Blight Canker of Apple Trees

BY

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BLIGHT CANKER OF APPLE TREES.

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Cankers in one form or another on apple trees are familiar to most orchardists. As the term is generally understood to-day, we mean by a canker a dead area in the living bark of the body or main limbs of trees. This area may be sunken and smooth or it may be swollen and rough. (Fig. 1 and 2). The term "canker," as used to-day, applies usually to diseases of trees that are caused by parasitic fungi or bacteria. Altho these injuries to the bark of living trees have been, in the large majority of cases, absolutely proven to be due to the growth of fungi or bacteria, growers very generally attribute them to "sun scald" or "winter injury." Not only have experiment station men shown that these injuries are due to the attacks of living organisms rather than to the results of unfavorable weather conditions, but they have demonstrated that the different forms of these cankers are due to distinctly different organisms.

Of the two common cankers in the State the best known is the New York Apple Tree canker. This is very prevalent in the orchards of Western New York. It has long been known to growers but the true cause of it was first worked out by Paddock of the New York State Experiment Station at Geneva in 1899. It is caused by a fungus, *Sphaeropsis malorum,* and is in most respects very different from the blight canker. In the early stages of this canker concentric cracks appear in the outer skin of the diseased area. (Fig. 3.). The cankered surface is always black and roughened and covered with minute black pimples, which are the fruit bodies of the fungus, often not so evident in old cankers. These occur, for the most part, on the main limbs of trees in old orchards, causing the death of limbs here and there on the tree (Fig. 4).

There is another canker which is very severe thruout the State, especially in certain sections. This we have named the Blight Canker. The surface of this canker is sunken with a cracked

margin caused by the drawing away of the diseased bark from the healthy tissue. This differs from the Sphaeropsis canker in that the surface is smooth, the only cracks being those which mark the extent to which the canker has spread in a given period of activity. The Blight Canker is always of a brown color and never shows any fruit bodies, except when it is old and the dead tissues have been attacked by rot fungi. Sometimes these cankers kill a limb, but frequently the disease does not extend thru the bark into the wood, except in a few places. It simply kills the outer portion of the bark (Fig. 5).

In the New York Apple Tree canker, the fungus lives from year to year, gradually spreading so as to involve a large portion of the limb, but the Blight cankers are for the most part annual, living only one year. Only a small percentage of Blight cankers live thru the winter and serve as infection sources for the spread of the disease the following year.

FORMS OF THE CANKER ON DIFFERENT PARTS OF THE TREE.

The chief differences between these two cankers are set forth in the following parallel columns:

NEW YORK APPLE TREE CANKER.	BLIGHT CANKER.
Caused by a fungus.	Caused by bacteria.
Usually found on the main limbs of old trees.	Occurring most frequently on the body and limbs of young trees just coming into bearing.
Diseased portion more or less swollen, cracked and roughened. (Fig. 3).	Diseased area sunken and smooth not cracked and checked. (Fig. 7).
Cankered surface black.	Cankered surface brown.
Covered with minute black pimples—the fruit bodies of the fungus often not so evident in old cankers. (Fig. 3).	Not showing any pimples or fungus fruit bodies, except in old cankers that have been invaded by saprophytic forms.
Freshly cankered tissue dry.	Freshly cankered tissue watery.
Cankers perennial, i. e., living over and spreading from year to year.	A large per cent. of the cankers active but one season.

DISTINGUISHING CHARACTERS OF THE BLIGHT CANKER.

Blight cankers occur most commonly and are most destructive on trees 8–14 years old—trees just coming into bearing. Unless promptly attended to they very frequently result in the death of the entire tree.

In young trees with smooth bark the cankers are easily detected, even in their first stages. They appear as discolored and somewhat sunken areas, the margin along the advancing front being usually slightly raised or blistered. The tissue in actively spreading cankers is of a darker green than the healthy bark and is very watery or sappy. On damp cloudy days drops of a milky, sticky fluid (Fig. 6) exude from the cankered tissues thru the lenticels or pores in the bark. After a short time the diseased tissue begins to turn brown and dry out. Unless in a very active state of progress the margins are very distinct, marked by a crack where, in drying, the diseased tissue has separated from the healthy bark (Fig. 1). The older cankers are brown, somewhat darker than the healthy bark. They are distinctly sunken. The surface is smooth, never checked or roughened or beset with pustules or pimples, except in the old cankers, where, after a time, rot fungi gain entrance and, thriving in the already dead tissues, produce their fruit bodies on the surface. The progress of the spreading canker depends largely on the continuation of favorable weather conditions, which seem to be a humid atmosphere and cloudy days. With the return of bright sunny weather, the active spread of the canker is checked abruptly, often to be resumed again with the return of favorable conditions. This checking and renewing of activity sometimes results in large cankers with concentrically arranged cracks within the cankered area (Fig. 7). This renewal of activity may take place during the same season or the canker may partially heal over to spread anew the following year (Fig. 8). A large percentage of the cankers are active during but one season. There are always some, however, in which the disease is perennial, living thru the winter to become active again the following spring, spreading and enlarging the original limits of the cankered area (Fig. 9). The diseased bark is usually killed to the wood, to which it clings tenaciously the first season. It gradually decays, however, and falls out, leaving the wood bare and

exposed (Fig. 8). In small cankers the cone of diseased bark may be quickly forced out by the rapidly formed calluses, which heal and close the canker wound (Fig. 10). In some cases the canker is superficial, never reaching the cambium, except, perhaps, in a limited area at the point of infection. Such wounds heal quickly beneath the dead bark, which clings to the tree as a sort of scab (Fig. 5).

The canker manifests itself in different forms on different parts of the tree. Those that grow on limbs are usually small and circular. If the disease is very severe the canker may be larger. These we designate as "pit" cankers (Fig. 11). Often the dead bark remains as a sort of lid to the pit but is easily removed with the finger or knife blade (Fig. 10). These pit cankers, in most cases, heal over quickly and by the end of the second year close the wound entirely. Aside from affording entrance to rot fungi such cankers unless they enlarge do not seriously affect the health of the tree.

There is another form of the canker which frequently becomes serious, called "crotch canker." It usually appears in the crotches where the main limbs arise from the body (Fig. 12), but may also appear in the secondary crotches well up in the tree. In general characters they are similar to the limb and body cankers. Owing to their peculiar position, water is retained more readily in the dead bark, thus affording the very best conditions for the entrance and growth of rot fungi. These find easier access to the heart wood at the crotch than on the limbs. It was observed that these crotch cankers heal much less readily and successfully than do the limb and body cankers. Crotch cankers, unless promptly attended to, mean the almost certain destruction of the trees. In some sections of the country, especially the Hudson river valley, they have been very serious.

Cankers are frequently formed about pruned stubs (Fig. 13). These will be discussed further under another heading.

On the bodies of trees are often found large, irregular cankers, which originated from the "pit" cankers. They come either from new infection in the spring or from the organism remaining in the canker during the winter. Fig 9 shows how such cankers are formed.

The large cankers at the bases of young trees, frequently referred to by growers as "collar rot" (Fig. 14) are in many cases very probably due to the same cause as that of the cankers on the upper parts of the tree. The well known "collar rot" of King trees may also be due to the same or a similar organism.

History and Distribution of the Blight Canker.

The blight canker has been known for many years and was probably first observed by horticultural writers as early as 1780. It has been repeatedly referred to in horticultural writings since that time, altho its true nature does not seem to have been suspected until 1880. In that year Professor T. J. Burrill, of the Illinois State Experiment Station, while working on the fire blight of pears and apples, came to the conclusion that the so-called "sun scald" spots on the bodies and larger limbs of apple trees are due to the same cause. At a meeting of the Illinois State Horticultural Society in 1881, in answer to a query regarding the nature of "sun scald," he said: "The sun scald on apple trees is the same as pear blight." Upon what experimental evidence, if any, this and other statements were based I have so far failed to discover. A number of writers since that time have referred to these cankered patches as "body blight" due to attacks of Bacillus amylovorus, but none seem to have actually produced the cankers by the introduction of the bacteria into the bark of healthy trees. Much of my work has been to try to prove that these cankers were due to pear blight organisms. In Saratoga county and vicinity, the disease has been very bad. At least ninety-five per cent. of the young trees which were just coming into bearing were affected with this canker. It is a dangerous pest for the very reason that it affects the trees just at the time that the grower may expect some reward for his labor. In an orchard of about 400 trees (Fig. 15) there were not ten trees out of one hundred still alive that were entirely free from canker and finally the entire orchard was destroyed altho it was given the best of care. There are also sections in Central New York and Jefferson county where orchards are affected as bady as those in the Hudson River valley (Fig. 16). I believe the disease is common thruout the State, as well as in numerous

states in the United States. Wherever the twig blight of apples and pears occurs, I believe you will find the cankers on the bodies of the trees.

Cause of the Disease.

Most orchardists regard the trouble as due to freezing or sun scald. In seeking to discover the real cause of the trouble I examined many cankers in different orchards at different times of the year. One moist cloudy day early in May I discovered a cankered apple tree from the diseased bark of which were exuding drops of a sticky milky fluid (Fig. 6). Examined under a microscope this fluid was found to be made up almost entirely of bacteria,—minute rod-shaped plants (Fig. 17). The diseased tissue within the bark was also found to be alive with these minute plants. By their rapid growth and multiplication within the cells of the bark they cause its death. They are not carried along in the sap, but slowly work their way from cell to cell. When the canker dries down they die and disappear, so that examination of the tissues of old cankers does not show them. That they are the direct cause of the disease was proved in the following way: Bacteria from the cankered tissue were introduced into the bark on the body of a healthy apple tree and also into the bark of a healthy pear tree, with the result that typical cankers appeared in both cases (Fig. 18). Blossoms and growing twigs of both pear and apple trees were also inoculated with bacteria from this same canker. These nearly all developed good cases of blight in about ten days (Figs. 19 and 20), while twigs and blossoms punctured with a sterile needle gave no infection. This last experiment was twice repeated during the summer with pure cultures of the bacteria from the apple tree canker. The blight resulted in practically every case. Young fruits of both the pear and the apple were also inoculated and gave well developed cases of the disease (Fig. 21). By a comparative study in various culture media of the bacteria from cankers, twigs and fruits of both pear and apple secured from different orchards about Ithaca, the organism of the canker was shown to be identical with that of the well known "fire blight" of the pear and "twig blight" of the apple, *Bacillus amylovorus*.

How Trees Become Infected.

The next problem was to find out how the trees become infected. Only those ways of infection which have come under my personal observation will be mentioned, tho there is no doubt that the bacteria gain entrance to the bark in still other ways.

The bacteria frequently get into the bark of the limbs and body by way of short spurs and watersprouts (Fig. 22). In 1905 twig blight became very prevalent during July and August, especially in the region about Ithaca, and it was an easy matter to find blighted spurs and watersprouts with active cankers about their bases (Fig. 23). When these watersprouts grow out from the trunks, as is often the case in young trees, typical body cankers are formed. The infection of the sprout itself is generally attributed to the work of insects, which after visiting freshly cankered sprouts or blighted twigs introduce the bacteria into the succulent tissues of the rapidly growing healthy shoots. The blighted watersprout soon dries up and falls away, leaving often a very indefinite scar in the cankered area so that the following season it is usually impossible to tell with certainty the manner of infection. Observation on a large number of trees this past season, convinces me that the blighting of adventitious shoots on trunk and limb is responsible for most of the cankers in such locations.

Another source of infection was found to be the pruning knife. Along one side of an orchard of about 350 trees which was under observation thruout the season, it was early noticed that the pruned stubs, of 1904 especially, showed the collars of dead bark often two or three inches in width (Fig. 13). Instead of forming a callus and healing over the wound, as would normally occur, the tissue had died and shriveled up but still clung to the stub. In most cases the bacteria which had caused the death of the bark had died out the first season. In a few instances, however, the canker was observed to be active early in the spring, extending down the side of the adjoining limb. Two badly diseased trees on this side of the orchard seem to have been the source of infection. Owing to their diseased condition, they had been severely pruned the previous season and very probably the knife or saw had carried the bacteria to the healthy trees. Flies,

which were observed constantly to follow the pruner to suck up exuding sap, may have been the direct agent in many cases in transferring the bacteria. The knife itself may convey the disease, as is shown by the following incident: While making inoculations into the body of an apple tree on the Station grounds, I had occasion to remove from near the base a large sprout of several years' growth. This I did with my knife which I had but shortly before used to cut bark from a fresh canker. A typical canker soon developed about this pruned stub (Fig. 24).

Of a similar nature are infections which occur thru wounds or bruises on the limbs and bodies of trees. These wounds, commonly results of "barking," may be made by careless workmen when plowing or working about the trees or from the gnawing of animals; one of the worst animals in New York being the woodchuck. A large percentage of such wounds heal over eventually, but frequently thru the agency of insects or other means these wounds serve as infection courts for the canker bacillus. An interesting case of wound infection came under my observation last season In cutting a cankered branch, I accidently "barked" a healthy limb with the cut end of the diseased branch. The tree was not again visited until some weeks later, when a large and actively spreading canker was found to have developed about the abrasion (Fig. 25). The bacteria were found in abundance in the diseased tissue and pure cultures were secured.

The wounds or punctures of insects seem to be directly responsible for some of the infections. Sometimes cankers on the bodies of trees cannot be attributed to infection thru blighted shoots, and in some cases these cankers have been traced directly to the wounds made by insects. It is very probable that many of the cankers at the base of young trees originate in wounds made by borers. The bacteria are probably carried to these wounds by flies or other insects which visit these places to feed on the exuding sap and excrement. The infecting agents in the case of crotch cankers have not as yet been definitely determined. It seems likely that insects again are responsible. I have found them repeatedly hiding in the crevices of the dead bark that accumulates in the crotches, and one species seems to feed to some extent on the living tissue in such places. I have also

observed this same species feeding on the exuding sap of cankered limbs and stubs. That it may carry the bacteria to the crotches seems obvious. Besides this, many of the crotches are of such form that they readily retain moisture and thus afford the best of conditions for bacterial growth.

How the Disease Affects the Tree.

The effect of the canker on the tree is to lower its vitality to a greater or less degree by cutting off the food supply to the roots, and thus indirectly reducing the flow of sap to the branches and leaves. The "collar rot" and "crotch cankers" seem to be the most fatal to the tree. The effects of the canker are first evidenced in the foliage. If there is a large body canker, the entire tree may show the effects of the trouble. More often the first symptom noted by the grower is the peculiar appearance of the foliage on one or more of the limbs. Either these branches fail to leaf out at all in the spring, or if they do, the leaves never fully expand but remain undersized and curled or inrolled. They never take on the dark green color of healthy foliage, but remain pale and gray. Growers often refer to such trees as having "mouse ear" leaves. As the season advances and the cankers spread, the leaves often die and dry up on the branches. Sometimes badly infected trees may live for two or three seasons, but such trees have scanty foliage, blossom profusely and frequently set a heavy crop of fruit, which falls prematurely or is small and inferior in quality.

As I have already pointed out, small cankers may not of themselves seriously affect the health of the trees. When the trees are strong and vigorous they frequently succeed in promptly healing the wounds. The dead bark of the canker, however, makes an excellent infection court for the entrance into the tree of "heart rot" and decay-inducing fungi. Moisture, so necessary to the germination and growth of the spores of fungi, is retained for a considerable time in the dead tissue. This is more especially true of crotch cankers. No doubt these rot fungi are often to blame for the final death of the tree. The heartwood of badly affected limbs and trees is commonly found to be soft and rotted, with only a thin rim of sound sap-wood surrounding it.

Treatment.

In most cases, it is very difficult to cure a tree after it has become diseased. However, in the case of young trees that are just coming into bearing it seems that something should be done to save them. I believe they can be saved, at least long enough to bear several good crops.

In the first place, all dead limbs and trees should be promptly removed from the orchard and burned. Old pear trees in the neighborhood of young apple orchards are often a constant source of infection, and, unless kept absolutely free from blight, should be removed. Also every case of twig blight in both pear and apple trees should be cut out and burned.

Cut out with a sharp knife all the diseased tissue of the canker well back into the healthy bark, and treat all the cut surfaces with corrosive sublimate,—one tablet to one quart of water, or copper sulfate solution,—one ounce to four quarts of water. When dry, paint over thoroly with some heavy lead paint. This should be done early in the season, as soon as the cankers are discovered, for two reasons: 1st, the spreading of the canker and its consequent damage to the tree is checked; 2d, the wound is thus given a long period in which to heal. The painting should be repeated again toward the close of the season and again the next year, or until the wound has completely healed. This prevents a second infection or the entrance of rot fungi. A twice-monthly inspection of every tree should be made and all cankers carefully cut out and treated as soon as they appear. Cankered trees so treated early in the spring of 1905 have formed good calluses and are fast healing the wounds. Treat all accidental wounds in the same way.

Keep the body and main limbs of the tree free of watersprouts thruout the summer.

In planting, choose trees with open or spreading crotches.

Avoid excessive fertilizing with nitrogenous manures. Apply some form of phosphoric acid to ripen new growths.

The planting of varieties known to be more or less resistant to this disease is to be recommended. The Wolf River and Talman Sweet appear to be of this sort, while Baldwin and Ben Davis suffer most severely. Desirable non-resistant varieties may be top grafted on resistant stocks.

Discussion.

Prof. Bailey: Are the trees that have been thoroly sprayed as liable to attack as unsprayed trees?

Mr. Whetzel: I do not think it makes any difference as the canker develops where there has been some wound. Unless bordeaux was applied to a wound as soon as it was made it would not prevent infection. We treated a large number of trees with bordeaux mixture of double strength and I could not see that it made any difference in the number of infections.

Mr. Sirrine: Are there any ill effects from the use of linseed oil?

Mr. Whetzel: The tissue dies back a little but not enough to cause any trouble.

Mr. Eustace: Have you observed much twig infection?

Mr. Whetzel: I found practically no active cankers in the Hudson river valley, where the last two seasons have not been favorable for the development of this disease. However, around Ithaca the last two years have been good for the disease and twig blight and active cankers are easily found. The work of the disease in the Hudson River valley was chiefly done during the seasons of 1902 and 1903.

FIG. 1.—Showing a characteristic blight canker. This resulted from a wound infection. Note the crack limiting the diseased area; otherwise the diseased bark is smooth.

FIG. 2.—Typical New York apple tree canker. Note the cracked and roughened surface as compared with Fig. 1.

FIG. 3.—New York apple tree canker. The first season's development of the disease. Note the concentric cracks and cross checks, and also the fruit pustules of the fungus, sphaeropsis malorum.

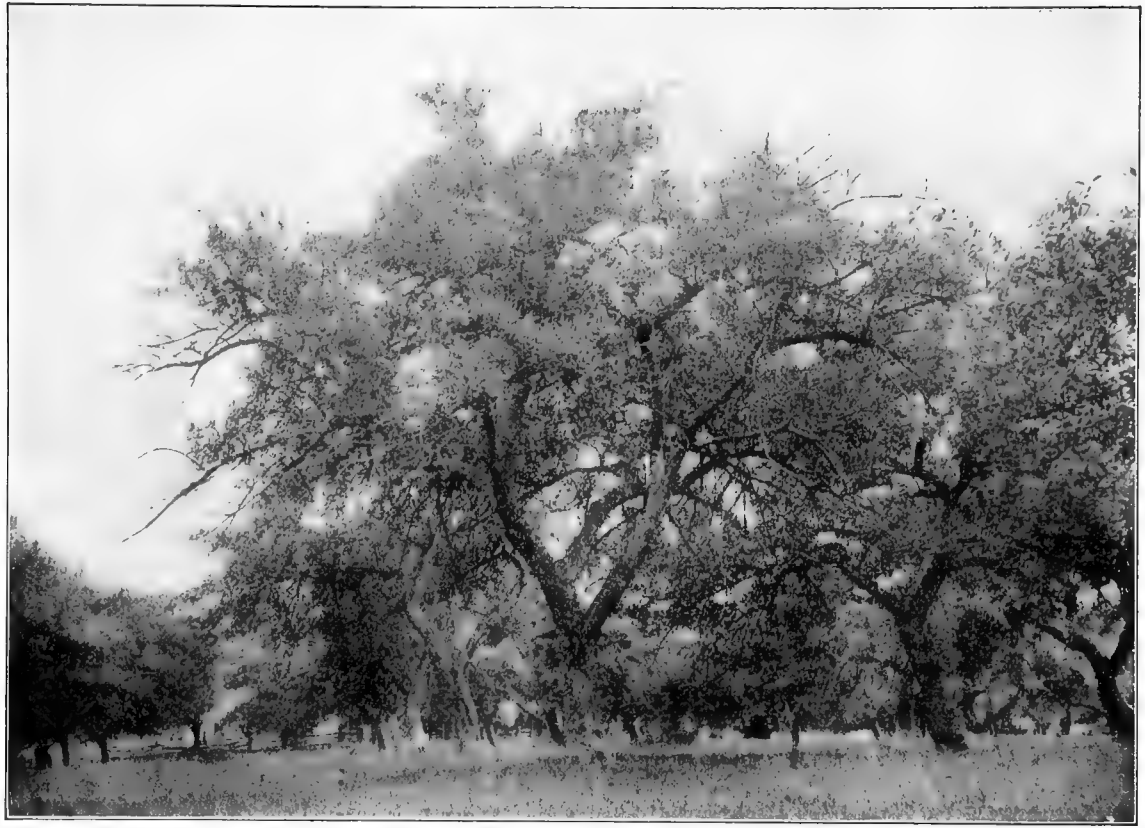

FIG. 4.—Dead limbs in an old tree killed by the New York apple tree canker.

FIG. 5.—The outer portion of the bark has been killed by the blight. The healing tissue beneath is pushing off the dead bark.

FIG. 6.—Active canker showing exuding milky drops. This sticky sap is made up almost entirely of the blight bacteria.

FIG. 7.—Showing concentric cracks in diseased area due to successive periods of activity of the canker.

FIG. 8.—Canker in body of tree, resulting from the renewal of activity, season after season.

FIG. 9.—Canker spreading the second season, destroying callus of last season and enlarging area of cankered surface.

FIG. 10.—Pit canker, rapidly forming callus, closing the wound and forcing out the diseased bark.

FIG. 11.—Typical pit cankers in the body of a tree from which the diseased bark has dropped out.

FIG. 12.—Crotch canker. The diseased bark has been removed.

FIG. 13.—Pruned stub canker, infected at the time of pruning. Note the collar of dead bark.

FIG. 14.—Large body canker near the base of the tree. The tree has made repeated attempts to heal this wound.

FIG. 15.—Orchard of some 400 trees in the Hudson River Valley. Began to go out from blight canker in 1903. Less than 50 alive in June, 1905.

FIG. 16.—Map showing the epidemic centers of the blight canker in the State in 1905.

FIG. 17.—Bacteria taken directly from active canker on apple tree.

FIG. 18.—Canker on pear tree resulting from inoculation with bacteria from active canker on apple tree.

FIG. 19.—Blossom and spur blight of apple resulting from artificial inoculation with bacteria from canker on limb of apple tree.

FIG. 20.—Actively growing pear twigs blighted by artificial inoculation with bacteria from canker on limb of apple tree.

FIG. 21.—Half grown apple inoculated with pure culture of bacteria, from canker on limb of apple tree. Note milky drops exuding from diseased tissue.

FIG. 22.—Recently blighted water sprout on limb of greening. Note the well marked canker about its base.

FIG. 23.—Active canker formed about base of blighted spur.

FIG. 24.—Pruned stub canker resulting from cutting away a water sprout with an infected knife.

FIG. 25.—Canker formed about a wound resulting from accidental "barking" with cut end of diseased limb.