatment: (1) spraying with Bordeaux mixture as explained below and (2) removal and destruction of all affected fruit from both the tree and the ground.

The trees should be sprayed with the Bordeaux mixture as follows:

1. Just before the buds open.
2. Just after the blossoms fall.
3. Ten days to two weeks later.
4. Keep the fruit covered with the Bordeaux mixture until ripening begins and then employ either the ammoniacal copper carbonat or a solution of dibasic copper acetat made by dissolving six ounces of the salt in fifty gallons of water. These two mixtures will not injure the fruit.

Too much stress cannot be placed upon the absolute necessity of removing from the tree all the diseased fruits since these are sources of infection and their presence upon the tree may lead to most severe attacks of the twig disease produced by this same fungus. The fruits that are allowed to fall to the ground after rotting may serve as the home of the perfect stage of the fungus and act as sources of infection during the next spring. Mummy fruits (Fig. 8 on Plate III.) should not be allowed to remain on the tree.

Aetiology.

The brown rot is caused by the fungus now known as *Sclerotinia fructigena*—the conidial or imperfect form of the fungus, however, known as *Monilia fructigena,* being the direct cause of the disease. The perfect form of the fungus has been found on old fallen peaches in Maryland and Georgia. Its discovery emphasizes the necessity of removing and destroying all fallen and mummy fruits.

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CROWN GALL.

History and Distribution.

Crown gall is a contagious disease affecting a considerable number of the smaller and larger fruit trees and plants. The disease has been reported upon the following plants: peach, almond, apricot, prune, plum, pear, apple, English walnut, raspberry, blackberry, cherry, poplar and chestnut. It is, however, not at all certain that the galls on all the above plants, though very similar in general appearance, are caused by one and the same organism.

Symptoms.

The gall generally behaves as an annual growth—those that begin in the spring mature the same fall. But in this climate the galls that start in late summer or fall continue their growth through the winter season. It is strictly a nursery disease—seedlings 1 to 6 months old being most likely to become infected. The first gall in such cases generally appears on one side of the main root a few inches below the surface or near the "crown" of the seedling. On larger trees the galls genrally appear on the lateral roots though the crown is also commonly attacked in the case of large trees. (Plate V.)

The wart at first is a light colored clear or translucent mass of succulent tissue frequently attached to the plant by means of a slender stalk or neck. The galls grow very rapidly and the outer surface soon takes on a warty appearance and a reddish brown color. The parts of a gall that become dark colored have lost their power of growth —the discoloration being due perhaps to the action of various fungi attacking the gall. From the surface of such a discorored gall many new smaller outgrowths may appear.

Toward the end of the season the gall becomes badly decayed and may readily be broken away from the plant leav-

ing an ugly deep wound. During the following spring a new lot of gall growth may take place around the margin of the old scar. And if the gall be removed new growth may begin even in the center of the wound thus formed. (Fig. 14 on Plate V.) This process may continue until the resulting wound is so deep that the tree falls of its own weight.

If a section of rapidly growing gall be examined there will frequently be found through it numerous darker colored irregular spots that are centers of more rapid growth. These centers frequently become beautifully twisted nodules of woody tissue—after the gall matures and begins to decay many of thes curious nodules may readily be removed from the outer portion of the gall.

Spread of the Disease.

The disease has been widely scattered over the country by shipments of stock from infested nurseries.

Locally it is known that a single diseased tree may in a few years suffice to infect most of the trees in the orchard. The spores of the parasite are small and may be carried by the air and it is likely that the disease may be communicated from old decayed galls.

The careless wounding of the crown of a tree or the break in the bark produced by escaping "suckers" both make a pathway for the parasite to gain entrance into the tree.

Care should in all cases be taken to see that all removed galls and uprooted diseased trees be burned on the spot and not hauled through the orchard at all.

Aetiology.

Toumey in Arizona gave special attention to the crown gall on the almond and described as the cause of this disease a new species of slime mould which he called *Dendrophagus globosus*. As has been said it has never been demonstrated that this organism is the cause of the widely dis-

tributed crown gall on the various plants that were mentioned above. Toumey was able to communicate the almond disease to the peach and apricot, but failed to do so to the apple. Selby believes that the gall may be communicated from the raspberry to the peach, but Halsted came to the opposite conclusion. Much work remains to be done on this very important disease.

Treatment.

The best advice that can be given fruit growers relative to the crown gall is this—never plant trees from a nursery known to be infested with the disease and never plant trees showing the disease. If a diseased tree is planted it is practically certain that the tree will never amount to anything. And what is even more important one is thereby very likely to introduce the disease into the soil of the orchard. If a bundle of nursery stock has a single crown gall on any of the trees the whole lot of trees should be destroyed.

It is possible that some good may be done by inspecting the orchards annually and removing all galls that have formed at the crown of the trees. After carefully cutting away the gall the wound surface should be covered with a paste made of lime and blue vitriol. But it must be remembered that, though the galls at the crown do the most damage, the smaller galls on the roots, which cannot be removed after planting, will reduce the vitality of the tree. It is therefore certaint hat no amount of after treatment of any sort will make a diseased tree give as large a yield as a healthy one.

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LEAF CURL.

History and Distribution.

The leaf curl of the peach is found practically wherever the peach is cultivated and is one of the most serious of all peach enemies. The total losses from curl in the whole United States have been estimated by Pierce to be as high as $3,000,000.00 in a single year.

Symptoms.

As soon as the young leaf buds begin to open the leaves

show the characteristic roughened surface and deeper green color. This "curling" of the leaves progresses rapidly as the leaves grow (Fig. 9 on Plate IV). A part only or all of the leaf blade may become affected. A mature leaf, affected with curl, may have a reddish color, but generally the diseased leaves become simply discolored.

The fungus also grows inside the terminal portion of the young twigs and causes these to become swollen and to take on a lighter, paler color. These swollen terminal portions of the twigs constitute the only home of the perennial portion of the fungus. The spring infection seems to take place largely from spores formed from the mycelium present in these swollen twigs. The leaves soon become covered with a greyish mealy coating—composed of the fruiting bodies of the fungus. The spores are produced in small sacs arranged parallel to each other and at right angles to the surface of the leaf. These asci are produced on the ends of hyphae that grow out through the epidermis of the leaf. Defoliation occurs soon after spore-formation.

Gummosis of affected twigs is frequently to be seen as a result of the action of this fungus.

The tree attempts to make up for the loss of leaf surface by forcing some of its dormant buds to grow—these buds may grow to give a healthy twig—but at the base will be left the swollen fungus-infested portion—constituting a dangerous source of infection for another spring.

Relationship to the Weather.

The epidemic character of leaf curl has been frequently noticed and attempts made to connect the sporadic character of the disease with some climatic factor. No very definite statements can be made further than the suggestion that the phenomenon referred to can perhaps best be explained as due to the influence of certain climatic factors upon the spores either at the time (a) they are being scattered or (b) during germination and infection of the tree.

Treatment.

Leaf curl may be prevented by

(1.) Spraying with Bordeaux just previous to the opening of the buds in the spring.

(2). Spraying again with weaker Bordeaux as soon as the petals of flowers have fallen; this is to prevent late infection from the ground or neighboring trees.

(3.) Spraying again with weak Bordeaux when the first leaves are full grown or when the spores of the fungus are developing. This is to prevnt summer infection and cover places where spores may lodge to pass over the winter.

Where winter spraying against San Jose Scale with the lime-sulfur-salt wash is conducted this treatment may suffice of itself to hold the curl in check.

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ROSETTE.

History and Distribution.

The rosette is known from a few stations in the West, but is principally known from Georgia and a part of South Carolina. It is found in peaches and almonds and perhaps also in plums. It seems not to have attracted much attention in Georgia until about ten years ago, but is now known to be present in many counties in budded and seedling orchards and also in seedlings growing in out of the way places.

Symptoms.

The rosette is in some respects closely related to the yellows. It may attack only parts of the tree at first, but may appear suddenly in the spring attacking nearly the whole tree at once. In such cases all the leaf buds grow out into compact tufts of leaves or rosettes, whence the name. Fig. 10 on Plate IV shows some of these characteristic rosettes. If a tree is attacked all over it will die the following autumn, but if only one or more branches are first attacked then only the diseased branches will die after a period of about six months. The leaves in these rosettes are generally of a peculiar yellowish color. The lower leaves in the rosette are frequently much larger than the normal

leaves and have inrolled margins and are stiffer than the usual leaves of the peach. These outer larger leaves turn yellow and fall early in the season while the inner leaves are still green. If a tree is attacked in all parts it bears no fruit, but otherwise the fruit born will generally be apt to shrivel up while still green and fall off or it may ripen naturally.

The disease may be spread through budding or root grafting as has been demonstrated by many experiments. However, it is known that mere contact of diseased with healthy tissue is not sufficient to introduce the disease, but there must be a real union of the two tissues.

Aetiology.

Like the yellows the exact cause of rosette is yet unknown.

Treatment.

All trees which show the rosette in the spring should be at once dug up and burned. If any of the diseased leaves have fallen these should be gathered also and burned as they may serve as sources of infection.

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YELLOWS.

History and Distribution.

This distinctly American disease is known to affect, in addition to the peach, the almond, nectarine, apricot and plum. It seems to be widely distributed in the United States.

Symptoms.

"Prematurely ripe, red-spotted fruits, and premature unfolding of the leaf buds into slender, pale shoots, or into branched, broom-like growths, are the most characteristic symptoms of yellows." The reddish spots in the fruit extend from the skin to the stone and their presence is one of the best tests for the disease.

During the first season that the disease is present in any given tree it may confine its attacks to one or a few only of the branches, but in later years other symptoms may appear and these are principally the premature opening of the winter buds. This is most plainly seen in the fall after the tree has lost all its leaves. The shoots may at this time be produced from these prematurely opened buds and are then very conspicuous. Very feeble shoots may also appear on the larger branches of the tree and these also are rather conspicuous on account of their broom like appearance. In the later stages of the disease or when the disease has been present in a tree for several years the yellowing of the leaves may become apparent and this condition has given rise to the common name, but this is not the most conspicuous symptom and has led many to confuse the disease with leaf curl and other diseases.

Aetiology.

The exact cause of the disease is not yet known, though it is generally looked upon as a so-called "physiological dis-

'ease." As to its spread and its infectious nature we are certain. It may be present in a dormant condition in buds employed in the nursery for budding and the disease is often introduced into a new region in just this manner.

The disease is also known to be spread from living and dead trees affected with the disease to healthy trees in the same orchard.

Soil and climatic conditions certainly cannot be charged with the cause of a disease which possesses such an infectious or contagious nature and there is no good evidence to show that the disease is caused by bacteria or other vegetable organisms.

Treatment.

The only line of treatment that promises to control the disease is to dig and burn the roots and entire tree as soon as it shows certain symptoms of this disease. Spraying is of no value and special fertilization of the soil seems to be of no value in its control. "Pits" or seeds from diseased trees should never be employed in a nursery or elsewhere.

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PEAR.

BLIGHT.

History and Distribution.

Pear blight, called also twig blight, and fire blight, is a contagious bacterial disease of pear, apple, quince and other pomaceous fruit trees. It is of very wide distribution and may be found practically throughout the United States east of the Mississippi river. It has been ascribed to the most

various causes, but the complete demonstration of its bacterial nature was made by Dr. Burrill, of Illinois, in 1879.

Symptoms.

This disease attacks the flowers, young fruits and the young twigs and shoots, frequently working its way down through the bark to the larger limbs or even to the trunk itself. The disease has its most prominent symptom in the blackish discoloration of the leaves on the attacked twigs, but the bacteria do not as a rule find their way into the leaves except into the petiole and the larger veins. This discoloration of the leaves occurs in a week or more after the death of the branch on which they are found. (See Fig. 15 on Plate VI.)

There is much variation in the manner the attacked plant behaves or rather in the way the disease works. In some cases the affected twig is simply girdled and in that case the damage is not so great as when the whole twig or branch is killed. The very sudden death and rapid discoloration of the leaves has led many to suppose that the disease spreads in the tree more rapidly than it actually does. As a matter of fact the disease does not spread more than 2 to 10 inches per day in the twigs.

In the spring the blight first makes its appearance in the blossoms causing there the so-called "blossom blight." The most rapid distribution of the disease in the orchard takes place while the tree is in bloom. It is now known that the principle agency in this work is the various bees that visit these flowers for the nectar there found. In this nectar the bacteria causing the blight find a most suitable situation for rapid development. Bees going from flowers whose nectar contain even a few of these bacteria to healthy flowers on the same or other trees are very apt to carry some of the germs and thus rapidly spread the infection.

The disease also gains entrance to the plant through the tips of young shoots or twigs. This form of blight is often referred to as twig blight. In the case of nursery stock

not in flower the disease is more often carried about in this manner.

Aetiology.

Pear blight is now known to be due to *Bacillus amylovorus,* one of the bacteria. This discovery was made in 1879 by Dr. T. J. Burrill. By means of the usual inoculation experiments this has been demonstrated beyond a shadow of doubt. There can never be any blight in the absence of this species of bacteria, no matter how very favorable soil and climatic conditions may be.

It was once supposed that the germ might live over winter in the ground, but that is now known to be false. As a rule the blight ceases at the close of the growing season, but in some cases, particularly where new infection has taken place late in the season, the germs may live over winter in the twigs and slowly push out into the healthy bark during the winter. The blighted twigs hold their moisture longer than healthy twigs and this is naturally very favorable to the germ and besides it is known that the germ may be exposed to a freezing temperature without injury.

In the spring the rapid accumulation of sap in the twigs sets up a flow of gum from the twigs in many cases and if the germs are alive in any of the twigs they are naturally carried out by this gum flow. Bees and other insects are attracted to this gum and by this means the germs are carried to flowers at which point they rapidly multiply in the nectar and enter the twig.

Influence of Environment Upon the Disease.

The pear blight makes best headway during warm moist weather and is more or less retarded by cold, dry and sunny weather. The germ is very sensitive to dryness and in the old, dead and dry twigs the germs will all be found to be dead.

Treatment.

Disease resistant sorts—

Such sorts as the Keiffer and Duchess resist the blight more than the Bartlett and some others and in general the apple is much less injured by the disease than are the pear and quince. There seems to be no need of attempting to breed special resistant sorts when we consider the positive remedial measures mention below.

Cultivation and soil fertility—

In general we may state that a well cultivated, highly fertilized and rapidly growing tree is most apt to be attacked by the blight. The use of too much barnyard manure is particularly dangerous if the soil is already rich in nitrogenous matter. In some cases it may be well to avoid too excessive cultivation. In general any measure that will tend to check the too rapid growth of the tree will tend at the same time to protect the tree against the blight. Heavy pruning in the winter time, since it promotes rapid formation of much new wood in the spring, may also be avoided at times with good results.

Treatment—

The absolute destruction of every blight germ should be aimed at and may be secured by the pruning away and destruction of each and every blighted twig as soon as detected. These may be removed during the growing season, but it is best to do this very thoroughly at the close of the growing season, but before the leaves have fallen. The blighted leaves will then serve as a guide. Most careful inspection of the trees must be made during the winter and again early in the spring before new growth starts to make sure that no cases of living blight are allowed to remain in the orchard. This is important since these cases of blight that are allowed to live over winter are the only starting points for new infection in the following spring.

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*This Bulletin bears on the outside the date, April, 1902, but within contains the statement, "Issued June 30, 1903."

LEAF BLIGHT.

History and Distribution.

This disease has long been known to horticulturists as the "leaf blight" or "scald" of pear and as the "cracking" of the fruit. It occurs practically wherever the pear is cultivated. It was mentioned in this country early in the sixties.

Symptoms.

The prominent symptoms are the premature discoloration of the leaves and their falling off together with the frequent cracking of the fruit. This leaf fall may be sudden or more gradual, extending in the latter case throughout the growing season. Often the leaf fall is accompanied with a second blossoming—both together making a rather severe drain upon the food supplies of the tree.

Small reddish spots are first seen upon the leaves; these spots as they increase in size take upon themselves a more definite circular shape. At maturity the spots are provided with a white to reddish brown center and a darker raised border. The spots may unite with each other and thus the whole leaf may become affected. The spots may come to be seated upon a reddish brown discolored leaf or the leaf may turn yellow. In any case the leaves fall from the tree.

In many cases there is also a so-called "cracking of the pear" produced by the same fungus. Small reddish spots appear upon the fruit and these spots may rapidly increase in number and finally coalesce with one another to give the fruit a very much blotched appearance that will greatly reduce its market value. At the same time the growth of the spots may be accompanied by a cracking of the fruit and of course this cracking may make an entrance for the spores of the rot fungi that may cause much damage. The same fungus often attacks the young twig of the pear. The spots upon the green bark of these twigs are somewhat elongated, sunken and of a black color.

In each of the spots referred to above on either the leaves, fruits or twigs one may see one or more blackish spots just beneath the surface. These spots are the spore producing bodies of the fungus.

The petioles and leaf scales are also frequently attacked.

Aetiology.

This disease is produced by the fungus *Entomosporium maculatum.*

Treatment.

Fallen leaves should be gathered together and burned.

The disease may be controlled by spraying with Bordeaux mixture, as follows:

(1.) When leaves are half grown.

(2.) Three subsequent sprayings at intefvals of two weeks.

The sprayings after the second should be made with ammoniacal copper carbonat to avoid the "russetting" injury to the fruit often produced by the Bordeaux mixture.

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SCAB.

History and Distribution.

The scab of pear is, like the similar disease of apple, very

widespread and well known. It is known from practically every region where pears are grown.

Symptoms.

The symptoms are practically the same as for the apple scab. (See page 97.)

Aetiology.

This disease is due to the fungus called *Fusicladium pirinum.*

Treatment.

The diseased leaves should be plowed under or else gathered together and burned during the fall.

Two sprayings with Bordeaux mixture of the 1-10 formula should be made while the pear leaves are opening. Considerable good in controlling pear scab will result from a spraying with the lime-sulphur-salt mixture as late in the winter as possible.

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PLUM

CANKER.

History and Distribution.

This disease is one of the most serious plum diseases we have to contend with in this State. Its distribution is somewhat uncertain.

Symptoms.

The real canker may be preceded by a gummosis. (See Gummosis under Cherry on page 106.) And this gummosis may be due to one of several causes. But when through gummosis or any other cause wounds of plum trees remain for a long time unhealed a canker may form on the twig.

It is probable that aside from wounding the most frequent source of the trouble is to be found in the attacks of the brown rot fungus. (*Sclerotinia fructigena.*) This fungus, as has been explained, works in the tissues of the twigs, particularly the fruiting spures, and finally may kill such parts. Then gummosis sets in to be followed soon by the canker. The canker may also follow severe attacks of plum pockets.

The Japan plums, being very subject to brown rot, and having soft coarse grained wood, are very apt to succumb to this canker.

Treatment.

The only treatment to be recommended consists in a thorough spraying to prevent the brown rot and plum pockets; and then the removal and burning of the cankered limbs.

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PLUM POCKETS.

History and Distribution.

This disease on account of its very characteristic and striking symptoms has long been known to horticulturists and others. It is very widely distributed throughout the United States and has frequently been forwarded to me from various parts of this State.

Symptoms.

The vegetative portion or mycelium lives over winter in the younger twigs and grows out into the developing ovaries in the spring. All or most all of the parts of the ovary are affected and the action of the fungus is to greatly stimulate the tissues of the ovary so that a very rapid growth takes place. The result is a much swollen, somewhat irregular and spongy body of light yellowish or white color (Fig. 17 on Plate VII.) No stone is developed in this "plum-pocket" but the center is hollow or frequently traversed by loose threads of torn tissue.

The leaf buds and young twigs may also become modified by the action of this fungus to form very irregular spongy swollen objects. In this case the resulting hypertrophy varies with the stage at which the fungus begins its work. If the leaves are not far developed when attacked their normal form may never be attained, but the hypertrophy may affect only a portion of the leaf if its attack is made upon the leaf when partly grown.

Aetiology.

This disease is produced by the fungus *Exoascus pruni*—a species somewhat closely related to the one causing the leaf curl of the peach.

Treatment.

No special spraying treatment can be recommended, though the use of Bordeaux mixture would no doubt reduce the chance of infection. Diseased fruits, buds, leaves and twigs should be removed and burned.

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FUNGICIDES.

Spraying is now looked upon by progressive and successful fruit growers as a necessary operation to be per-

formed if a full crop of fruit of a good quality is desired. In the case of a large and increasing number of diseases spraying has been demonstrated on a large scale to be of immense value. The financial gain from intelligent spraying depends solely upon the number of trees and the diseases prevalent in your orchards.

Spraying is plant insurance and, like life insurance, should be attended to before the disease has gained a foothold in the orchard. All trees should be sprayed every year whether the diseases usually present make their appearance or not.

A large number of formulas have been proposed by various investigators for special purposes. We give below directions in some detail for the preparation of the fungicides now most widely employed in connection with diseases mentioned in this Bulletin.

Bordeaux Mixture.

Bordeaux mixture consists of two essential ingredients, freshly slaked lime and copper sulfat, dissolved in water. The fungicidal action is entirely dependent upon the copper sulfat. The lime is added for the following reasons:

(1.) To prevent injury to the foliage.

(2.) To render the mixture more adhesive.

(3.) To render the mixture more readily seen after being applied.

Standard Formula for "1-10" Bordeaux.

We give here the formula of the common "1-10" Bordeaux mixture—so-called because it contains 1 pound of copper sulfat to 10 gallons of water.

Copper sulfat—5 pounds.

Quick lime (not slaked)—3 1-2 to 5 pounds.

Water—50 gallons.

A. Dissolve the 5 pounds of copper sulfat in hot or cold water in a wooden vessel. Dilute the solution thus secured to 25 gallons.

B. Slake the lime carefully and thoroughly. Dilute this milk of lime to 25 gallons.

C. Pour the two solutions thus obtained through strainers, at the same time, into the spray barrel. The mixture in the spray barrel should be stirred while the two solutions are being poured together.

D. Never attempt to mix the two solutions until they have been diluted as suggested above.

SPECIAL DIRECTIONS.

A. The copper sulfat may best be dissolved in cold water by suspending it in a coarse sack near the top of the water.

B. In slaking the lime add at first a small amount of water, preferably hot water, and then, as slaking begins, continue to add small amounts of cold water as needed. Never add much water at a time and never allow the lime to become dry.

C. For the more tender foliage of peaches and plums employ the "1-25" Bordeaux mixture, i. e., one containing 2 pounds of copper sulfat to 50 gallons of water.

D. In all cases use at least 2 pounds of lime to 3 pounds of copper sulfat.

E. A small amount of yellow prussiate of potash or potassium ferrocyanid dissolved in about ten times its bulk of water is often used as the so-called "ferrocyanid" test to determine whether or no the Bordeaux is properly made. A few drops of this solution are added to the Bordeaux. If a brown discoloration at once appears not enough lime has been used. Continue to add lime solution and stir until no discoloration appears upon adding a few drops of the ferrocyanid solution.

F. *The most important precaution is to unite the cold dilute solutions of lime and copper sulfat quickly and then to stir the mixture thoroughly.* (See Fig. 22 on Plate IX.)

Ammoniacal Solution of Copper Carbonat.

This mixture, designed for use when the Bordeaux might by adhering to the fruit injure its market value, is made according to the following formula:

Copper Carbonat—6 ounces.
Ammonia—3 pints.
Water—50 gallons.

The copper carbonat is to be dissolved in the ammonia, just as much ammonia being used as is required to dissolve the copper carbonat. This solution is then thoroughly stirred into the water.

Lime-Sulfur-Salt Wash.

This wash, long used along the Pacific coast to control the San Jose Scale, has recently sprung into favor for the same purpose in the East. We mention it here since its use seems to reduce various plant diseases, particularly apple scab and peach leaf curl. It is in a sense therefore both an insesticide and a fungicide. We give but one of the several formulas suggested:

Stone or lump lime—15 lbs.
"Flowers of sulfur"—15 lbs.
Salt—15 lbs.
Water—50 gallons.

"Place the lime in a kettle, or in a vat if steam is used, and slake it with hot water so that it forms an even white paste. Now add enough water to reduce the lime paste to a thin whitewash. The sulphur and salt are then added and should be thoroughly stirred in. If the mixture is not already boiling, bring it to this point and allow it to boil for one hour."

Stir the mixture frequently and at the end of the hour dilute the resulting mixture with hot water to make the required amount. Apply the wash, while hot, with any good nozzle to the trees.

This mixture is very caustic and must be applied to none

but dormant trees and should not be allowed to come into contact with the hands or face.

SPRAYING MACHINERY.

The type of spraying outfit to be employed and its size depends upon the size of the orchard in which it is to be employed. We can only briefly consider the matter here and refer to the two essential parts of any spray outfit: (1) the nozzle and (2) the pump and its accessory parts.

No nozzle of the multitude of forms upon the market is superior to those constructed on the principle of the Vermorel nozzle. These nozzles will give fairly good results even when the pump gives a very low pressure, though best results are secured with pressures of 100 pounds or higher. The "mistry" nozzle (Fig. 24 on Plate IX) made by the Goulds Mfg. Co., is of the Vermorel type and throws a finer spray with low pressures than do the Vermorel nozzles.

A good spray pump should have all working parts exposed to the spraying mixtures made of brass or some sort of bronze. And in addition neither rubber nor leather valves should be used. Assuming these two characteristics to be present the spray outfit is to be selected to fit the local conditions, particularly the number of trees to be sprayed. Fig. 23 on Plate IX, shows a well known type of pump to be attached to a barrel.

For further information on the subject of spraying outfits, consult the references in the Bibliography following and the catalogues to be secured from the following firms —well known as makers of spray outfits:

Deming Co., Salem, Ohio.

Field Force Pump Co., Elmira, N. Y.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. Bitter rot of apples showing both isolated and confluent diseased areas and the concentric circles formed by the fruiting bodies of the fungus causing the disease. (From Bull. 44, Bureau of Plant Industry, U. S. Dept. Agr.)

Fig. 2. Limb cankers produced by the fungus causing the bitter rot. (From Bull. 44, Bureau of Plant Industry, U. S. Dept. Agr.)

Plate II.

Fig. 3. Twig of the red cedar showing one of the galls called "cedar-apples." This gall is produced by one stage of the same fungus that causes the rust of apple leaves. (Original.)

Fig. 4. The lower surface of an apple leaf showing the peculiar elongated horn-like fruiting bodies of the fungus causing the apple leaf rust. (From Rept. U. S. Dept. Agr. for 1888.)

Fig. 5. Fly speck and sooty blotch of the apple. (From Bull. 79, Ohio Exp. Stat.)

Fig. 6. The upper pile of apples is from the sprayed tree, the lower pile from the unsprayed tree—both together show the advantage in spraying against the apple black rot. (From Bull. 59, Ky. Exp. Stat.)

PLATE III.

Fig. 7. Brown rot of peaches. (From Bull. 50, Ga. Exp. Stat.)

Fig. 8. "Mummy" peaches, killed by the brown rot diseases, adhering to the tree and thus constituting a very fruitful source of new infection. (From Bull. 50, Ga. Exp. Stat.)

PLATE IV.

Fig. 9. Leaf curl of peach. (From Bull. 20, Div. Veg. Phys. & Path. U. S. Dept. Agr.)

Fig. 10. Rosette of peach. (From Journ. Mycol. Vol. 6.)

PLATE V.

Fig. 11. Longitudinal section of a root affected with crown gall. (From Bull. 33, Arizona Exp. Stat.)

Fig. 12. Crown gall; the upper left hand figure shows gall on Lombardy poplar, the upper right hand figure on pear and the two lower figures on peach. (From Journ. Mycol. Vol. 7.)

Fig. 13. Crown gall on apple; this gall appeared at the point where the graft was inserted shown at "A" in the figure. (From Bull. 93, Ky. Exp. Stat.)

Fig. 14. Crown gall showing the growth of new gall tissue after the removal of the old gall. (From Bull. 33, Arizona Exp. Stat.)

PLATE VI.

Fig. 15. Pear blight. (Original.)

Fig. 16. Hairy root of peach. (From Rept. Geneva N. Y. Exp. Stat. for 1900.)

PLATE VII.

Fig. 17. Plum pockets. (From Rept. U. S. Dept. Agr. 1888.)

Fig. 18. Black knot on plum. (From Prof. Farlow's paper in Bull. Bussey Institution, 1876.)

Fig. 19. Apple canker. (From Bull. 163, N. Y. Geneva Exp. Stat.)

PLATE VIII.

Fig. 20. "Shot-hole" affect produced on Japan plum leaves by improper spraying. (From Bull. 164, N. Y. Cornell Exp. Stat.)

Fig. 21. Cherry leaf-spot disease. (From Report N. Y. Geneva Exp. Stat., 1896.)

PLATE IX.

Fig. 22. Jars showing, after one hour's standing, the amount of settling of the precipitate in Bordeaux mixture made in the following ways. The lower light colored part in each figure is the precipitate:

A. Dilute lime poured into dilute sulfat slowly.
B. Dilute sulfat poured into dilute lime slowly.
C. Made as in E, but using hot lime milk.
D. Made as in E, but less thoroughly stirred.
E. Properly made from dilute solutions, quickly united and thoroughly stirred.
F. Made as in E, but with concentrated solutions.
G. Properly made mixture, one day old.
H. Old Bordeaux mixture, two weeks old.
I. "Bordeaux Powder" mixed with water.

Fig. 23. One example of the barrel-type of spraying apparatus. (From Bull. 243, N. Y. Geneva Exp. Stat.)

Fig. 24. "Mistry" spray nozzle. (Cut loaned by the Goulds Mfg. Co., Seneca Falls, N. Y.)

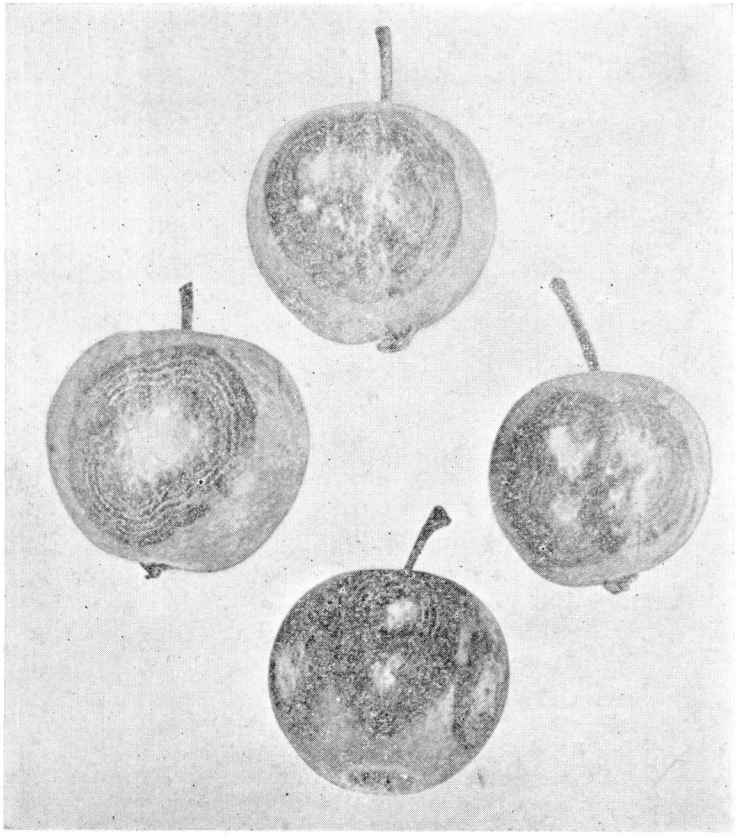
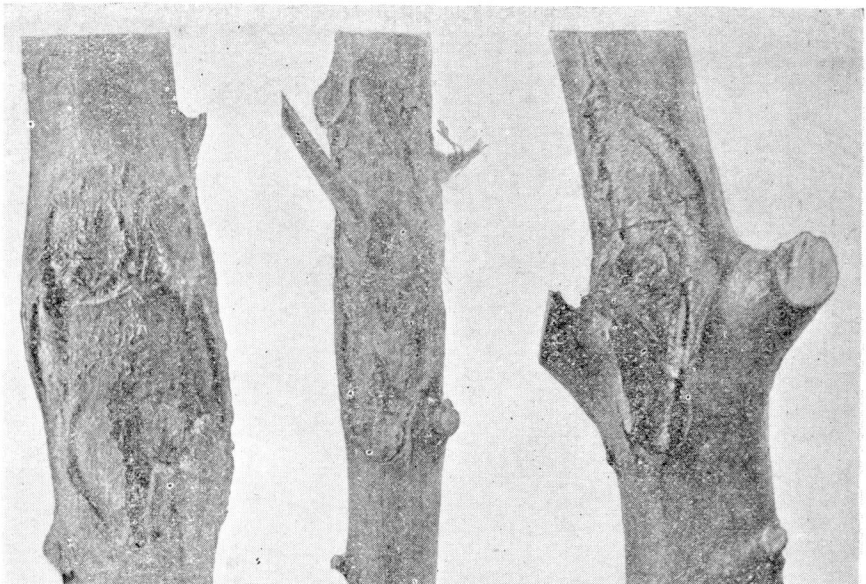


Fig. 1.



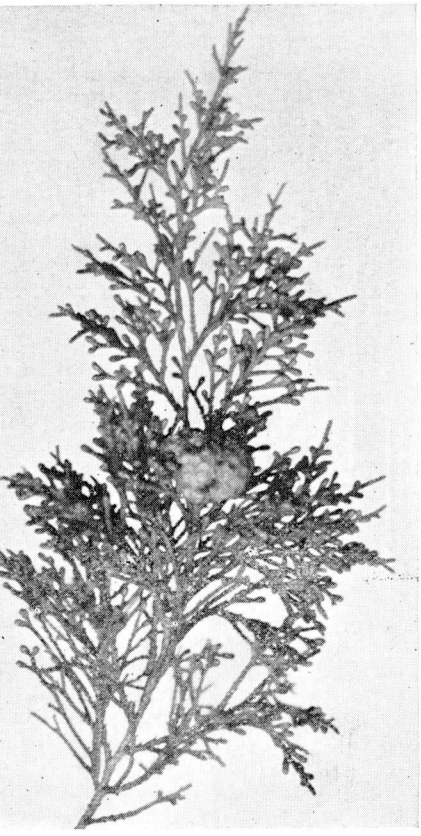


Fig 3.

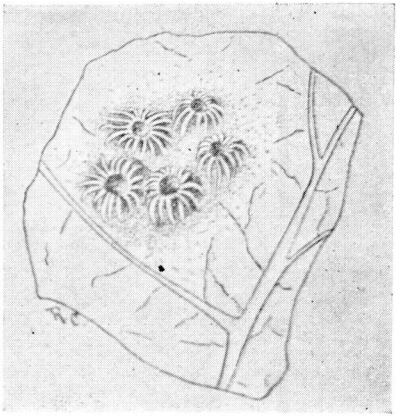


Fig. 4.

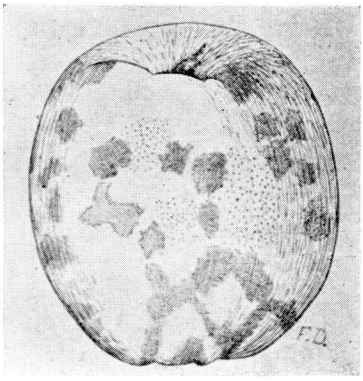
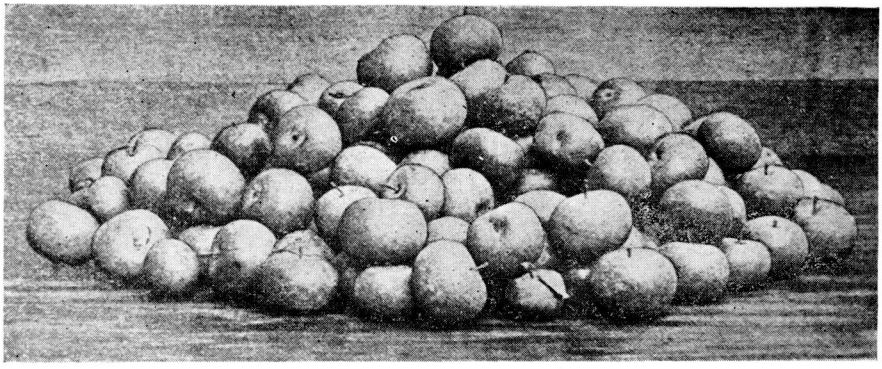


Fig 5.



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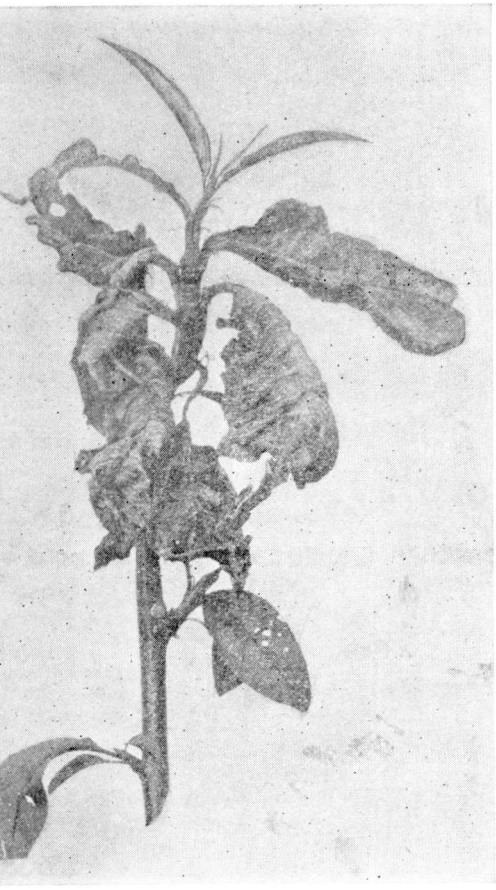
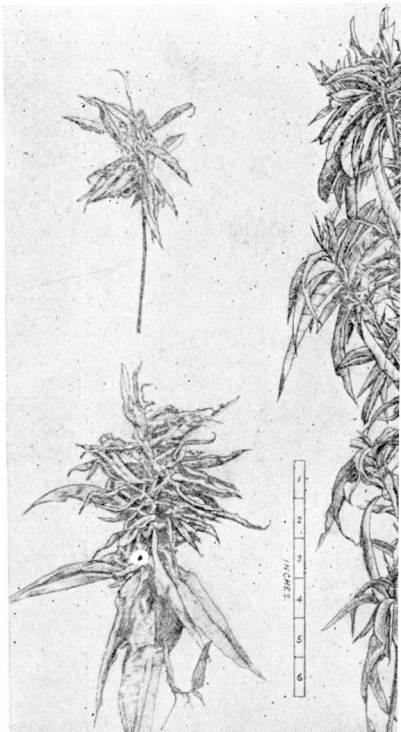


Fig. 9.



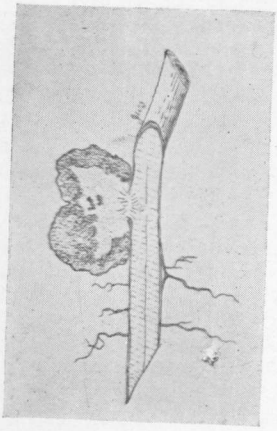


Fig 11.

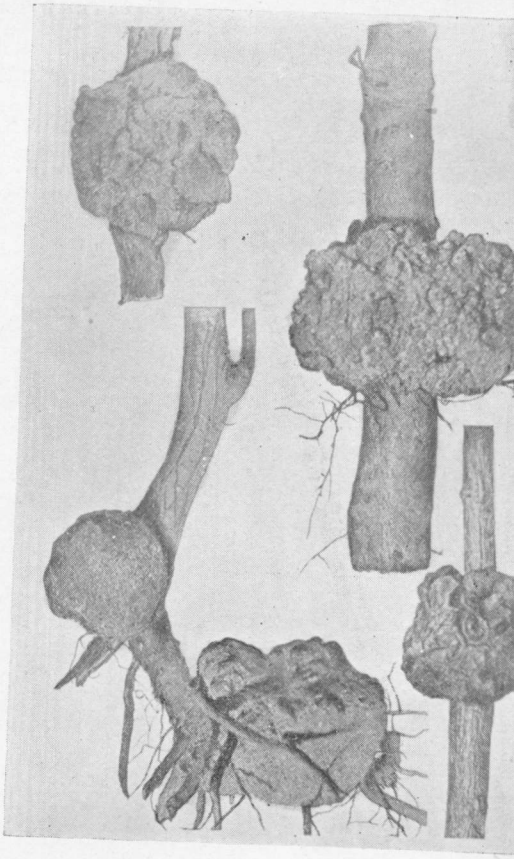
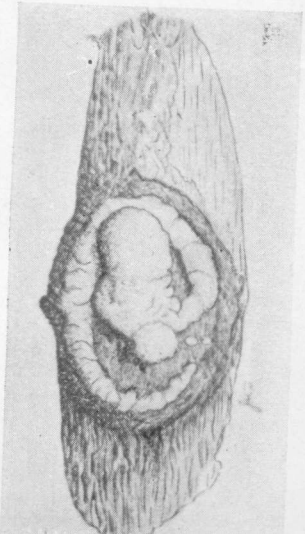


Fig 12.



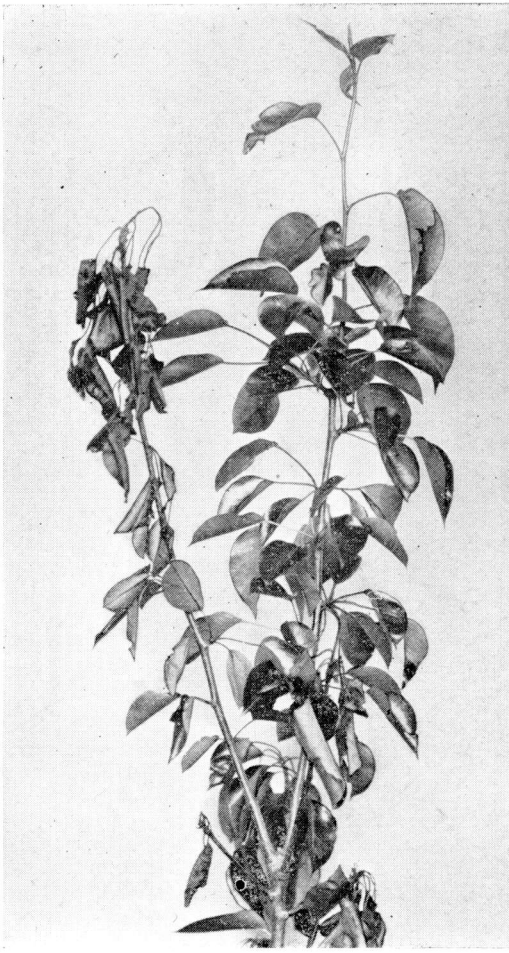
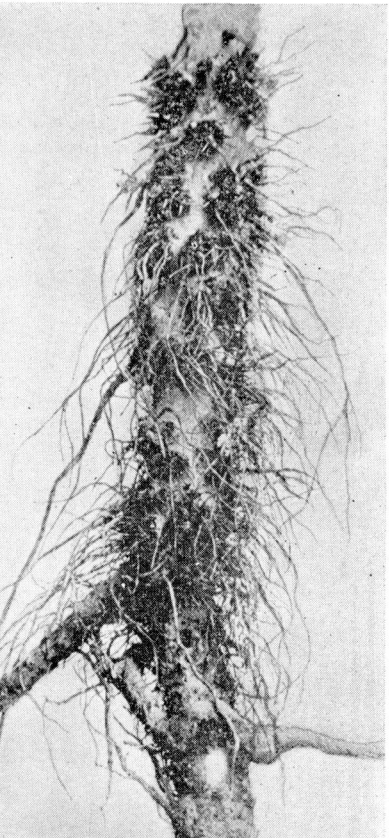


Fig. 15.



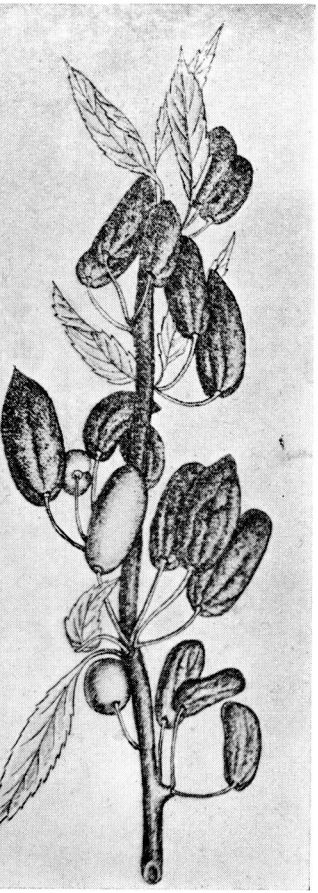


Fig. 17.

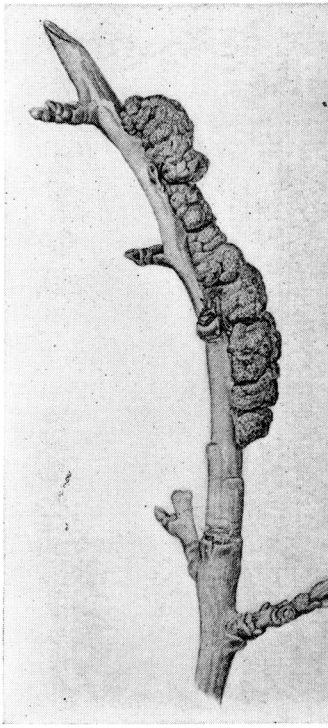
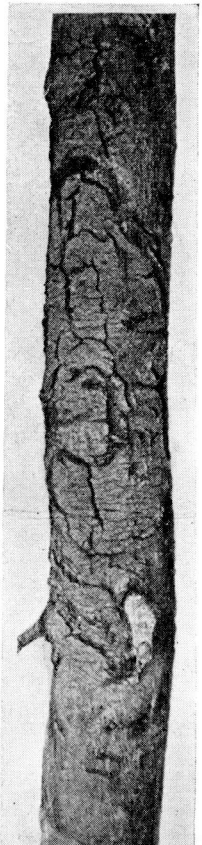


Fig. 18.



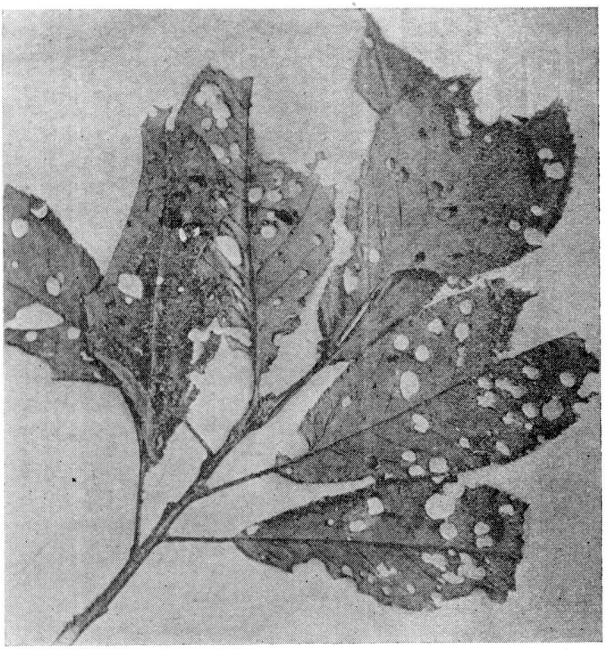
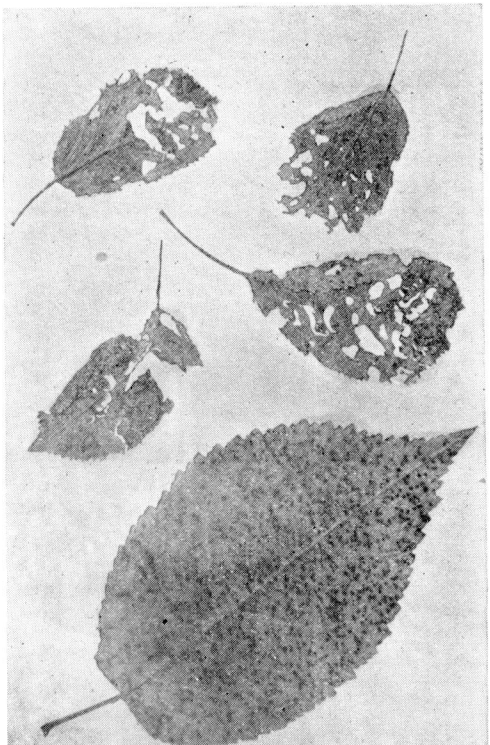


Fig. 20.



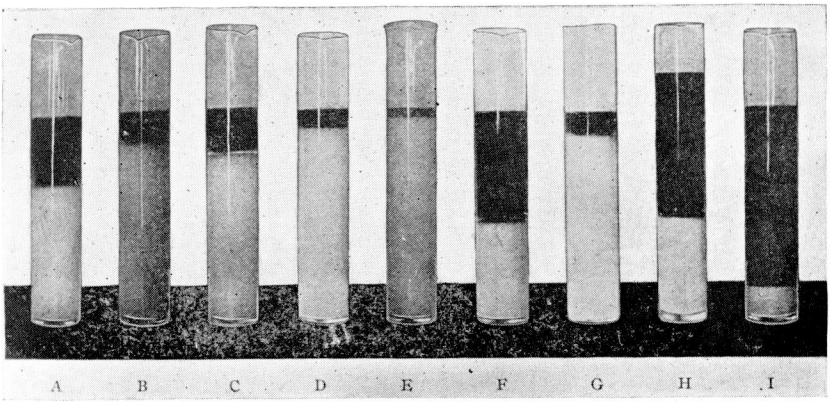


Fig. 22.

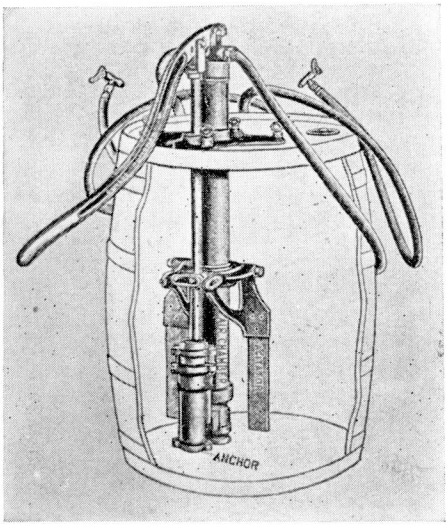


Fig. 23.

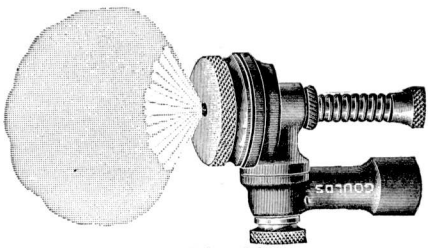


Fig. 24.