Diagnosing Orchard Ills
Michigan State University Agricultural Experiment Station
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BOTANICAL SECTIONS

East Lansing, Mich.

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KEYS TO THE MORE IMPORTANT DISORDERS OF TREE FRUITS IN MICHIGAN

The Apple

Symptoms	Possible Cause	See page
I. The entire plant		
1. Noticeably weak growth of entire top, but leaves not obviously diseased.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Noticeably weak growth of individual limbs, but leaves not obviously diseased.	a. Crown injuries	16
	b. Root killing	20
II. Crown, trunk, crotch, limbs, shoots and twigs		
1. Dieback of shoot or spur growth, dead leaves persisting a long time.	a. Fire blight	39
2. Dieback of vigorous growth in winter.	a. Winter killing	23
3. Dieback of spurs and weak limbs, leaves not persisting.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
4. Dieback of shoots, dead shoots with attached leaves falling to ground.	a. Twig girdlers and pruners	28
5. Holes or perforations in bark of trunk and large limbs, with frass.	a. Borers	24
6. Holes or perforations in bark of trunk and large limbs, without frass.	a. Birds	27
7. Rough or saw-tooth punctures in bark of twigs.	a. Tree crickets, etc.	28
	b. Hail	26
8. Cankers on crown, trunk, crotches and limbs.	a. Fire blight	26
	b. Black rot	26
	c. Superficial bark canker	33
	d. Normal bark cleavage	36
	e. Limb rub	33
	f. Winter injury	32
	g. Sun scald	34
9. Splitting of bark and sometimes wood.	a. Winter injury	35
	b. Growth cracks	36
	c. Overloading	36

Symptoms	Possible Cause	See page
10. Cottony-appearing patches in crevices of bark, etc.	a. Woolly aphis	29
11. Speckled or thinly encrusted bark.	a. Scale	28
12. Girdling, usually at crown or crotch.	a. Winter injury	35
	b. Fire blight	30
	c. Rodents	27
	d. Borers	24
III. Leaves		
1. Leaves somewhat dwarfed but not curled, yellowish green rather than the normal green.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Leaves of normal size but with a bronze yellow cast.	a. Leaf hoppers	43
3. Lower or basal leaves on spurs dwarfed and somewhat curled.	a. Frost	38
	b. Spray burn	39
4. Outer edges of leaves burned, center green.	a. Excess of commercial fertilizer	39
	b. Frost injury	39
	c. Spray burn	39
5. Leaves spotted, sometimes turning yellow and falling prematurely.	a. Leaf spot	45
	b. Spray injury	46
6. Leaves eaten, mined or skeletonized.	a. Caterpillars	40
7. Leaves rolled and eaten from inside of roll.	a. Leaf roller	40
8. Top limbs stripped of leaves, buds and flowers early in season.	a. Climbing cutworms	40
9. Leaves of spurs or shoots dying but not falling off for a long time.	a. Fire blight	39
10. Leaves curled, color remaining green as normal.	a. Aphids	41
IV. Blossoms		
1. Blossoms blighting.	a. Fire blight	48
2. Fruit not setting properly.	a. Scab	48
	b. Poor pollination	48
	c. Nitrogen deficiency	48
	d. Disturbed moisture relations	49
V. Fruit		
1. Fruit wormy.	a. Codling moth	49
	b. Maggot	49
2. Fruit with surface blemishes.	a. "Stings"	51
	b. Codling moth	49
	c. Scab	53
	d. Scald	56
	e. Jonathan spot	58
	f. Russeting	60
	g. Frost rings	60
	h. Limb rub	61
	i. Fruit worms	49
	j. Wartiness	61
	k. Scale	58
	l. Sooty blotch	54

Symptoms	Possible Cause	See page
3. Fruit with injured but not decaying flesh.	a. "Stings"	51
	b. Baldwin spot	57
	c. Hail peck	59
	d. Watercore	61
4. Fruit cracked or deformed and perhaps dwarfed.	a. Fruit worms	49
	b. "Stings"	51
	c. Scab	53
	d. Aphids	60
	e. Russeting by spray	60
	f. Cracking	59
5. Fruit decaying.	a. Rot	54

The Pear

I. The entire plant		
1. Noticeably weak growth of entire top, but leaves not obviously diseased.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Noticeably weak growth of individual limbs, but leaves not obviously diseased.	a. Crown injuries	16
	b. Root killing	20
II. Crown, trunk, crotch, limbs, shoots and twigs.		
1. Dieback of shoots or spur growth, dead leaves persisting for a long time.	a. Fire blight	39
2. Dieback of spurs and weak limbs, leaves not persisting.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
3. Holes or perforations in bark of trunk and main limbs.	a. Birds	27
4. Rough or saw-tooth punctures in bark of twigs.	a. Tree crickets, etc.	28
	b. Hail	26
5. Cankers on crown, trunk, crotches and limbs.	a. Fire blight	26
	b. Superficial bark canker	33
	c. Limb rub	33
	d. Normal bark cleavage	36
	e. Winter injury	32
	f. Sunscald	34
6. Splitting of bark and sometimes wood.	a. Winter injury	35
	b. Growth cracks	36
	c. Overloading	36
7. Speckled or thinly encrusted bark.	a. Scale	28
8. Girdling, usually at crown or crotch.	a. Winter injury	35
	b. Fire blight	30
	c. Rodents	27

Symptoms	Possible Cause	See page
III. Leaves		
1. Leaves somewhat dwarfed but not curled, yellowish green rather than normal dark green.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Leaves of normal size, but with a grayish cast.	a. Leaf hoppers	43
3. Leaves spotted or perforated, sometimes turning yellow and falling prematurely.	a. Leaf spot	45
	b. Scab	45
	c. Spray burn	39
4. Outer edges of leaves burned, center green.	a. Excess of commercial fertilizer	39
	b. Frost injury	39
	c. Spray burn	39
5. Leaves eaten.	a. Caterpillars	40
6. Top limbs stripped of leaves, buds and flowers early in season.	a. Climbing cutworms	40
7. Leaves becoming sticky with honeydew which in time become sooty.	a. Psyllids	41
8. Leaves wilting and dying when only partly expanded.	a. Thrips	42
9. Leaves showing blisters.	a. Blister mite	42
10. Leaves of shoots or spurs dying but not falling off.	a. Fire blight	39
11. Leaves turning red or purple in late summer or fall.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
IV. Blossoms		
1. Blossoms blighting and poor setting of fruit.	a. Fire blight	48
2. Fruit not setting properly.	a. Scab	48
	b. Poor pollination	48
	c. Thrips	42
	d. Nitrogen deficiency	48
	e. Disturbed moisture relations	49
V. Fruit		
1. Fruit wormy.	a. Codling moth	49
2. Fruit with surface blemishes.	a. "Stings"	51
	b. Codling moth	49
	c. Scab	53
	d. Scald	56
	e. Frost rings	60
	f. Russeting	60
	g. Limb rub	61
	h. Fruit worms	49
	i. Scale	58
3. Fruit sticky and sooty.	a. Psyllids	41
4. Fruit with injured, but not decaying flesh.	a. "Stings"	51
	b. Hail peck	59

Symptoms	Possible Cause	See page
5. Fruit cracked or deformed.	a. "Stings"	51
	b. Scab	53
	c. Russeting by spray	60
	d. Fruit worms	49
6. Fruit decaying.	a. Rot	54

The Peach

I. The entire plant

1. Noticeably weak growth of entire top, but leaves not obviously diseased.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Blackheart	18
	g. Crown injuries	16
	h. Yellows and "little peach"	19
	i. Black peach root-aphis	22
2. Noticeably weak growth of individual limbs, but leaves not obviously diseased.	a. Crown and crotch injuries	16
	b. Root killing	20

II. Crown, trunk, crotches, limbs, shoots and twigs.

1. Stunting of entire top, leaves obviously dwarfed and paler than normal.	a. Yellows	19
	b. Little peach	19
2. Dieback of most vigorous shoot growth.	a. Winter injury	23
3. Dieback of least vigorous growth.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
4. Holes or perforations in bark, with frass.	a. Borers	24
5. Rough or saw-tooth punctures in bark of twigs.	a. Tree crickets	28
	b. Hail	26
6. Cankers on crown, trunk, crotches and limbs.	a. Winter injury	32
	b. Sunscald	34
	c. Limb rub	33
	d. Gummosis	37
7. Gumming.	a. Gummosis	37
	b. Borers	24
8. Splitting of bark and sometimes wood.	a. Winter injury	35
	b. Growth cracks	36
	c. Overloading	36
9. Speckled or thinly encrusted bark.	a. Scale	28
10. Girdling, usually at crown or crotch.	a. Borers	24
	b. Winter injury	35
	c. Rodents	27
11. Rough excrescences, especially at crotch.	a. Normal irregular growth cracks	34

Symptoms	Possible Cause	See page
III. Leaves		
1. Leaves somewhat dwarfed but not curled, yellowish green rather than the normal dark green.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Black peach aphis	22
	g. Crown injuries	16
2. Leaves somewhat dwarfed, sometimes slightly rolled, yellowish green.	a. Yellows	19
3. Leaves of normal size, but with a grayish cast.	a. Leaf hoppers	43
4. Outer edges of leaves burned, center green.	a. Excess of commercial fertilizer	39
5. Leaves spotted or perforated, turning yellow and falling prematurely.	a. Shot hole	45
	b. Spray burn	46
6. Leaves much thickened, velvety, curled.	a. Peach leaf curl	47
7. Leaves eaten.	a. Caterpillars	40
8. Top limbs stripped of leaves, buds and flowers early in season.	a. Climbing cutworms	40
IV. Blossoms		
1. Blossoms blighting.	a. Brown rot	48
2. Poor setting of fruit.	a. Nitrogen deficiency	48
	b. Disturbed moisture relations	49
	c. Poor pollination	48
V. Fruit		
1. Fruit dwarfed and maturing prematurely.	a. Yellows	19
2. Fruit dwarfed and maturing late.	a. Little peach	19
3. "Buttons" developing instead of normal fruits.	a. Improper pollination	63
4. Fruit wormy.	a. Curculio	50
	b. Codling moth	49
5. Fruit with surface blemishes.	a. Scab	53
	b. "Stings"	51
	c. Fruit spot	58
	d. Black spot	58
	e. Blight	58
6. Fruit showing small punctures as it softens.	a. Alabama moth	50
7. Fruit decaying.	a. Brown rot	54
	b. Alabama	50

The Plum

I. The entire plant		
1. Noticeably weak growth of entire top, but leaves not obviously diseased.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Noticeably weak growth in individual limbs, leaves not obviously diseased.	a. Crown injuries	16
	b. Root killing	20

Symptoms	Possible Cause	See page
II. Crown, trunk, crotch, limbs, shoots and twigs.		
1. Dieback of spurs and weak limbs, leaves not persisting.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Blackheart	18
	g. Crown injuries	16
	h. Leaf spot	45
2. Dieback of most vigorous growth.	a. Winter injury	23
3. Rough or saw-tooth punctures in bark of twigs.	a. Tree crickets	28
	b. Hail	26
4. Cankers on crown, trunk, crotches and limbs.	a. Winter injury	32
	b. Sunscald	34
	c. Superficial bark canker	33
	d. Normal bark cleavage	36
	e. Limb rub	33
5. Rough excrescences, especially at crotches.	a. Normal irregular growth cracks	34
6. Black warty growths or excrescences on limbs.	a. Black knot	33
7. Splitting of bark and sometimes wood.	a. Winter injury	35
	b. Growth cracks	36
	c. Overloading	36
8. Speckled or thinly encrusted bark.	a. Scale	28
9. Girdling, usually at crown or crotch.	a. Winter injury	35
	b. Rodents	27
III. Leaves		
1. Leaves somewhat dwarfed but not curled, yellowish green rather than the normal green.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
2. Leaves of normal size and shape, but with grayish cast.	a. Leaf hoppers	43
3. Leaves spotted or perforated, turning yellow and falling prematurely.	a. Shot hole	45
	b. Spray burn	46
4. Leaves eaten.	a. Caterpillars	40
5. Leaves curled and dwarfed, but not turning yellow.	a. Aphis	41
6. Top limbs stripped of leaves, buds and flowers early in season.	a. Climbing cutworms	40
7. Outer edges of leaves burned, center green.	a. Excess of commercial fertilizer	39
IV. Blossoms		
1. Blossoms blighting.	a. Brown rot	48
2. Poor setting of fruit.	a. Poor pollination	48
	b. Nitrogen deficiency	48
	c. Disturbed moisture relations	49

Symptoms	Possible Cause	See page
V. Fruit		
1. Fruit wormy or stung.	a. Curculio	50
2. Fruit with surface blemishes.	a. "Stings"	51
	b. Frost rings	60
	c. Limb rub	61
3. Fruit decaying.	a. Rot	54
4. Fruit with dry spots in flesh or developing gum pockets.	a. Curculio	50
	b. Drouth spot	57
5. Half-grown fruit puffy and hollow.	a. Plum pockets	63

The Cherry

I. The entire plant		
1. Noticeably weak growth of entire top, but leaves not obviously diseased.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Noticeably weak growth in individual limbs, but leaves not obviously diseased.	a. Crown injuries	16
	b. Root killing	20
II. Crown, trunk, crotch, limbs, shoots and twigs.		
1. Dieback of vigorous growth in winter.	a. Winter killing	23
2. Dieback of spurs and weak limbs, leaves not persisting.	a. Nitrogen deficiency	14
	b. Moisture deficiency	14
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
	h. Leaf spot	45
3. Rough or saw-tooth punctures in bark of twig.	a. Tree crickets	28
	b. Hail	26
4. Cankers on crown, trunk, crotches and limbs.	a. Winter injury	32
	b. Sunscald	34
	c. Gummosis	37
	d. Limb rub	33
5. Rough excrescences, especially at crotches.	a. Normal irregular growth cracks	34
6. Gumming.	a. Gummosis	37
7. Splitting of bark and sometimes wood.	a. Winter injury	35
	b. Growth cracks	36
	c. Overloading	36
8. Girdling, usually at crown or crotch.	a. Winter injury	35
	b. Gummosis	37
	c. Rodents	27

Symptoms	Possible Cause	See page
III. Leaves		
1. Leaves somewhat dwarfed, but not curled, yellowish rather than normal dark green.	a. Nitrogen deficiency	38
	b. Moisture deficiency	38
	c. High water table	16
	d. Hardpan	16
	e. Root killing	20
	f. Crown injuries	16
	g. Blackheart	18
2. Leaves of normal size and shape, but with a grayish cast.	a. Leaf hoppers	43
3. Leaves spotted or perforated, turning yellow and dropping prematurely.	a. Shot hole	45
	b. Spray injury	46
4. Leaves eaten.	a. Caterpillers	40
5. Top limbs stripped of leaves, buds and flowers early in season.	a. Climbing cutworms	40
6. Leaves curled, especially those at ends of shoots.	a. Aphids	41
7. Outer edges of leaves burned, center green.	a. Excess of commercial fertilizer	39
IV. Blossoms		
1. Blossoms blighting.	a. Brown rot	48
2. Poor setting of fruit.	a. Poor pollination	48
	b. Nitrogen deficiency	48
	c. Disturbed moisture relations	49
V. Fruit		
1. Fruit wormy.	a. Curculio	50
	b. Maggots	49
2. Fruit decaying.	a. Brown rot	54
3. Flesh and skin becoming brown.	a. Wind bruises	61
4. Fruit cracking.	a. Cracking	59

GENERAL CONSIDERATIONS

Much of the expense and effort involved in developing the fruit plantation and in bringing to maturity a good crop of high grade fruit of most kinds is incident to the control of diseases of various types and of losses caused by insects. Neglect of proper control measures is attended by more or less complete loss of crop and sometimes the loss of the tree or vine itself. With certain fruits, as the strawberry or raspberry, little attention may seem necessary. However, in these cases that seem at first to be exceptions to the rule, it is usually disease or insect attack that determines the commercial longevity of the plantation. Ability to recognize those troubles that are most common and serious and knowledge of how to deal effectively with them is a necessary part of the equipment of every grower.

The number of different insects that occasionally injure even a single kind of fruit is large; the same fruit may be attacked by an equally large number of fungi and by bacterial and so-called virus diseases; in addition there are still other injuries that are occasioned by unfavorable weather conditions, by soil deficiencies, and by other factors. When all the more common fruits are considered it will be seen that the kinds of troubles that bother them literally run into the thousands. To make matters still more complicated for the grower, the pest itself, that is the causal organism, is often microscopic in size or very difficult to find. Perhaps it works only at night, or a non-harmful insect is present and is mistaken for the true parasite. For the average grower to acquaint himself with even the majority of these orchard pests, or even to learn to recognize the work of each and every kind, is out of the question. Fortunately, neither of these things is necessary. It is desirable, however, that the grower be able to identify the more important troubles likely to be found in his orchard.

General and Localized Troubles

The troubles that must be dealt with in the orchard may be placed together in one or another of two classes: (1) those which seem to affect the entire tree or a considerable part of it; and (2) those which affect individual parts and cause local injuries. The first group includes most of those troubles sometimes classes as constitutional or physiological, along with a number of others which are caused by bacterial, fungous, or insect parasites. Symptoms of troubles belonging to the second group are distinctly localized in the plant and for the most part are caused by organisms attacking the plant or its tissues at the point or points where the injury is seen, though in some instances the causal organism may be found at some point other than where the symptom appears and in still other instances the lesions are caused by other agencies, such as hail or wind.

This classification, however, is more or less arbitrary and artificial, for there are certain pests that attack either the roots or the aboveground parts of the plant to such an extent that its general appearance

Figures 1 and 2.—Winter injury at the crown and killing of the roots on one side has been resp
shown in the figure at the left. Growth has been much checked in this limb and its leaves are f
at the right shows the extent of the wood, bark and root killing below ground in the tree pictured

of weak growth is a poor soil, that is, a soil that does not furnish the plant with an adequate amount of water or that is deficient in available nutrient supply. If one or both of these two factors are directly or principally responsible for the condition of the trees, the root system will be found in an apparently healthy condition. The roots may have rather wide lateral spread, though vertical penetration will probably be normal. The character of the soil itself, together with its apparent fertility as measured by the growth of other cultivated plants and of native vegetation, will usually suggest whether drouth or nutrient supply is the factor of greater importance. If nutrient supply is the limiting factor, fertilizers, generally those containing quickly available nitrogen, can be applied. If drouth is responsible for the trouble, wide spacing of plants, removal of some of the trees, better cultivation, or the use of artificial mulches to conserve moisture, irrigation, measures to secure deeper root penetration, or pruning to reduce the amount of water required by the plant are suggested. Some of these measures are preventive, others remedial; some are adapted to certain situations and would be impracticable in others.

If examination shows that the roots have penetrated to a reasonable depth and then the deeper roots have died, resulting in what amounts to a shallow functioning root system, this is a good indication that at some time the water table has risen to a point close to the surface and submerged a portion of the roots long enough to kill them. Drainage is suggested as a remedy. A rather uniformly high water table likewise leads to a shallow root system but without the attendant killing of the lower roots, for the roots seldom penetrate a saturated soil. Hardpan close to the surface results in a similar root distribution and to a severe checking of growth in time of drouth. The remedy for these difficulties lies in soil amelioration.

If examination shows that the part of the root system lying closest to the surface is dead, though the lower roots are still alive and functioning actively, winter freezing has probably been responsible. Both symptoms and causal agent are well illustrated in Figures 1 and 2, though in that case only one side of the tree is affected. Under such circumstances the more extensive use of cover crops to prevent such hard and deep freezing of the soil and perhaps the use of windbreaks to keep the snow from being blown off the land will aid in preventing a recurrence of the trouble. When damage of this kind is done, it may be repaired by setting nursery trees around the injured tree and inarching their tops into its trunk or limbs or it may eventually be repaired by the tree itself through the formation of new roots. Pruning back the top will help tide the trees through their period of readjustment to a limited supply of water and nutrients.

Examination of trunks and crown should show at once whether there has been girdling, and the location of the injury together with the condition of the tissues will usually indicate rather clearly what has been responsible for it. Mouse injury is on the roots or on the trunk near the surface of the ground (see Figures 5 and 6); rabbit and woodchuck injury is higher on the trunk. Recent blight cankers (Figures 3, 4 and 22) can be identified by their characteristic streaks and stains and at certain seasons by the presence of bacterial ooze in the bark and on the surface of the cankers. Older ones are not easy to distinguish from

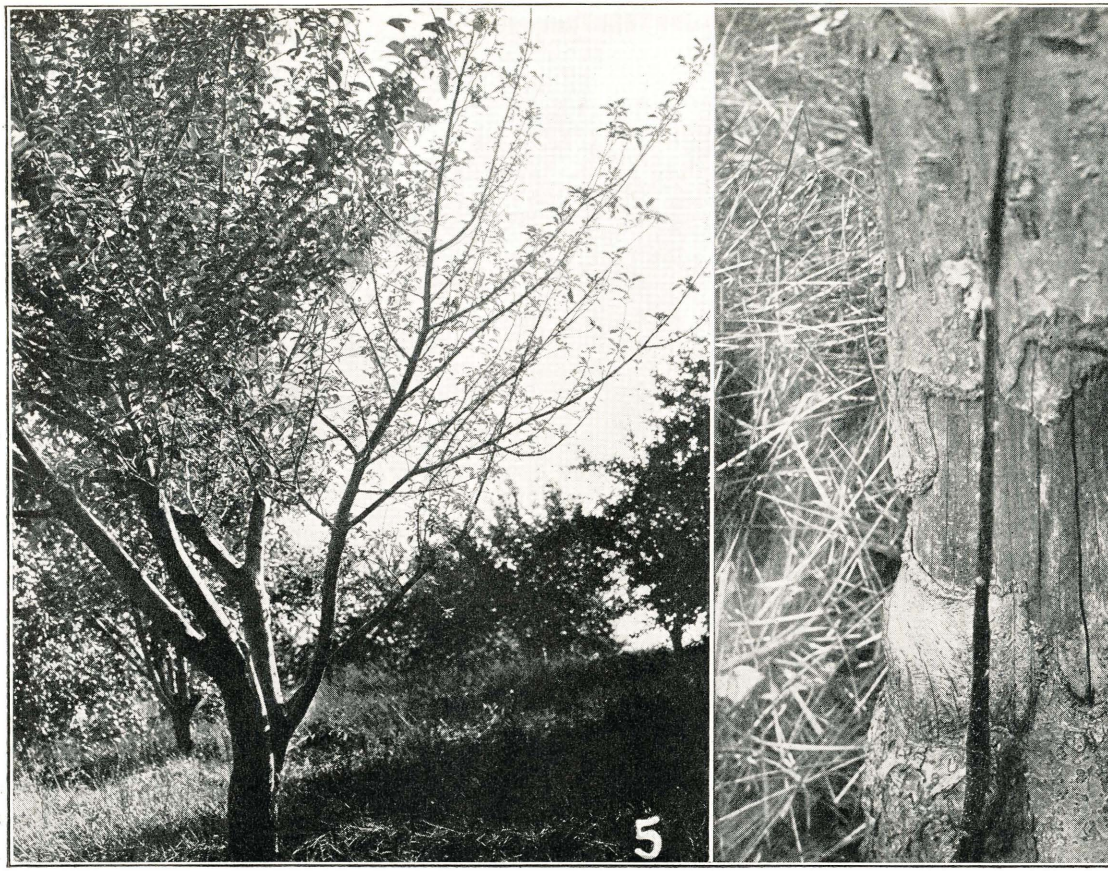
considered later as causing local lesions, when present in large numbers or when the infection is general, lead to the appearance of some of the same symptoms as those produced by drouth, starvation, root rot, or girdling. Among the more important pests that should be mentioned in this connection are the San Jose scale, the pear psylla, and shot hole or leaf spot fungi.

Mosaic, Curl, and Related Diseases.—These diseases are usually characterized by mottling of the foliage as a consequence of alternating light and dark green areas. Generally this is accompanied by more or less curling, rolling, or crinkling of the leaves. Stunting and malformation of the shoot growth are likewise common symptoms and, frequently, these are the ones first noted. Diseases of this general type are serious with many herbaceous crops and with the bramble fruits; their occurrence in tree fruits is less common. The exact causes are not known. They are called virus diseases and are easily and rapidly spread throughout a plantation when they get started, apparently in most cases through the agency of insects. No remedy is known except to cut out and destroy infected plants and to destroy or repel the virus-carrying insects, if the identity of such carriers is known. In starting a new plantation care should be taken to secure stock from disease-free fields.

Yellows, Little Peach, Rosette, and Related Diseases.—Apparently closely related to diseases of the mosaic type is another group that for want of a better classification may be considered under the above names that are more or less descriptive of some of the symptoms of the specific disorders which they designate. They are all characterized by dwarfing or stunting both of shoots and leaves and in some instances by a marked shortening of internodes (see Plates 1 and 2). This classification is admittedly artificial, for some of these diseases such as yellows in the peach, are highly contagious; others, like rosette in apples, are evidently more in the nature of symptoms of disturbed nutrition or disturbed water relations or both, since apparently they are not communicable and often they are curable. There is no known remedy for peach yellows and little peach, and the prompt removal and destruction of diseased trees is recommended. Before taking measures of this kind with apple, pear, plum, or cherry trees liberal applications of nitrogenous fertilizers and artificial mulching should be tried.

LOCALIZED SYMPTOMS

The symptoms that are here rather arbitrarily classed as local may again be divided more or less arbitrarily into several groups, depending on where they appear on the plant. Attention should be called to the fact, however, that the appearance of some symptoms in a shoot, spur, leaf, or fruit does not necessarily indicate that the real cause of the trouble is located at that point. The trouble may be in the root, crown, or at some other point and treatment must be made accordingly. Such cases are comparable to conditions developing in the human organism. Headaches, frayed nerves, even rheumatism may all trace back to ulcerated teeth that to all external appearances are perfectly sound.



Figures 5 and 6.—The limb at the right in figure 5 has slackened in growth because its wat has been partly cut off by girdling near the ground. The extent of the girdled area is shown in making a none-too-successful attempt to cover over the wound with callus tissue. Had the injure grafting the limb above it would have made a normal growth. It could still be saved by bridge gra injury.

considered later as causing local lesions, when present in large numbers or when the infection is general, lead to the appearance of some of the same symptoms as those produced by drouth, starvation, root rot, or girdling. Among the more important pests that should be mentioned in this connection are the San Jose scale, the pear psylla, and shot hole or leaf spot fungi.

Mosaic, Curl, and Related Diseases.—These diseases are usually characterized by mottling of the foliage as a consequence of alternating light and dark green areas. Generally this is accompanied by more or less curling, rolling, or crinkling of the leaves. Stunting and malformation of the shoot growth are likewise common symptoms and, frequently, these are the ones first noted. Diseases of this general type are serious with many herbaceous crops and with the bramble fruits; their occurrence in tree fruits is less common. The exact causes are not known. They are called virus diseases and are easily and rapidly spread throughout a plantation when they get started, apparently in most cases through the agency of insects. No remedy is known except to cut out and destroy infected plants and to destroy or repel the virus-carrying insects, if the identity of such carriers is known. In starting a new plantation care should be taken to secure stock from disease-free fields.

Yellows, Little Peach, Rosette, and Related Diseases.—Apparently closely related to diseases of the mosaic type is another group that for want of a better classification may be considered under the above names that are more or less descriptive of some of the symptoms of the specific disorders which they designate. They are all characterized by dwarfing or stunting both of shoots and leaves and in some instances by a marked shortening of internodes (see Plates 1 and 2). This classification is admittedly artificial, for some of these diseases such as yellows in the peach, are highly contagious; others, like rosette in apples, are evidently more in the nature of symptoms of disturbed nutrition or disturbed water relations or both, since apparently they are not communicable and often they are curable. There is no known remedy for peach yellows and little peach, and the prompt removal and destruction of diseased trees is recommended. Before taking measures of this kind with apple, pear, plum, or cherry trees liberal applications of nitrogenous fertilizers and artificial mulching should be tried.

LOCALIZED SYMPTOMS

The symptoms that are here rather arbitrarily classed as local may again be divided more or less arbitrarily into several groups, depending on where they appear on the plant. Attention should be called to the fact, however, that the appearance of some symptoms in a shoot, spur, leaf, or fruit does not necessarily indicate that the real cause of the trouble is located at that point. The trouble may be in the root, crown, or at some other point and treatment must be made accordingly. Such cases are comparable to conditions developing in the human organism. Headaches, frayed nerves, even rheumatism may all trace back to ulcerated teeth that to all external appearances are perfectly sound.

Affecting the Roots

Because the root system of the tree, after it has once been planted, is covered with soil and does not come under the direct observation of the grower it is generally assumed that it remains healthy or at least that no attention need be paid to it. Only when the entire top shows a diseased condition, which does not seem to be due to something attacking the top directly, is it suspected that something may be the matter with the roots. This is but another way of saying that the first recognizable symptoms of root trouble usually appear in the top, and then they may be mistaken for something else for a long time.

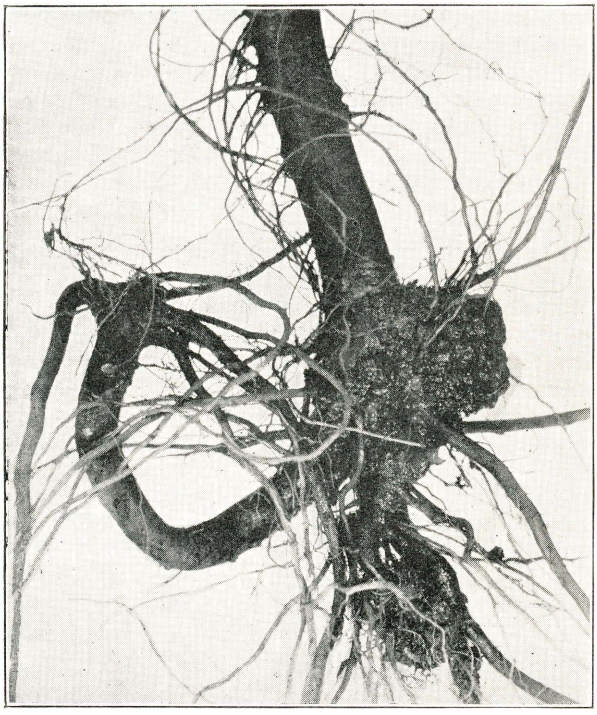


Figure 7.—Crown gall on roots of the apple.

Root Killing. The destruction of a part of the roots of a tree by winter freezing, by high water-table, or by some parasite almost always causes a weak growth. The conditions that most commonly lead to root killing in well established trees and methods of dealing with this disorder have already been explained in the discussion of general or constitutional disorders showing symptoms of this kind.

Much of the failure of nursery stock to grow when set in the orchard is due to death of all or part of the root system. Sometimes this is caused by severe freezing while in transit between nursery and orchard, sometimes to deep and severe freezing of soil after planting, sometimes

to extreme drying out, and sometimes to still other factors. Methods of dealing with root killing in well established orchards have been discussed. When trees that have been planted a year or two show much root killing they should be removed and replanting resorted to.

Crown Gall and Hairy Root.—Two of the most common root troubles of nursery stock are crown gall and hairy root. (Figure 7.) They affect fruit trees of most kinds and the first of the two is especially severe on bramble fruits. There is much difference of opinion as to the seriousness of these diseases on tree fruits, some claiming that they are relatively harmless and others that they result in the weakening and premature death of the tree. Nursery stock that is free from these diseases is certainly to be preferred to trees that are infected. There

Figure 8.—Woolly-aphis on roots of the apple. Note the gall-like swellings which they cause.

is no question but that these diseases greatly shorten the life of the bramble fruit plantation and reduce its productivity. All cane fruit plants showing the least trace of gall should be discarded at the time of planting and so far as possible nursery stock should be obtained only from disease-free fields. It probably does not pay to remove galled plants from bearing fields.

Woolly Aphis.—A species of woolly aphid attacks the roots of apple trees, causing gall-like swellings or knots. A badly infected root system is shown in Figure 8. Presence of the aphids on the roots is usually indicated by the appearance of insects of the same species on twigs and branches. Their general effect on the tree is to reduce its vitality, though under ordinary conditions in this State little attention need be paid to them further than to make sure that only nursery stock free from the aphids is planted.

Black Peach Root-aphis.—It is often noted that when an old peach orchard is reset to peach trees the newly planted trees fail to thrive properly. In three or four years they may not be more than half the size they should be and many will have died out. Especially is this true on the lighter sandier soils. Examination discloses no borers and the soil may be reasonably fertile. If trees behaving in this way are pulled up in many cases their roots will be found to be suffering from a bad attack of the black peach root-aphis. Remedial treatments are unsatisfactory. The difficulty can be prevented or at least very materially reduced by digging rather large holes where the trees are to be planted and filling them with clay soil. The peach root-aphis does not work freely in a soil of this character and when the tree reaches a size such that its roots are penetrating the sandy soil beyond the clay in which it was first planted it is able to resist attacks of this pest. However,

Figure 9.—Tunnels of the shot-hole borer in the wood of the apple tree.

whenever it becomes necessary to remove trees from an orchard because of this pest, it is inadvisable to reset to peach trees for several years. If an entire orchard is taken out because of black peach aphis the land should be used for general farm crops for a number of years before resetting to peach trees.

Affecting Trunk, Branch, and Shoot

Dieback.—The difference between the symptoms shown by the group of constitutional disorders that have been discussed under the heading of weak growth and what is here termed "dieback" is more one of degree than of kind. Moderate cases of root rot, partial girdling, starvation, or rather severe drouth may result simply in a check to growth or in a weakened condition of the entire tree or of one or more of its main limbs; but more complete girdling or starvation or destruction of the root system or more severe drouth may be attended by an actual dying out or dying back of the limbs. The same statement holds for

extremely severe attacks of a number of different kinds of insects and of fungi that are here mentioned as producing only local lesions. Dieback that is limited to the twigs or shoots on one side of the tree or even to a single main limb is perhaps more common than dieback distributed throughout the top of the tree. It is often more insidious and fully as dangerous as general dieback because the grower fails to recognize it in its early stages; and, then, because it is puzzling, it is ignored until the affected limb or side of the tree dies out. The result is a one-sided top that sooner or later breaks down and the tree is lost. Usually associated with dieback that is thus limited to one limb or one side of the tree is a diseased crown or root system directly under that portion of the tree. This is well illustrated in Figures 1 and 5, though in neither of those instances has the dieback stage been reached in the limbs above the wounds. It will be seen from the statements which have been made that in diagnosing the causes of dieback one should follow much the same procedure as in diagnosing the cause of weakened growth. It likewise follows that preventive and remedial treatments are essentially the same.

There are, however, certain forms or types of dieback that are not associated with the factors that are responsible for weakened growth. One of the most common forms is a killing back of the new growth of the past season as a result of severe late fall or winter freezing. A certain amount of this type of injury almost invariably occurs in the bramble fruits and in grapes. With them it is usually not serious for the injured portions are removed at the time of their spring pruning without reducing the prospects of a full crop. Occasionally, however, the killing back is so severe that the following crop is materially reduced.

Figure 10.—Egg-laying punctures of the 17-year cicada on a small branch of the apple.

A similar form of injury is often seen in peach trees and occasionally in other fruits, especially in the case of young trees that have been growing vigorously and whose growth has continued until late in the summer or into the fall months. As already stated dieback due to this cause is usually limited to the new shoot growth; dieback associated with drouth, starvation, premature defoliation, or an injured root system or crown is usually limited to spurs and to the shorter and weaker shoots or to whole limbs whose laterals are weak. Cultural treatments that promote an early and thorough ripening of the wood are the best means of preventing dieback due to severe cold.

A form of dieback occurring in midsummer and in which the leaves

remain attached to the dead shoots or twigs for the rest of the season is caused by the fire blight organism. Midseason girdling of twigs or limbs by the black rot fungus may give rise to the same symptoms.

Borers.—Borers of many different kinds cause trouble in the fruit plantation. Some limit their activities to certain species or kinds of fruit. Others are less particular in their feeding habits. In most cases the work and the location of the borers themselves can be recognized by the holes which they leave, by the frass near some of these openings or by the exudations of sap or gum from the injured tissues. Sometimes, however, it is only the weakened growth of the plant or the sudden wilting of a branch or shoot that has been practically severed from the inside that leads one to suspect their presence. In the case of trunk or crown borers in most tree fruits, the most satisfactory remedy has been to dig out the larvae and destroy them. This is the remedy usually recommended for the apple tree borers and for borers in young peach trees. Treatment with paradichlorobenzene has proved an efficient method of dealing with peach tree borers working in the crown and roots of trees over four years old. However, when the borers attack these trees in the trunk, crotches, or scaffold limbs, digging out must be resorted to.

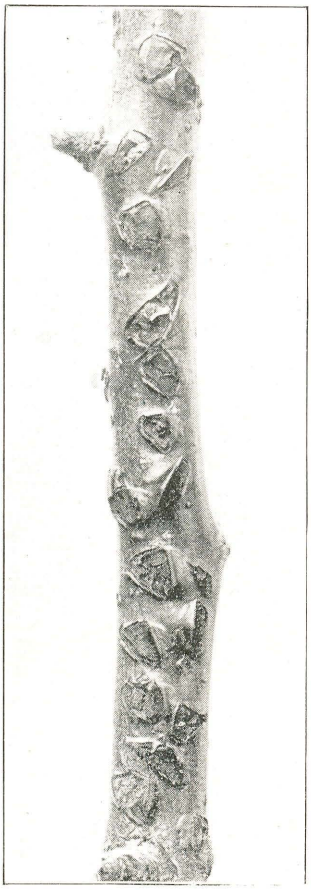


Figure 11.—Fresh egg-laying punctures of one of the tree hoppers on the apple.

A word of caution should be inserted regarding the use of paradichlorobenzene. After the mounds containing this chemical have been removed from the base of the tree they should be replaced with fresh soil to protect the crown from winter injury. Failure to do this has resulted in many cases of partial or complete girdling and later death of the tree due to winter killing of the tissues made unduly tender by the protection of the soil mound during treatment. Usually these injuries have been attributed to some direct effect of the chemical rather than to the true cause of the trouble.

The presence of the so-called "pin-hole" borers and other borers that work principally in the smaller limbs (see Figure 9) is usually an indication that something else is wrong with the tree, for they are usually found only in trees that are in a weak condition. An attempt should be made to locate and deal with the factor or factors that are responsible for the weak growth. Good sanitation, about the orchard is a preventive measure. If the plants are kept growing vigorously they are able to resist the attacks of these pests.

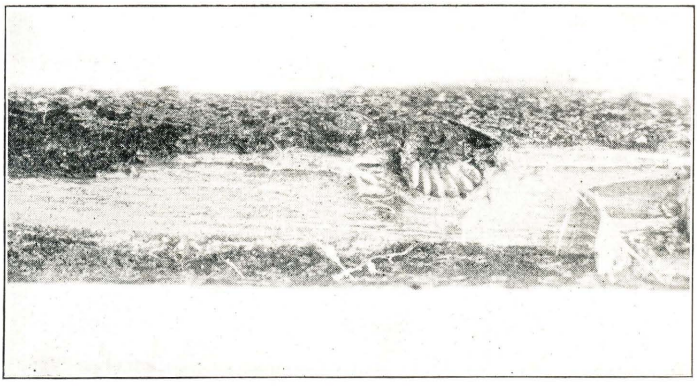


Figure 12.—An enlarged view of a section of the twig shown in figure 11. Note the egg cluster embedded in the wood.

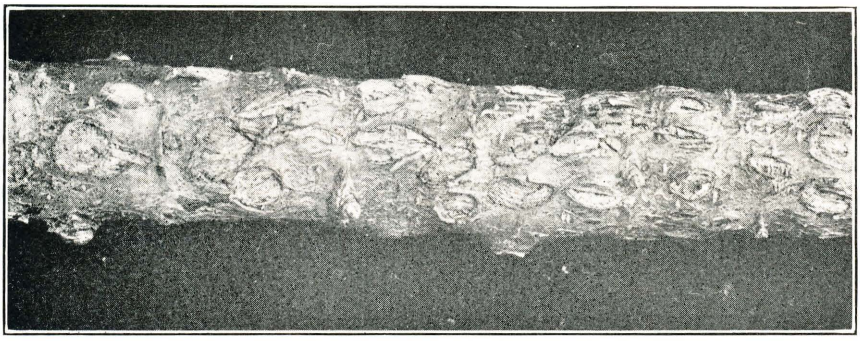


Figure 13.—Old scars caused by the Buffalo tree hopper. In this instance the wounds are fairly well healed over.

Figure 14.—Scars on an apple twig caused by hail. They resemble injuries caused by insect punctures but they are limited to one side of the branch.

The old bark of mature apple and pear trees is often perforated with small round holes, frequently appearing as rings encircling trunk or limbs. These holes bear some resemblance to those made by certain kinds of borers and are often mistaken for them. They are made by sapsuckers that drill holes to provide a place for sap to collect and attract insects other than borers. The holes do the tree comparatively little harm in the majority of cases.

Rodents.—Mice have been mentioned as frequently responsible for the girdling of tree trunks at or just below the surface of the ground. Sometimes they also gnaw the bark off the main roots as they branch out from the trunk. They are especially troublesome in orchards that

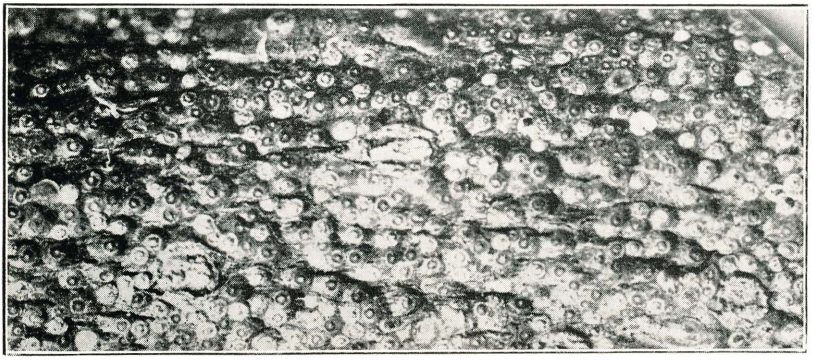


Figure 15.—San Jose scale on the limb of an apple, slightly enlarged.

are maintained in sod. Their depredations may be largely prevented by replacing the soil immediately about the crowns to a depth of four to six inches and for a distance of a foot or more out from the trunk with coarse cinders. Soil should then be worked into the open spaces between the cinders to prevent such deep and hard freezing as would otherwise occur. Where an orchard has become badly infested with field mice poisoning should be resorted to.

Rabbit injury is found on the trunk at a point somewhat higher than the girdling due to mice and, in the case of low headed trees and deep snow, the bark may be gnawed from some of the lower limbs. Protection is afforded by the use of wood veneer or half-inch to quarter-inch mesh galvanized wire tree protectors, illustrated in Figure 32.

Occasionally woodchucks injure young trees by scratching the bark

as cats do. They may be dealt with by the use of tree protectors like those that are employed against rabbits.

Twig Girdlers and Twig Pruners.—Trees of many kinds, particularly some of the shade and forest trees, are attacked by insects which eat around or through growing shoots some distance from the end. The result is a weakening of the tissues at the point of attack such that the shoots break over and die. Arsenical sprays are sometimes effective against insects of this class. More frequently the best preventives are what would be included under the heading of good sanitation, for example, the burning of fallen twigs.

Figure 16.—The scurfy bark louse on the apple. Note the male scales on the spur.

Tree Crickets, Tree Hoppers, Cicadas, and Similar Insects.—Injuries that are often confused with those just described as having been made by twig girdlers or borers are caused by the egg-laying punctures of certain insects. The 17-year cicada, some of the tree-hoppers, and the tree-crickets are among the worst of these offenders. Figure 10 shows the egg laying punctures of the 17-year cicada and Figure 11 those of one of the tree hoppers. Figure 12 pictures a twig in which a part of the bark and wood has been cut away to show a cluster of the tree hopper eggs. Some old partly-healed lesions of the tree hopper are shown in Figure 13. In some cases the lesions heal over without seriously damaging the tree or branch; in others, especially in young trees, the tissues are so weakened that breakage usually occurs sooner or later. Preventive treatments are most effective, but not always satisfactory. Young orchards that are in sod or in any succulent crop, such as alfalfa, or that are adjacent to woodland are generally most subject to attacks from these groups of pests. In case of rather severe injury there is need of rather careful corrective pruning.

Injuries to the bark of shoots, twigs, and smaller branches, more or less closely resembling those due to egg-laying punctures, are occasionally caused by hail. Hail injury can be identified, however, by the fact that it is limited to one side of the twig or branch. It is illustrated in Figure 14.

Scale-Insects.—Among the most serious pests of the orchard are the scale-insects. When scale is mentioned most growers think of San

Jose scale because they have come to regard it as their worst enemy of this type. There are a number of other scale insects, however, that are of considerable economic importance. The common name for this group of insects is sufficiently descriptive to make identification or diagnosis reasonably certain, even for an amateur. The three most common scale insects attacking fruit trees in Michigan, which are the San Jose scale, the scurfy bark louse, and the oyster shell bark louse, are illustrated in Figures 15, 16, and 17. The injury comes largely from enormous numbers of these insects sucking the juices of the plants and producing a poisoning due to absorption of the saliva of the insect. The tree as a whole is weakened and eventually it may be killed. Mild infestation of some of the less serious of this group of insects, such as the oyster shell bark louse, may usually be dealt with by cultural measures that reinvigorate the tree, for weakened trees seem more susceptible to their attacks. On the other hand, dormant season applications of lime-sulphur or of a miscible oil or oil emulsion must be resorted to for

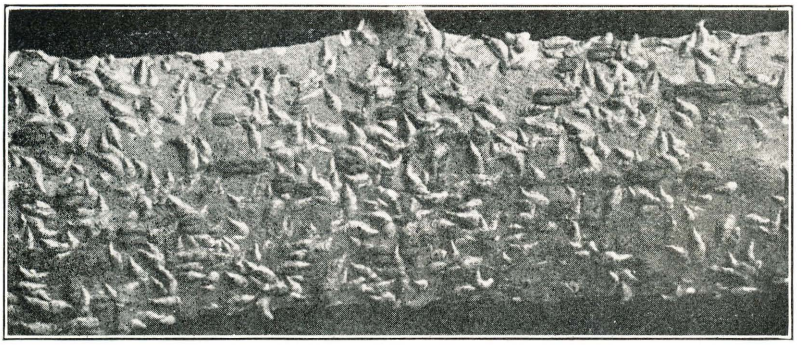


Figure 17.—The oyster shell bark louse on a small branch of the apple.

the San Jose scale and occasionally for certain of the other scale insects.

Woolly Aphis.—The woolly aphis of the apple more closely resembles the scale insects in its mode of attack than other aphids to which it is more closely related. It works principally on the basal portion of new shoot growth or on older wood, especially where crevices, growth cracks, pruning wounds or mechanical injuries afford some kind of protection to the insects themselves and also expose tender or semi-tender bark tissues (see Figure 18). Usually, another form of the same insect will be found on the roots of trees whose limbs are attacked by woolly aphis. The general effect of the attacks of this pest is to weaken the tree, but it seldom becomes serious under Michigan conditions. The galls on the roots that are caused by woolly aphid attacks are pictured in Figure 8 and similar gall-like or wart-like swellings on the branches due to the same pest are shown in Figure 19. The usual remedies employed against the scale insects will serve to hold woolly aphis in check on the tops of the trees, though they are not effective against the root forms of the pest.

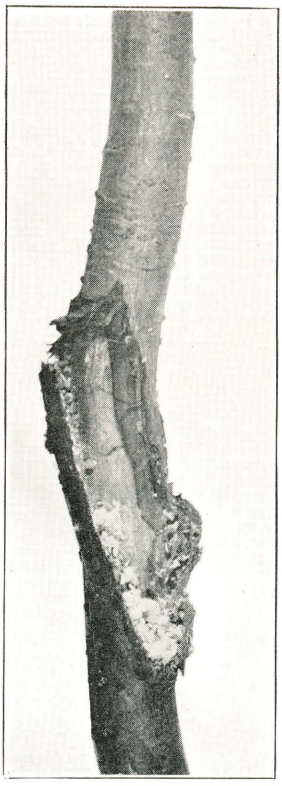


Figure 18.—Woolly aphis clustering about the edges of a mechanical wound on an apple branch. This is a characteristic point of attack.

Cankers.—A large number of fungi and several kinds of bacteria are parasitic on tree trunks, limbs and twigs. Usually they work in the living portion of the bark, killing the affected tissues and giving rise to dead, sunken areas of greater or less extent. Their spread often leads to a girdling of the twig, limb, trunk, or crown and to the subsequent death of the portion of the tree above the invaded area, as shown in Figures 3 and 4. The dead tissues are subject to the attacks of wood- and bark-rotting fungi and these secondary parasites then often spread from the cankered areas to sound tissues, perhaps in the end causing more trouble than the fungus or bacteria of the original canker.

The spraying schedules recommended for the different fruits are effective against a large number of the canker diseases and as a rule it is unnecessary to make any special spray application for them. Some canker diseases, however, notably the fire blight of pears and apples, cannot be controlled by spraying treatment, although the control of plant-lice in infected orchards should be part of the program of eradication since plant-lice spread the infection. In such instances it is necessary to trim out the diseased tissues and then sterilize and paint the wounds. In general the winter season is the best time for work of this kind, since the germs are not so abundant and active as that time and there is less danger of spreading disease through wounds made in the bark. The importance of the complete removal of all so-called "hold-over" cankers of the fire blight

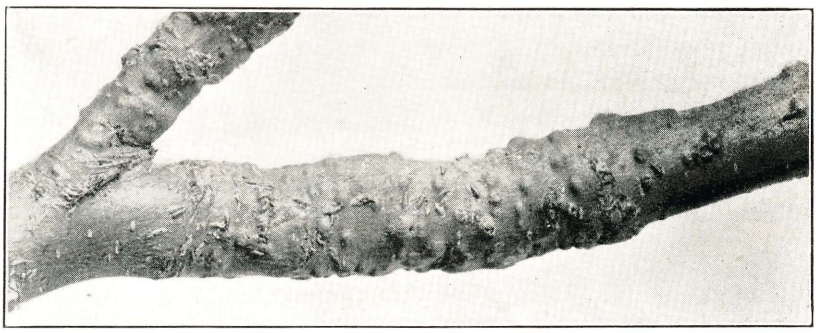
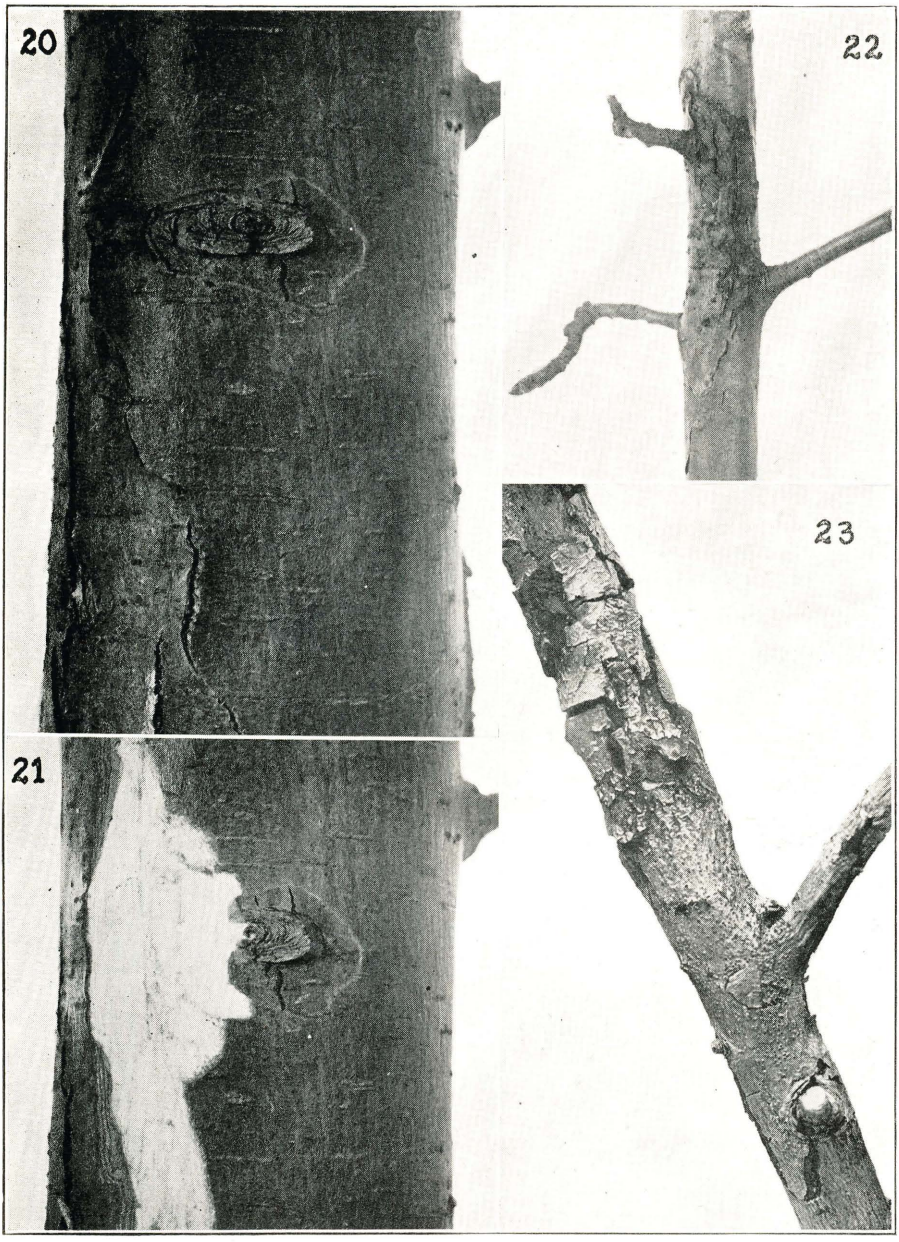
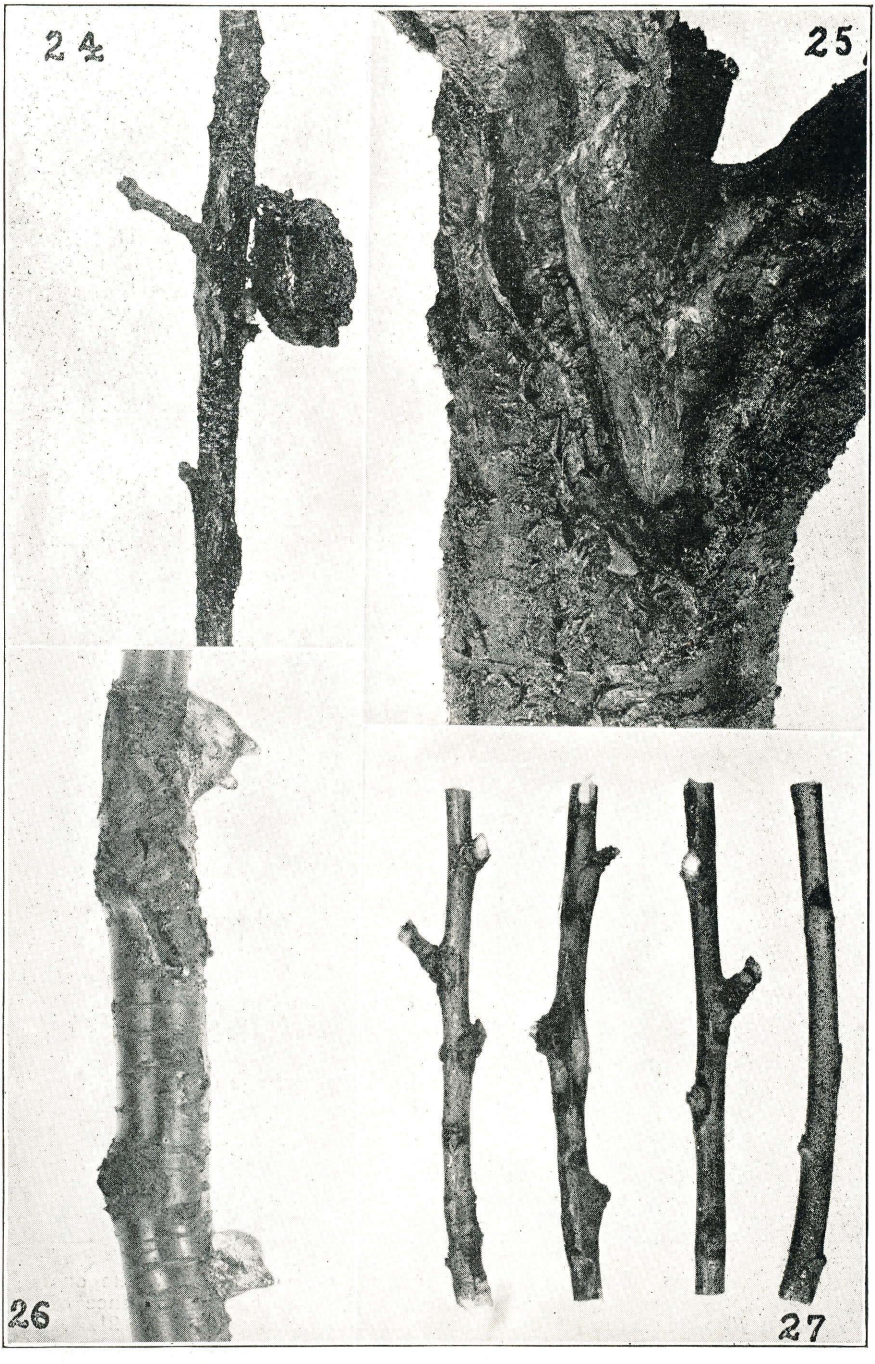


Figure 19.—The pimple or wart-like condition of this apple branch is due to earlier attacks of the woolly aphis, not to the presence of the few oyster shell bark lice seen in the picture.



Figures 20-23.—A group of cankers found on apple and pear trees. The one shown in figure 20 is superficial and harmless, as evidenced by the presence of live bark beneath the thin layer of dead tissue. This is shown in figure 21. A typical "hold-over" canker of the fire blight organism is shown in figure 22 and a black-rot canker in figure 23.



Figures 24-27.—Cankers on stone fruits. Figure 24 shows peach branch with a brown rot canker and mummied fruit attached. Figure 25, crotch injury in peach, due to winter-killing. Figure 26, gummosis on cherry. Figure 27, cankers on peach caused by arsenical sprays.

disease some time during the winter cannot be too strongly emphasized, because these cankers provide a source of infection for rapid spread of blight germs during the following growing season. A typical "hold-over" blight canker is shown in Figure 22 and a black-rot canker in Figure 23.

Growers should realize, however, that superficial bark cankers, such as are illustrated in Figures 20 and 21, are perfectly harmless and develop on trees of many kinds. Some of these superficial cankers are caused by fungi working in the surface layers of the bark; others are the result of normal bark cleavage due to the growth of trunk or limb. Still other canker-like surface lesions are caused by limb-rub. Removal of these surface cankers entails an almost endless amount of work and is of no benefit to the tree. Such cankers can usually be readily distinguished from those caused by harmful parasites by their superficial character and the fact that beneath them is a layer of healthy inner bark, (see Figure 21). Similarly, the removal of cankers caused by cer-

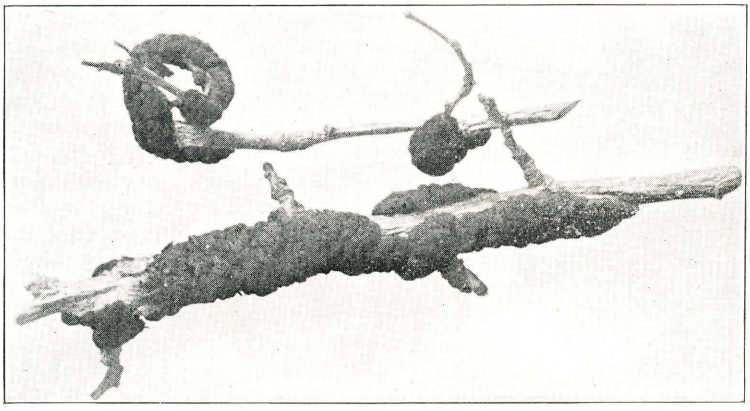


Figure 28.—Black knot on the branch of a plum tree.

tain fungi in which the fungus itself has died out is unnecessary if the cankered area is small. This applies particularly to the small cankers left from the killing of spurs or small twigs by such organisms as the brown rot fungus. If the cankered areas are large, even though the causal organism has died out, its removal and proper treatment of the exposed tissues to prevent the entrance of wood-rotting fungi is to be recommended. A group of cankers on stone fruits is shown in Figures 24-27. Except for the one caused by bacterial gummosis of the cherry, illustrated in Figure 26, nothing will be gained by cutting out the cankers appearing in trees of the stone fruits.

Black-Knot.—A rough, wart-like, woody excrescence appearing on the twigs and limbs of certain plum varieties is more or less accurately described by its name—black knot. It is illustrated in Figure 28. In its early stages it is light greenish brown in color, later turning to a dark brown and finally black. The knots are caused by the invasion of a fungus, which results in a girdling of the twig or branch. European

varieties, particularly those of the Damson group, are especially susceptible. It can be controlled by cutting out the diseased limbs. The regular spraying schedule generally recommended for the control of plum insects and diseases aids in the control of this disease.

Rough knot-like or burl-like growths or excrescences are common in the crotches of most stone fruit trees. They are not due to fungus or bacterial attacks but result from normal growth where cracks in the bark permit woody tissue to be laid down more freely than elsewhere on trunk and limbs. In the cherry they are not limited to the crotches but they may occur anywhere along the trunk or main limbs of older trees where fissures appear in the bark.

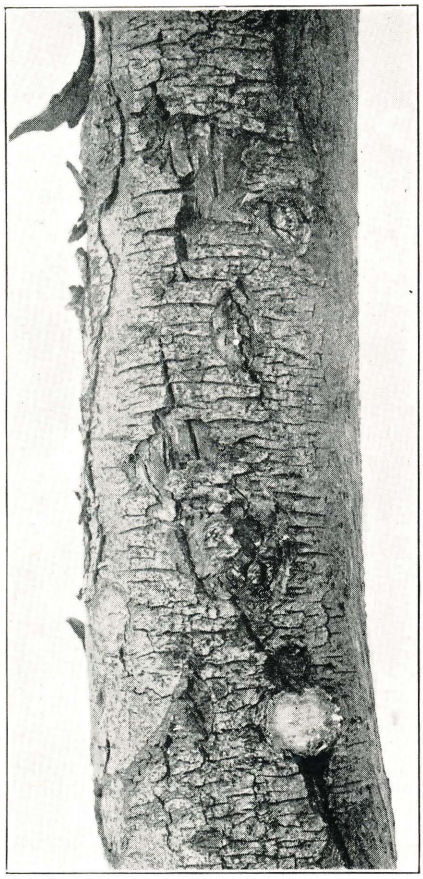


Figure 29.—Sunscald on the limb of an apple tree. Note the flaking off of the dead bark and the cracks in the wood.

Sunscald.—Dead areas of bark and wood, similar in appearance to those caused by certain fungi, are also caused by extremes in temperature. Some of the most common forms of injury here referred to go under the name of sunscald. Sunscald cankers may be occasioned either by extreme heat or by severe late winter freezing. Both forms are found on the south or southwest sides of trunks or main limbs and more commonly on comparatively young trees. In Michigan the trunks of trees that are more than two years old are seldom injured by summer sunscald. The injury is usually within a few inches from the ground on trees growing in a light soil and on a south or west slope. The direct and reflected sun's rays result in temperatures within bark and cambium layers high enough to kill actively growing tissues. The same kind of injury is also found on the limbs of older trees.

In late winter and early spring bark tissues most exposed to noon and afternoon sun often become comparatively warm and when the sun goes down they are subject to a sharp drop in temperature and severe freezing. This rapid freezing, perhaps in some instances associated with a gradually increasing tenderness of the underlying cambium due to a breaking of the rest period, may result in more or less killing. The result is a dead area of bark, around which uninjured tissues grow normally, a typical canker. Figure 29 pictures an

apple branch with a very large cankered area that might easily be confused with a canker caused by fire blight or black rot. Cankers due to winter freezing are sometimes referred to as frost cankers. Spray applications are ineffective against injuries of this type. Low heading of the trees so that the limbs will provide the trunk with at least a limited amount of shade is one of the best preventive measures. Whitewashing the trunk is reasonably effective, especially against summer sunscald. After sunscald cankers have once developed, remedial measures such as those recommended for other cankers should be employed. Unless they are taken promptly wood rotting and wound parasites are likely to gain entrance and seriously damage or even destroy the tree.

Crotch Injury.—Frost cankers, similar in appearance to those caused by sunscald are often found in tree crotches and in the angles between main limbs (see Figure 25). However, they are usually caused by sharp freezing in late fall or early winter, rather than by late winter cold or midsummer heat. In other words, like certain forms of collar or crown rot, they are associated with immaturity in the fall and preventive measures consist in the employing of cultural practices that tend to promote early maturity. Remedial measures are the same as those employed for sunscald or crown injuries.

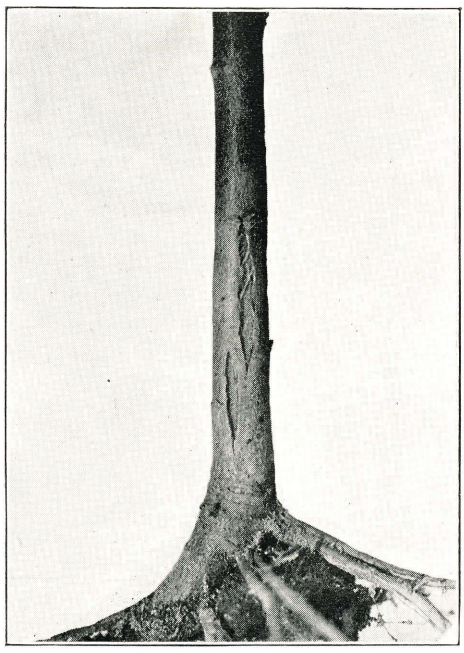


Figure 30.—Frost cracks in nursery trees caused by a drop in temperature to 23° F. on October 20, following a prolonged period of mild and rainy weather.

Bark Splitting. — Unusually severe weather at any time during late fall or early winter is likely to result in the splitting of the bark on the trunk near the ground (Figure 30). Indeed bark splitting may occur at the first sharp frost in the fall if this has been immediately preceded by an unusually long period of mild wet weather that has promoted late vegetative growth. It is a characteristic form of winter injury associated with immaturity. It is serious because wood-rotting fungi gain entrance through the wound, and often the wood itself is so injured as to become more susceptible to their attack. The environmental conditions favorable for the occurrence of bark splitting cannot be prevented, but trees can be made resistant to their influence by cultural practices promoting maturity in the fall. After bark cracks have developed the prompt tacking down of the bark edges checks drying out and sometimes results in the loosened bark uniting with the wood beneath, thus

reducing the size of the wound and hastening healing. If the bark fails to unite with the wood when tacked down, it should be cut away promptly and the exposed tissues protected by a good wound dressing.

Figure 31.—A young tree girdled by rabbits.

Bark splitting associated with immaturity in the fall should be distinguished from normal growth cracks or checks in the surface layers of the bark and also from the deeper cracks that appear in the spring and which often extend to the wood. Both of these types are due to the expansion and growth of the underlying woody tissues. Growth cracks are likely to appear anywhere on the trunk or main limbs; bark splitting due to frost is usually limited to the basal portion of the trunk.

Trunk Splitting.—More or less distinct from bark splitting from the standpoint of attendant conditions, though of necessity accompanied by longitudinal cracks in the bark, is splitting of the trunk and occasionally of some of the larger limbs. Wood cracks are likely to occur in well ripened tissues and perhaps are more common several feet above ground than lower on the trunk. They occur only in very cold weather and with a sudden drop in temperature. Generally they close before spring and heal over. They may reopen in a subsequent winter and heal again, giving rise to a high ridge or "lip" of callous tissue. The bark seldom curls back from the edges of the wound in the case of these wood cracks and there is comparatively little danger of infection from wood-decaying organisms, perhaps because of the temperatures prevailing while the cracks are open. Little can be done to prevent injuries of this kind. If the cracks fail to close promptly of their own accord, bolting may aid in repairing the damage.

Splitting at the crotches or in the limbs, due to heavy loads of fruit or to storm, can best be prevented by careful training while the tree is

Plate 1:-Symptoms of peach yellows as they appear in fruit and leaf are shown in A and B, contrasted with the healthy condition in C and D. Fruits of yellows-infected trees ripen somewhat prematurely.

Plate 2:-Symptoms of little peach or "littles" as they appear in the fruit and leaf are shown in A and B, contrasted with the healthy condition in C and D. Fruits of "littles"-infected trees ripen somewhat after the normal ripening period for the variety.

Plate 3A:-The leaf spot or shot-hole fungus of the cherry. Compare with Plate B and note the similarity to the spotting sometimes caused by bordeaux mixture.

B:-Bordeaux injury on cherry leaves. Compare with A and note the similarity to spotting caused by leaf spot disease.

Plate 4:-Spray injuries on apple leaves. A. Bordeaux injury in different stages of development. This may appear within ten days or may not develop for many weeks after an application. B. Lime-sulphur injury such as develops soon after an application. It appears as a browning of the leaf, in part or whole, and usually develops when spraying is done in hot weather and in patchy areas in the tree where the spray gun was held too close, resulting in a heavy dosage, Yellowing and dropping of the leaves often follow.

Plate 5:-Foliage injuries on the apple and pear. A. The yellow leaf condition which sometimes develops during severe drouth, independent of spray injury. B. A pear leaf injured by a lime-sulphur and lead arsenate spray. C, D, E and F. Stages and types of lime-sulphur-lead arsenate injury on apple leaves. Such leaves usually turn yellow and drop, generally within two weeks after an application, but yellowing may continue for many weeks.

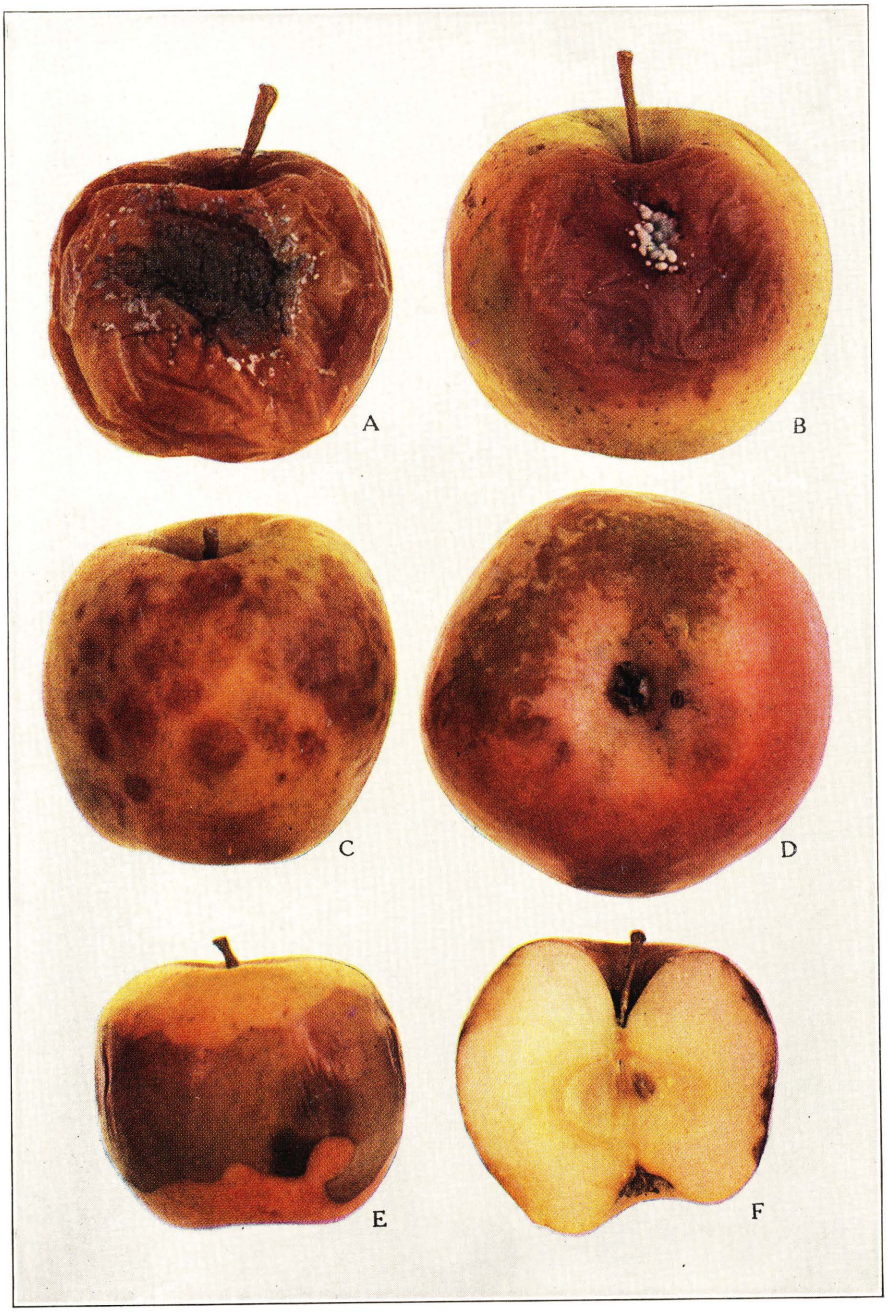


Plate 6:-Storage diseases of the apple. A and B—Soft rot. C and D—Common storage scald. E—A type of scald often found on Jonathan. F—Cross-section of a Jonathan apple showing scald.

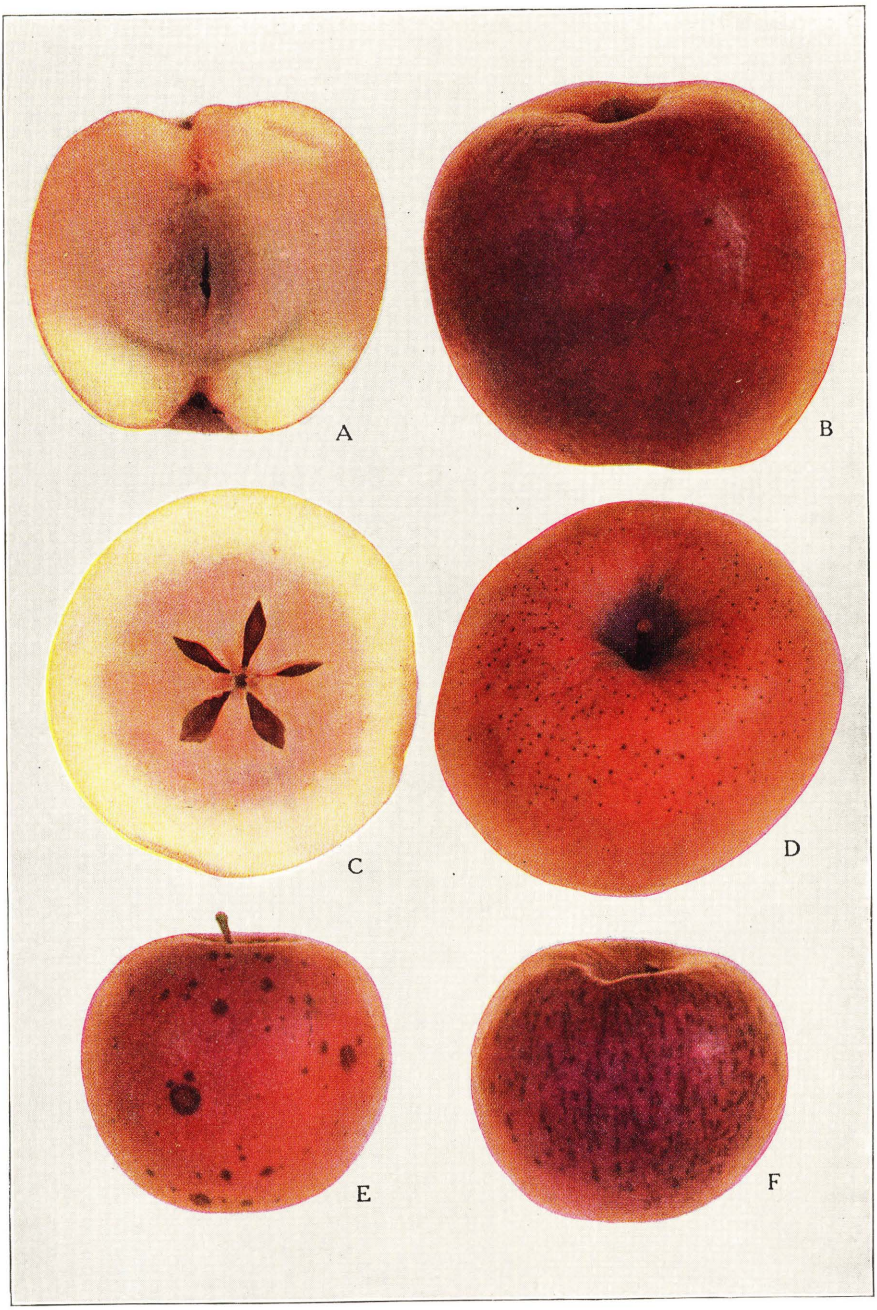


Plate 7:-Physiological troubles of the apple. A and B, watercore. C, internal browning or "breakdown". D, Jonathan spot on Northern Spy. E and F, Jonathan spot on Jonathan.

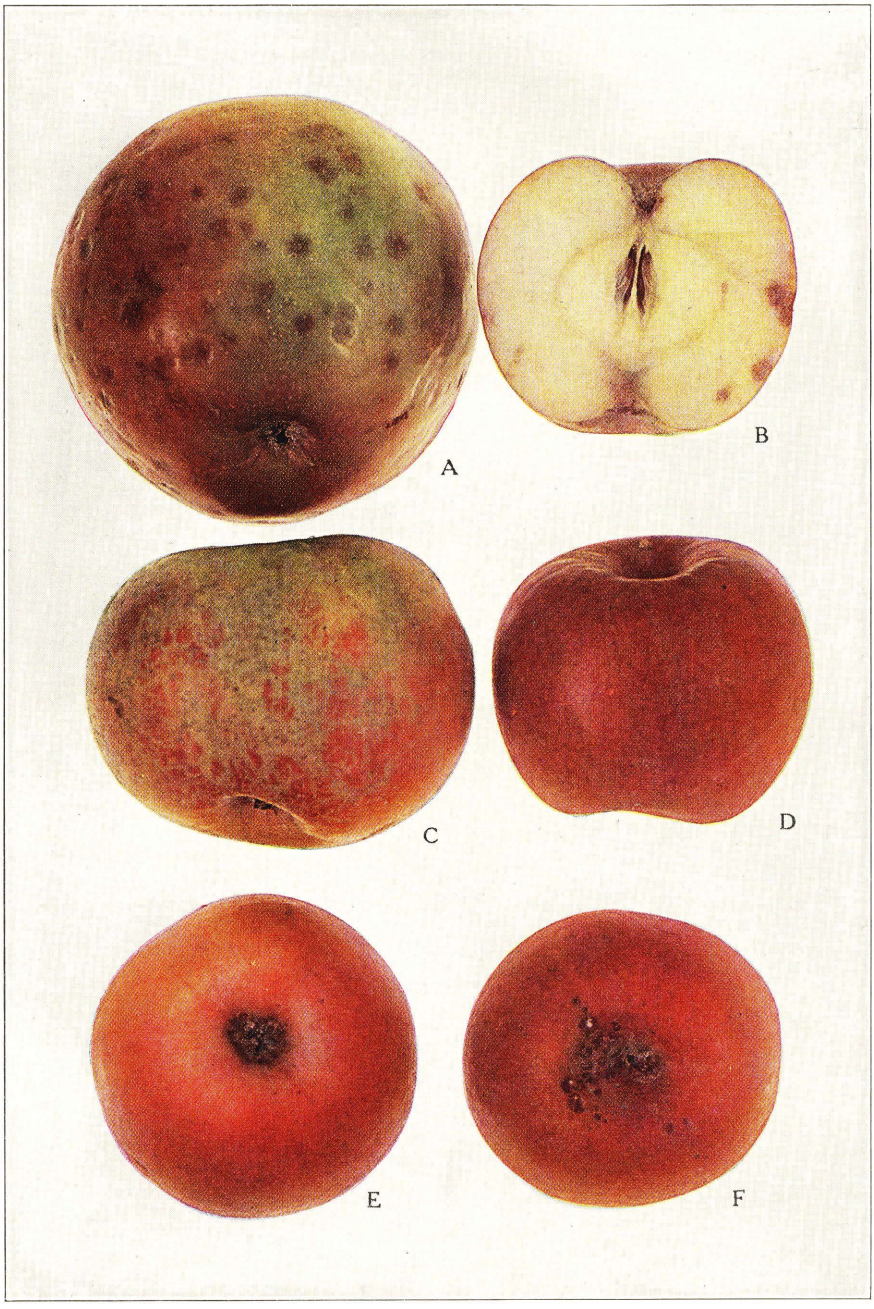


Plate 8:- Bitter pit or fruit spot, a physiological disorder, is shown at A and B. At C is shown a characteristic russeting due to bordeaux spraying and D a russeting due to lime-sulphur-arsenate of lead application. E and F show blossom-end injuries following the use of lime-sulphur and lead arsenate.

young and by propping or bracing when necessary in later years. Often it is practicable to save limbs that have split part way off by bolting or wiring them back into place.

Gummosis.—A condition similar to cankers on trunks and limbs of a number of stone fruits is generally referred to under the name of gummosis, though cankers of this type seldom show such clear-cut margins

Figure 32.—A tree protected from rabbits by galvanized screen wire. Wire protectors are to be preferred to those made of wood veneer.

as those found in the apple and pear. The disorder gets its name from the gummy exudations where the lesions occur. Some gumming may take place where the tissues are apparently sound or where perhaps there is a slight injury such as a growth crack in the bark or severe pressure between two limbs. Gumming of this type in no way injures the tree and may be ignored. However, any extensive gum formation is usually associated with more or less serious injury to bark and wood,

such as the attack of borers, fungi, or bacteria. A bacterial gummosis of the cherry works in that fruit in much the same manner as fire blight canker in apples and pears. A typical canker produced by that disease is shown in Figure 26. Sweet cherries are especially susceptible. It should be treated in the same manner as fire blight canker in apple and pear, except that summer cutting is advisable and sterilization of the cut surface is neither necessary nor desirable. The gummosis that is incident to the attack of borers or other insects or that which in some instances seems to be due to a high water table can be best remedied by removing the cause.

Affecting the Leaves

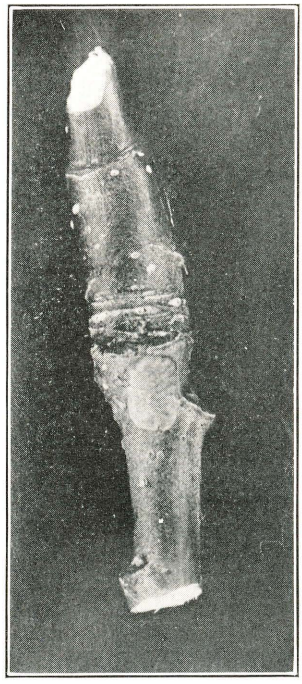


Figure 33.—An egg cluster of the fruit tree leaf roller on the twig of an apple.

Dwarfed Foliage.—Dwarfed, crinkled foliage is mentioned in a number of places as a symptom of a diseased condition or of the attack of some insect and, when diagnosis depends on foliage conditions alone, considerable caution is necessary in deciding what may be the cause of the trouble. Drouth and insufficient nutrient supply usually result in a reduced leaf size that is general over the entire tree and that is unaccompanied by any crinkling or curling. Internodes will be somewhat, but not greatly, shortened. If the leaves are a pale yellowish green in color the evidence indicates nutrient supply as responsible for the condition; if they are more nearly a normal green but perhaps rather dull it is more likely to be a case of drouth injury. Both of these foliage conditions, however, may be induced by actual soil deficiencies or by a decreased water or nutrient intake occasioned by root or crown killing. In every case, roots and crown should be examined to aid in definitely locating the cause of the trouble.

Dwarfing, crinkling and curling of the leaves all over the plant, perhaps accompanied by a yellowing or mottling of the foliage or by the development of a deeper green color and by very marked shortening of the internodes is usually a symptom of one of the mosaic or virus diseases. Dwarfing of the leaves without crinkling or curling, but with a marked yellowing and with a very marked shortening of the internodes so as to give rise to almost a rosetted appearance, is more frequently a symptom of that group of disorders commonly designed as yellows, little peach, rosette, (see Plates 1 and 2).

Dwarfing accompanied by some crinkling but by little curling and by no yellowing of a few of the lower leaves of the shoot or spur, the leaves opening later being normal in appearance, is often a result of frost injury in the spring. It may also result from heavy spray applica-

tions, particularly of lime-sulphur. Dwarfing of these same lower leaves of shoot or spur, accompanied by much curling, is usually the result of aphid attack. Dwarfing, accompanied by curling but seldom by yellowing of a group of leaves somewhere along the shoot, with normal leaves above and below, is usually due to a temporary local attack of aphids, leaf hoppers, or mildew. Occasional dwarfing of a group of leaves somewhere along the shoot but unaccompanied by either yellowing or curling is likely to be associated with a temporary slowing down in growth, followed by a period of renewed vegetative activity.

Yellow and Purple Foliage.—As already indicated, deficiencies in soil moisture or soil nutrients and crown or other injuries that interfere with the conduction of the sap, tend to give the leaves a pale green or yellowish green tinge. However, such leaves, if disease-free, persist well throughout the growing season except in cases of extreme drouth. On the other hand, yellowing that follows the attack of some fungus or bacterial disease or some form of spray injury usually comes on more quickly, the yellow is much more intense and leaf fall takes place much earlier.

Figure 34.—A cherry leaf, natural size, partly skeletonized by a slug. The insect itself is shown slightly to the right of the center of the picture.

The leaves of the pear and to a lesser degree those of some of the other fruits often assume a bright reddish or purple color towards the end of the growing season. Any pronounced coloration of this kind in fruit trees usually indicates the presence of crown or root injury. It may occasionally result from drouth late in the season.

Burned or Scorched Foliage.—Midseason girdling of a limb, twig or shoot, such as is occasioned by the fire blight of the apple and pear (see page 30) often results in a sudden browning or blackening of the foliage above the girdle and these withered leaves may persist on the trees until late in the summer or even well into the winter. A similar blighting or blasting of the opening buds of the pear is sometimes caused by the pear thrips (see page 42).

A scorching or burning of the edges of the leaf, the center remaining green, may be due to frost, spray burns, or too heavy applications of

commercial fertilizers. If caused by frost, there is usually an accompanying dwarfing and curling of the leaf; if caused by spray applications or by too heavy applications of commercial fertilizers there is little or no curling and dwarfing. When the burning is due to spray applications, old and new foliage alike is affected; when it is due to fertilizer applications, the youngest leaves are injured most severely.

Caterpillars, Slugs, and Other Leaf Eaters.—The larvae and in some cases the adults of a large number of different species of insects eat the foliage of fruit plants. For the most part these insects are popularly classed together as caterpillars and slugs. Some kinds devour the entire tissues of the leaf, others only the softer tissues between the ribs and large veins; and some skeletonize the leaves by eating away the succulent upper-surface or under-surface tissues. Slug injury of this kind on a cherry leaf is shown in Figure 34. Miners eat out the tissues between the two surfaces of the leaf; some kinds of caterpillars spin webs of one kind or another, like the webworms or tent caterpillars; some, known as leaf-rollers, make a sort of a nest out of a leaf or leaf cluster and then feed on the protected tissues within; some, like the rose-chafers and bud-moths, feed principally on opening buds; and still others have different habits. An egg cluster of one of these leaf eaters, the fruit tree leaf roller, is shown in Figure 33. There is one remedy for practically all of these leaf eating insects, namely, timely spraying with some poison, such as arsenate of lead. Usually the regular spraying operations outlined in the calendar, which is framed principally to control the more serious pests such as the codling moth, curculio or grape-berry worm, will incidentally control these leaf eaters. One notable exception is the apple-tree leaf-roller which is best controlled by an oil emulsion or a miscible oil so applied as to reach the eggs just as growth is starting in the spring.

Climbing Cutworms.—Though the climbing cutworms might be properly classed with the caterpillars, slugs, and other leaf eating insects, their nocturnal habits, the control measures effective against them, and their relative importance in Michigan all contribute toward making necessary their special consideration. These caterpillars spend the daylight hours in the soil or under trash. At night they climb the tree and may completely defoliate the topmost branches, returning to the ground before daybreak. Most of their work is done in the spring as the buds are opening or before the leaves are full grown. Naturally the caterpillars themselves are seldom seen but their preference for the opening leaves and flowers of the topmost braches makes the identification of their work comparatively easy. Sometimes the defoliated terminals of non-vigorous trees fail to leaf out again, resulting in more or less dieback and the development of a more or less characteristic "staghorn" condition.

Since they are such voracious feeders and since they work principally on expanding foliage and opening buds, arsenical sprays are not very effective against them. Banding the trunk of the trees with bands of loose cotton batting or tree tanglefoot to prevent the larvae from reaching the branches is the most satisfactory control measure. Poison bran mash placed in the crotches of the trees or on the soil immediately around them will destroy many.

Aphids or Plant Lice.—Aphids or plant lice of one kind or another attack almost all kinds of plants. They generally work on the under side of the more tender foliage, causing the leaves to curl around them. The leaves are dwarfed, shoot growth is checked, and other ill effects follow. Control measures to be effective must be applied relatively early, that is, when the eggs are hatching or at least before the leaves are curled around the insects, for it is then practically impossible to reach them with a spray, and, as they are sucking insects, the insecticide must come in contact with their bodies to be effective against them. Nicotine sulphate spray or dust applications constitute the most satisfactory method

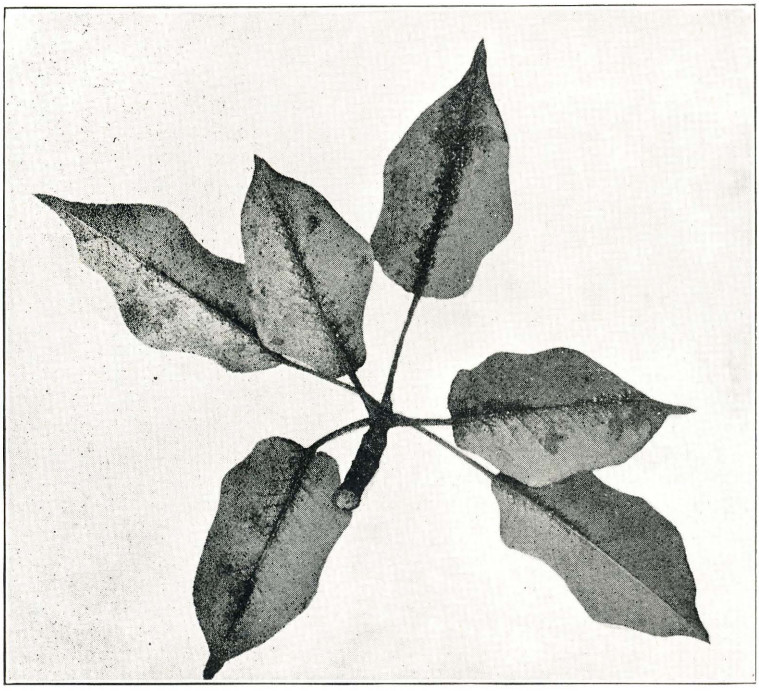


Figure 35.—Nymphs of the pear psylla. (Photograph furnished by Wm. A. Ross.)

of control. A delayed-dormant season application of the winter strength of lime-sulphur mixture or of miscible oil is likewise of some aid in the control of certain species, especially of the apple aphids.

Psylla.—One of the most serious pests of the pear is the psylla, a sucking insect that in its adult form is not more than an eighth of an inch long. It winters over in the adult or "fly" stage, and may frequently be seen in great numbers hiding under rough bark. In spring and summer the nymphs, pictured in Figure 35, suck the juice of both foliage and fruit, reducing the size of the latter, causing premature defoliation, and greatly weakening and lowering the productivity of the tree. In addition to this, the honeydew which the nymphs secrete "gums

up" both foliage and fruit, collects dust, and furnishes an ideal medium for the growth of sooty mold and other fungi (see Figure 65). The result is that the fruit is practically unsalable. The proper use of certain contact insecticides in the regular spraying or dusting schedules generally recommended for bearing pear trees is as effective against this pest as anything yet known.

Thrips.—Though the work of thrips would generally be classed by growers as a foliage trouble, because of the wilting and dying of partly expanded leaves, they do not confine their attention to foliage. One species attacks the buds of the strawberry and prevents the opening of

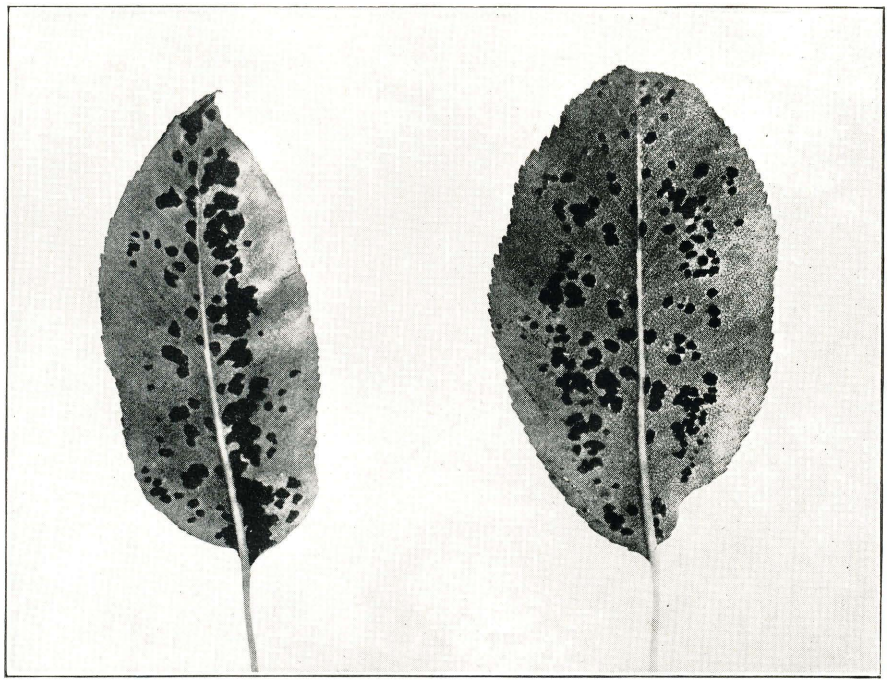


Figure 36.—Blisters on a pear leaf caused by mites. Mites also attack apple foliage, but the injury has a somewhat different appearance from that on the pear.

infested buds. The same species attacks developing peach fruits, producing characteristic blemishes which persist until picking time (see Figure 63). Another species attacks pear blossoms and "blasts" the set and still others attack other orchard trees. The usual recommended delayed-dormant sprays are fairly effective in holding them in check.

Blister Mites.—Blister mites, creatures of microscopic size, cause small, irregularly-shaped blisters on the leaves of pears and a number of other fruits (see Figure 36). Their general effect is to weaken the tree, check its growth, and lower its productivity. From the standpoint of control they are to be regarded as bud-inhabiting pests, as they winter over about the bud scales and are best controlled by dormant or

delayed-dormant season spraying with winter-strength lime-sulphur or with a miscible oil.

Leaf Hoppers—Leaf hoppers of many kinds cause injury to the foliage of fruit plants. They are more likely to attack late in the season or in midseason than earlier. They suck the juice of the plant and give the foliage a grayish cast. A hopper-injured apple leaf, along side of an uninjured one, is shown in Figure 37. When infestation is severe the plants are seriously weakened, with attendant reduction of crop. Orchards that are maintained in sod are somewhat more subject to the attack of these pests than those under clean cultivation and sometimes a change from the one system of management to the other is warranted

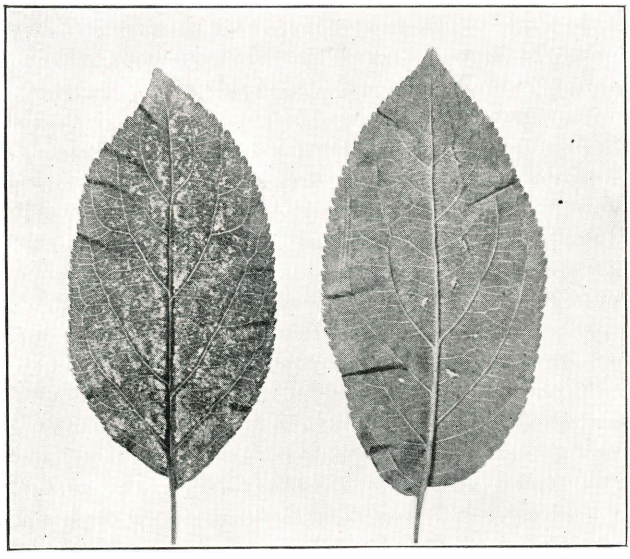


Figure 37.—An apple leaf showing leaf hopper injury is pictured at the left. On the right is an uninjured leaf for comparison. Note several cast skins of the leaf hopper on the leaf at the right.

on this account if for no other reason. Summer applications of nicotine sulphate and bordeaux are the most effective remedial measures. However, if they do not become numerous until just shortly before the time for normal leaf fall, little attention need be paid to them.

Red Spiders.—Injuries to foliage more or less closely resembling those occasioned by leaf hoppers are caused by red spiders. These pests are so small that they are hardly visible to the naked eye. Nevertheless, under favorable conditions, they are found in great numbers on the under sides of the leaves of raspberries, dewberries, currants, gooseberries, and occasionally other fruits. Their feeding punctures result in the death of much of the green tissue of the leaf, giving its upper surface a grayish or bronze yellow cast. The under sides of affected leaves have a cobwebby appearance. Attacks are usually most

Figure 38.—A spotting of apple leaves caused by San Jose scale. Close inspection shows the presence of a scale insect near the center of each spot. These spots are usually dark reddish purple in color and may be found on any of the common orchard fruits except the cherry.

severe during periods of hot dry weather. Damage to the foliage is often considerable.

Fire Blight.—The canker form of this disease has already been described and control measures discussed under the heading of localized disorders affecting trunks, branches, and shoots (see page 30). It should be mentioned here because its most striking, if not its most dangerous, symptom is the brown dead leaves that cling tenaciously to the blighted twigs throughout the summer and often well into the winter. Few will mistake this trouble after it has once been pointed out to them. This disease may make its appearance almost any time during the growing season. It may spread very rapidly when there are abundant sources of infection, namely the hold-over winter cankers (see Figure 22) and blighted blossoms and when environmental conditions are favorable. Many of its outbreaks or epidemics are associated with periods of relatively high temperature.

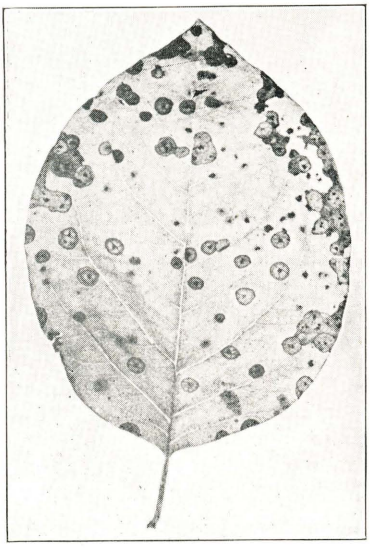


Figure 39.—Leaf spot on quince foliage. This same disease also attacks the fruit (see figure 73).

Control measures have been already explained in connection with the discussion of the winter cankers.

Removal of all blighted twigs as they appear in the growing season has been recommended but when infection is severe is hardly practicable. In a large percentage of cases the blight dies out of its own accord when it is limited to the new shoot growth. Usually only when it runs back into considerably older wood are hold-over cankers formed that serve to spread the disease the next season. If, however, a watersprout or sucker coming out from the crown, trunk, crotch or one of the main branches starts to blight, it should be removed immediately, as failure to do so might permit the spread of disease to bark tissues in one of these vital spots where a hold-over canker will form and girdling of limb or the tree will begin.

Leaf Spots, Scab, and Shot-hole.—These terms are intended to refer to a large group of ailments characterized by a spotting of the leaves of fruit plants and caused by various kinds of insects, bacteria, and fungi. Other terms almost equally descriptive, such as frog-eye, blight, and rust are sometimes used to designate diseases of this type. Frequently the spots are so numerous that they run together, causing large irregularly-shaped lesions. The spots caused by different fungi or bacteria that are here grouped together vary greatly in size, color, shape and general appearance (see Figures 39, 40, 41 and Plate 3). A leaf spotting caused by San Jose scale is shown in Figure 38. In some instances, the tissues invaded by the organisms are cut off and drop out of the leaf, giving it a perforated or "shot-hole" appearance. In many cases infected leaves turn yellow and drop off prematurely.

Figure 40.—Scab lesions on the leaf of an apple. Scab also appears on pear leaves in a similar form.

In any case the effect of these diseases is to weaken the plant as a whole, resulting in reduced yields of lower grade fruits, in lessened vegetative growth, and in greater susceptibility to winter injury. Some of these leaf-spotting or leaf-blighting fungi invade the tissues of the fruit and cause lesions that seriously affect their market value. One of these, the leaf blight of the quince, as it affects the fruit, is illustrated in Figure 73. For the most part these diseases can be satisfactorily controlled by proper spraying with suitable fungicides, such as are recommended in the regular spraying schedules for the different fruits. In the

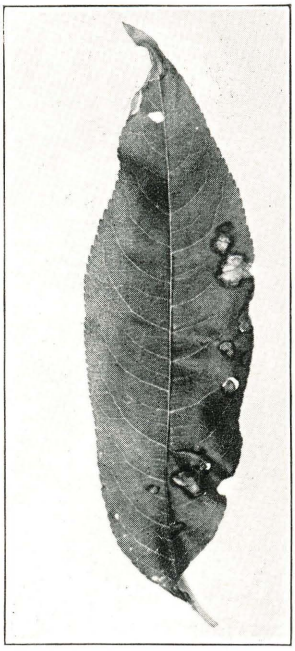


Figure 41.—Bacteria leaf spot of peach. This disease also occurs on plums. Compare with Figure 42, showing a similar condition due to spray burn.

case of certain fruits, as for instance the sour cherry, the spray schedule is framed primarily to control its leaf spot disease.

Spray Burn.—Leaf spotting that in general appearance closely resembles that caused by certain fungi and bacteria is sometimes caused by spray applications. Sometimes the injury takes the form of either round or irregularly-shaped spots or of brown areas along the margins of the leaf. If this marginal spotting or killing occurs when the leaf is only partly grown it may arrest development locally, resulting in more or less crinkling, curling, and even dwarfing of the foliage. Almost any of the spray materials when used in too great concentration or in excessive amounts may lead to this form of foliage injury, though the standard materials recommended in the regular spray schedules of the Experiment Station are much less injurious than certain of the trade preparations. Certain characteristic forms of spray injury on cherry foliage are shown at B in Plate 3 and on apple foliage in Plates 4 and 5. A leaf spotting and shot-hole effect in peaches caused by spraying is pictured in Figure 42.

Leaf spotting or burning is often followed by a premature yellowing and dropping of the foliage with all the attendant weakened effects on the tree. Certain seasonal or environmental conditions render foliage particularly susceptible to spray injury. Changing from one fungicide to another in the middle of the season's schedule of spray operations, particularly in the case of cherries, is very likely to lead to leaf yellowing and premature defoliation. Often it is very difficult to distinguish between some of the forms of spray burns and certain of the leaf spotting fungus lesions. Knowledge of the conditions under which the spotting appears, together with the appearance of

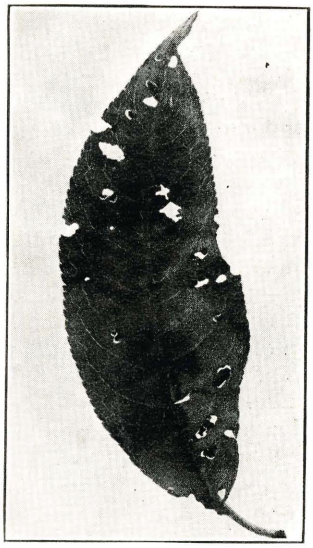


Figure 42.—Leaf spot and shot-hole of peach due to spray burn.

Compare with Figure 41, showing similar lesions caused by a bacterial disease.

spots due to different causes, furnishes the most reliable clues to what the trouble may really be.

From the very nature of the injury, treatment must be preventive rather than remedial. The statements that have been made incidentally offer a number of suggestions for avoiding the trouble.

Mildew.—Mildews are of two general types, powdery and downy. Powdery mildew is common on the foliage of the cherry, grape, raspberry, and gooseberry though the gooseberry is the only one of these plants seriously damaged (see Figure 43). With this fruit and with powdery mildew in general the treatment is usually remedial rather than preventive.

Rust. — Though often applied to such disease as the leaf spot of strawberry and to anthracnoses of various kinds, this term more accurately describes true rust diseases such as are found on apple, quince, blackberry and raspberry. Apple rust is uncommon in Michigan but quince rust occurs in a number of places. It more commonly attacks the stems and fruits causing swollen areas tinged with red and covered by a distinct fungous growth. A rust-infected fruit is shown in Figure 72. The same disease attacks the red and lowbush cedar, producing galls or "cedar apples." The disease can be controlled by destroying the cedars which serve as the spring source of infection.

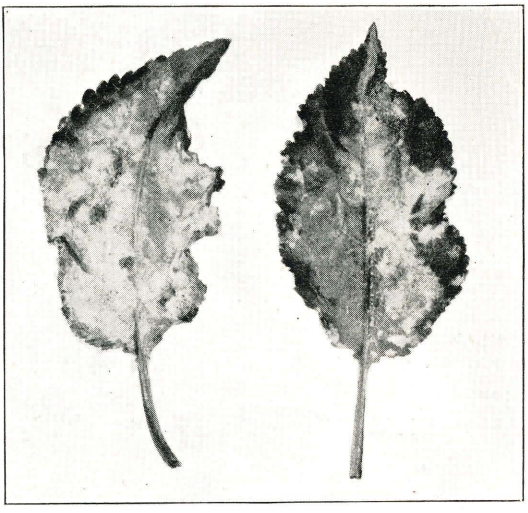


Figure 43.—Powdery mildew on leaves of the cherry.

Peach Leaf Curl.—The swollen, curled, and velvety appearance of peach leaves that are infected with this disease, illustrated in Figure 44, makes identification very easy. About the middle of the season they turn yellow and fall off. Fortunately the curl does not spread from leaf to leaf to any considerable extent during the growing season, being limited almost completely to those leaves that open out with it in the spring. It is readily controlled by dormant-season spraying with lime-sulphur mixture. It is important that application be made before the buds start to open in the spring.

Sooty Fungus. A number of fungi that give rise to a sooty growth are occasionally found on the surface of leaves and fruit. For the most part they grow on honeydew secreted by aphids, psyllids, or other suck-

ing insects. They are not truly parasitic on the plant. They may be best controlled by combating the pests responsible for the main injury.

Affecting the Flowers

Blossom Blight.—The term blossom blight is used to refer to the destruction of open or partly open flowers by fungi or bacteria. The fire blight of apple and pear and the brown rot fungus of stone fruits are the most common causes of this trouble in Michigan. The destruction

Figure 44.—A peach shoot showing healthy leaves and leaves infected with the leaf curl fungus.

of some of the flowers is not in itself a cause for much alarm but when the blight of the blossoms means the subsequent invasion and killing of the spur or twig, as it often does in the apple and pear, it is a more serious matter. A blighting or "blasting" of the opening buds of the pear is also due to thrips (see page 42). Most cases of failure to set fruit, however, are due to factors other than disease. Among the more important of these factors are poor soil, especially a deficiency in available nitrogen, cloudy, rainy weather during the blossoming season, frost, lack of satisfactory varieties for cross pollination purposes, and failure to provide bees to effect a transfer of pollen from flower to

flower. Disturbed water relations during the period of fruit setting, such as are occasioned by plowing or discing at that time, frequently leads to the dropping of many blossoms that otherwise would set fruit.

Affecting the Fruit

Codling Moth.—The most important of the fruit-infesting insects of deciduous fruits is the codling moth. It is responsible for most of the so-called "worms" in apples, pears, and quinces and not ununcommonly is found in the fruits of the peach and many wild relatives of the apple, such as the haw. It is likewise responsible for a considerable percentage of the "stings" of the apple and pear. Figures 45-48 show various types of injuries and blemishes caused by this insect. It may be controlled satisfactorily by proper spraying with an arsenical poison. The summer spraying schedule generally recommended for apples and pears is always planned with the control of this insect in view.

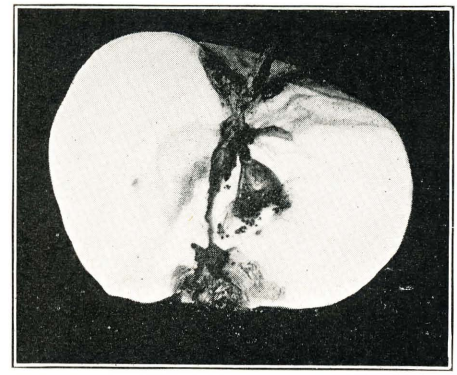


Figure 45.—A codling moth burrow about the core of an apple.

Surface-eating Fruit Worms.—The larvae of a number of insects are known to eat the surface tissues of different kinds of fruits. Such injuries seldom extend deeply into the tissues of the fruit but they result in blemishes that seriously reduce its market value. Some of these injuries are shown in Figures 49-51. As a rule thorough spraying for the codling moth or curculio or the leaf eating caterpillars will control pests of this type, no special application being necessary for them.

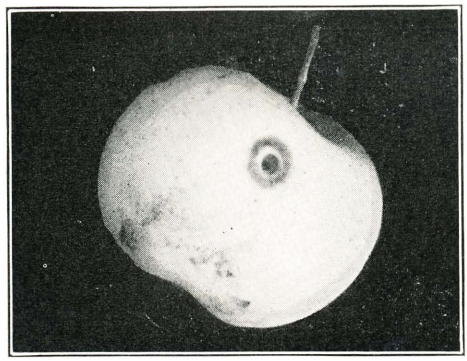


Figure 46.—A codling moth exit hole.

Maggots. — Fruit - infesting maggots are the larvae of so-called fruit flies. The two most important kinds in Michigan are the apple and cherry maggots. They are easily recognized by the small tunnels which they make through the flesh of the fruit in all directions and surrounding which the tissues turn brown and often start to decay. A section through a badly infested apple is shown in Figure 52 and Figure 53 shows scars on the surface of the apple where the skin was punctured

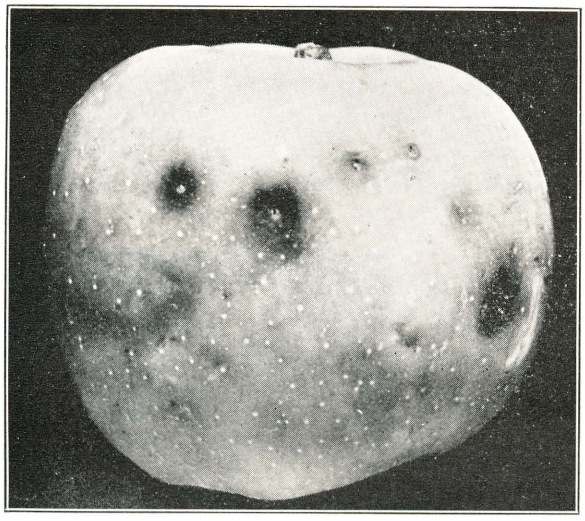


Figure 47.—An apple showing a number of the smaller type of blemishes caused by the second brood larvae of the codling moth. These are typical codling moth "stings."

by mature flies for egg laying. The larvae themselves are footless, headless, slender, and less than a quarter of an inch long. Infested fruit is practically worthless. The arsenical poisons recommended in the regular spraying schedules usually afford sufficient protection against them. Clean sanitation about the orchard will do much toward holding maggots in check.

Curculios. — Worminess in the stone fruits is generally due to attack by one or another of the curculios, a group of pests that is of about the same relative importance in their culture as codling moth is in the culture of apples and pears. Typical curculio injury on plum is shown in Figure 54 and Figures 55-58 show various forms of curculio injury on apples. Control is secured by the proper use of arsenical sprays. The regularly recommended spraying schedules of all these fruits are primarily devised for the control of these pests.

Alabama Moth. — During the harvesting season the skin of the peach may be punctured by the Alabama moth. These punctures appear as small round holes, often not larger than pin pricks. The soft tissues underneath soon start to decay and the fruit becomes unsalable. The holes are the feeding punctures of the adult moth that sucks the juices of the ripe fruit. Fruit that is still firm is not punctured. Frost kills the

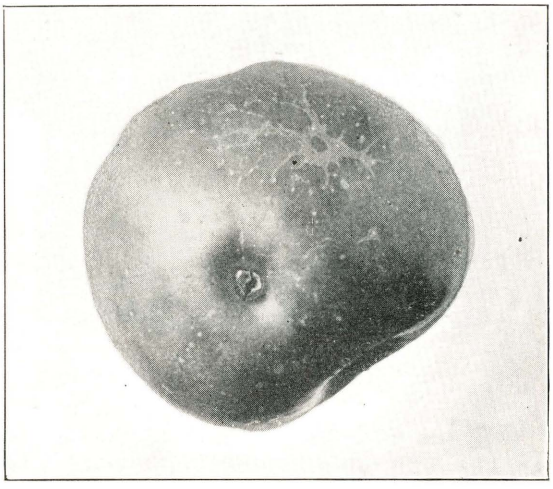
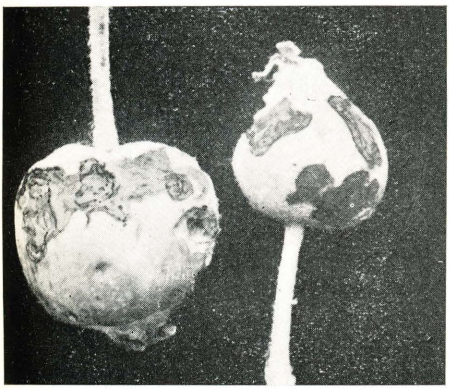
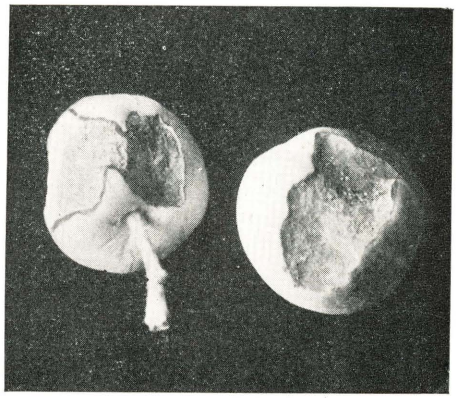


Figure 48.—A surface blemish caused by a first brood codling moth larva.

moths each year and apparently the pest does not breed in Michigan but a fresh invasion from more southern districts may be expected each fall. Spray applications are ineffective. Control consists in picking





Figures 49 and 50.—Injuries to partly grown apples caused by larvae of the tussock moth.

peaches while they are still firm and, if they are left in the orchard or packing shed until they soften, in so covering or protecting them that the moths cannot puncture them.

Stings.—So-called "stings" are of many kinds and may be caused by any of a large number of insects. The chief offenders are the codling moth, several species of curculio, and the red bugs. It is often difficult to distinguish between the work of these different pests from a casual examination of the wound or blemish. Some of the more common "stings" are shown in Figures 55-59. Usually the surface of the fruit is depressed or indented at the point where the fruit was "stung." The injury is generally occasioned by a feeding or egg-laying puncture and may be little more than skin deep or it may extend to the core or pit of the fruit. The surface blemishes shown in Figures 60-64 would be classed by some as stings, though they are not caused by egg-laying punctures or by the feeding punctures of insects with biting mouthparts,

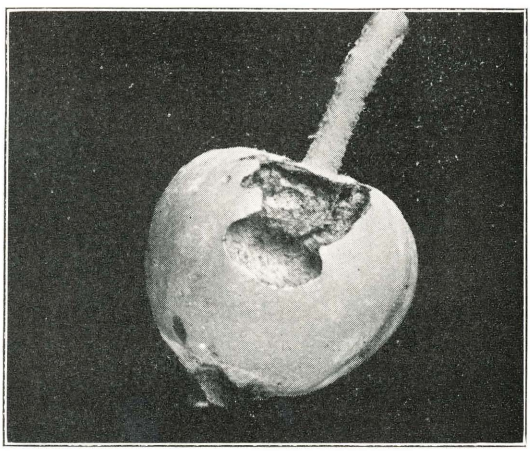


Figure 51. Work of the rose-chafer on the apple.

Figure 52.—Section of an apple showing the work of the apple maggot. The tunnels themselves are small but often the tissues for some distance about them turn brown.

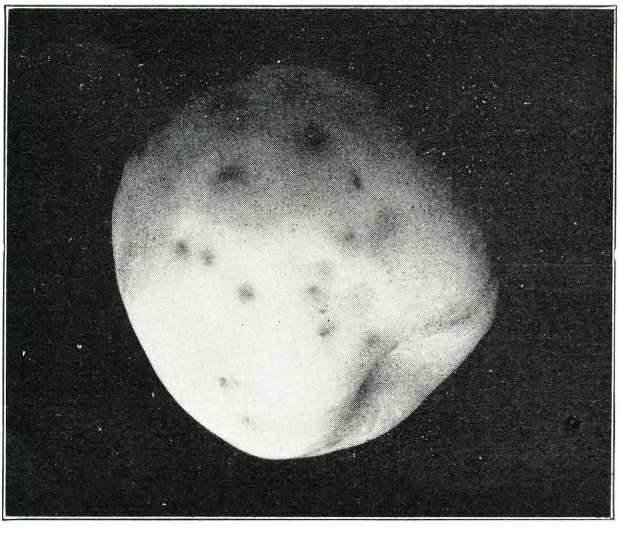


Figure 53.—Surface scars on the apple showing where eggs of the apple maggot have been deposited.

such as those in Figures 55-58. The feeding punctures of the aphids in particular usually lead to a very marked dwarfing and deforming of the fruit. The presence of one or two stings, especially where the injury is

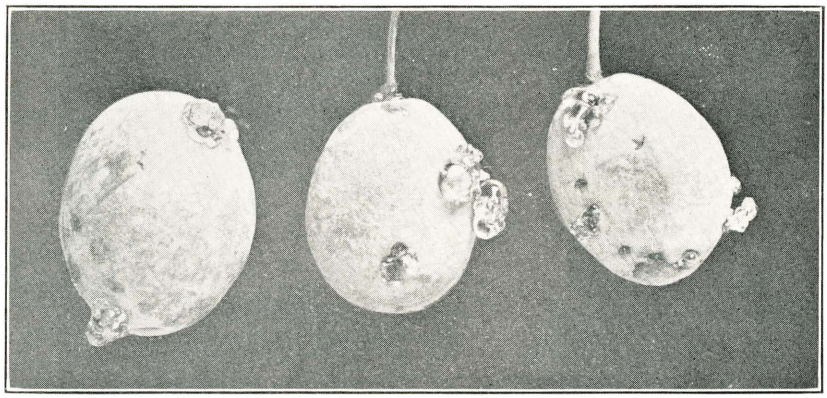


Figure 54.—Curculio injury on plums. The specimen on the right shows several typical crescent-shaped egg-laying punctures. In time more or less gum generally exudes and collects at these points before the fruit drops to the ground. The photograph shows a number of these exudations.

a surface one, may not ruin the fruit for market but it always results in lowering its grade and value. Fortunately the spraying treatments that are generally recommended for the more serious pests, particularly the codling moth, curculio and grape berry moth, generally take care of the stings.

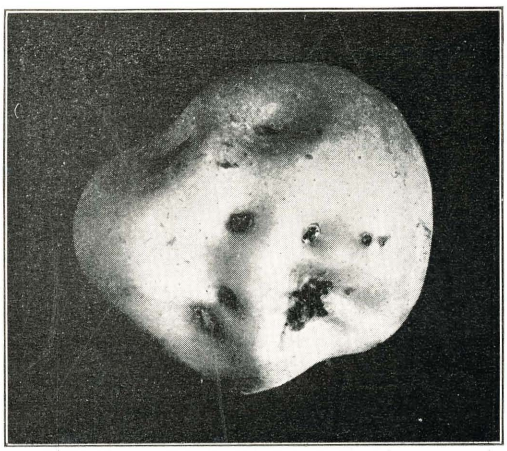


Figure 55.—An apple badly deformed by several egg-laying punctures of the plum curculio. Figure 56 shows an earlier stage of this injury.

Scab.—The term scab is more or less descriptive of a kind of spotting on the fruits and leaves and, in some cases on the twigs of apple, pear, and peach. These diseases are caused by fungi which grow for the most part on the surface or just beneath the cuticle of the affected portion forming a dark mass of fungous growth, which, together with the affected fruit tissue, gives the characteristic scabby appearance such as is shown in Figures 66 and 67. More damage is done to the fruit than to other parts. When the attacks are light the injury is limited to the

surface; when severe, it may result in a one-sided development of the fruit and sometimes cracking. The scab lesions not only are blemishes

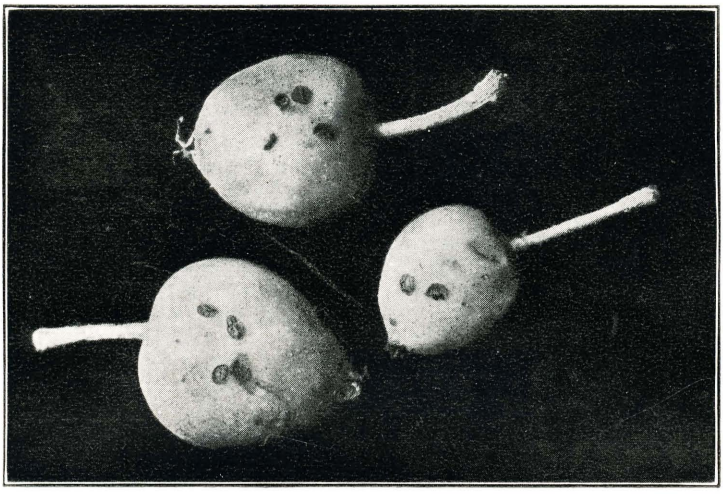


Figure 56. Partly-grown apples showing stings caused by the egg-laying punctures of the plum curculio. Note how closely they resemble those on the plum shown in Figure 54. If the egg fails to hatch the wound corks over and the fruit may mature without the injury becoming any more prominent than it appears in this picture. It remains a strictly surface blemish. On the other hand, if the egg hatches and the larva tunnels in to the core the result may be a serious deformity of the fruit, such as is shown in Figure 55.

in themselves, resulting in a lowered grade, but they provide points of entrance for a number of the different fruit-decay organisms. Control is secured by following the regularly-recommended spraying schedules.

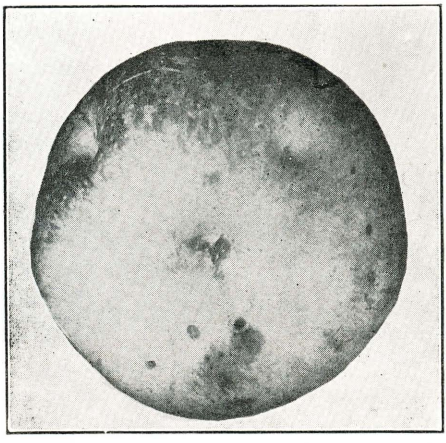


Figure 57.—Surface blemishes caused by the egg-laying punctures of the apple curculio, an insect related to the plum curculio. The nature of the attendant injury to the flesh is shown in Figure 58.

Sooty Blotch.—A surface fungus, often found on apples and pears is described fairly accurately by its name, sooty blotch. It is pictured in Figure 70. The regular spraying schedule recommended for scab generally gives satisfactory control of sooty blotch.

Rot.—The decay of fruit in storage, in transit and before picking may be due to any one or more of a number of fungi and more rarely to bacteria. Each of these rots presents certain characteristics by which it may be identified, though it is

often somewhat difficult to differentiate between them. The term black rot is applied to chacteristically black or dark colored decays of certain fruits, particularly apples and grapes. Figure 74 shows a photograph of an apple whose complete decay has been caused by the black rot fungus. Brown rot is especially destructive to stone fruits and each season many peaches, plums, and cherries rot before or soon after they reach the market. Rotted fruits are brown in color and are usually covered by tufts of the rot-producing fungus (see Figure 68). Soft rot or blue mold is the most destructive storage rot of the apple and the same disease attacks many other fruits. Decayed parts are brown, very soft and watery, and are usually covered by a bluish growth of mold. Apples that are decaying in storage because of soft rot or blue mold are shown in Plate 6. Fruits partially rotted have a very unpleasant but characteristic "blue mold" taste.

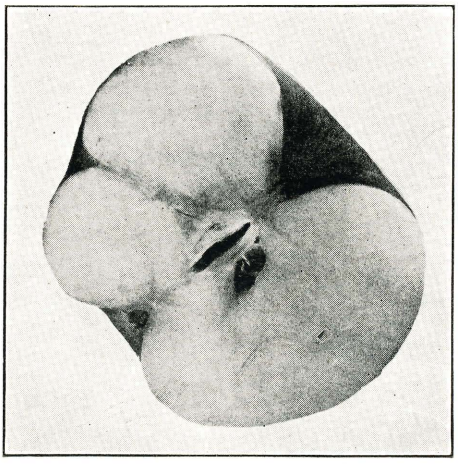


Figure 58.—A section through an apple stung by the apple curculio and in which the larva has tunneled through to the core. Surface blemishes caused by this same insect are shown in Figure 57.

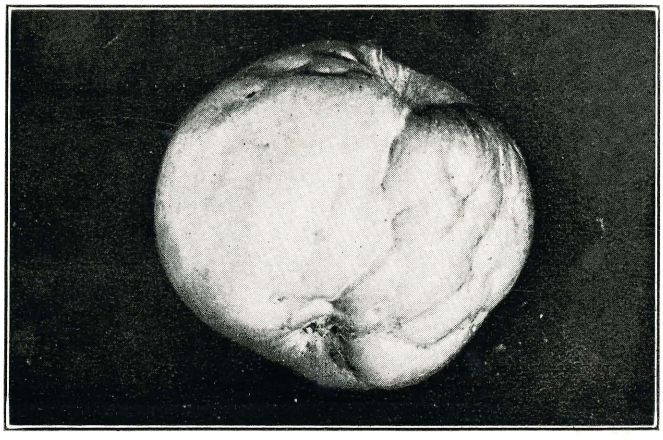


Figure 59.—Red bug injuries on apple.

Numerous other fungi, many of which like the soft rot organisms are commonly classed as molds, lead to the rotting of fruit in transit or in

storage, though they may cause very little or no loss before harvest. Most of these decays, even those working only on fruit after picking, may be prevented by proper orchard spraying. Fortunately, those

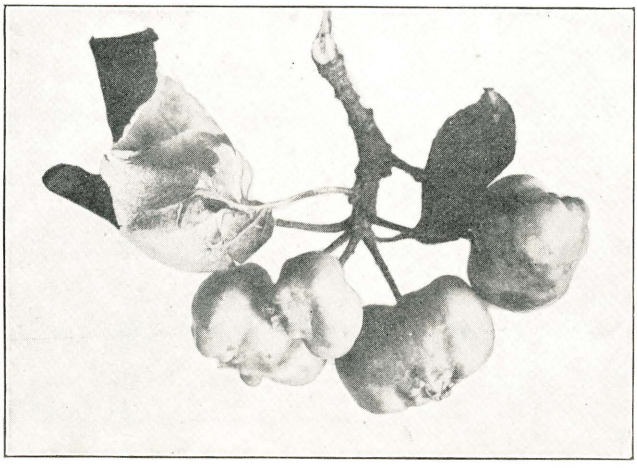


Figure 60.—Apples stunted and deformed by rosy aphids and green aphids.

spraying treatments that are effective against the leaf spots and other fungus diseases of the orchard are at the same time effective against the various fruit decays, though in some instances special spraying treatments are required. Care in picking, grading, and packing does much to reduce the decay developing in storage and transit, largely through avoiding mechanical injuries that bruise or break the skin or epidermis of the fruit. Maintenance of a comparatively low temperature during transit or storage greatly reduces storage losses from decay.

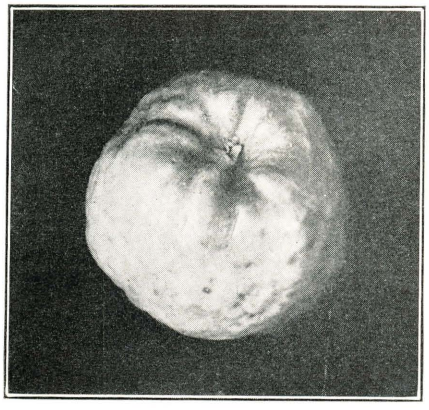


Figure 61.—An apple, somewhat dwarfed and with a rough, uneven, more or less pitted and warty surface, the result of rosy aphis attack.

Scald.—Intense sunshine, usually combined with low atmospheric humidity or high temperature or with both, may result in what is generally described as a scalding of the exposed side of the fruit. As would be expected, fruit on the south and west sides of the tree is most subject to this form of injury. In apples and pears it usually takes the form of somewhat sunken, dark, glossy areas, with more or less cork formation just beneath the surface (see Figure 71). The injury is often mistaken for something caused

by fungus attack. Prevention lies in the use of such cultural and pruning practices as will augment and conserve the soil moisture supply, reduce transpiration, and provide at least a certain amount of shade for the developing fruit.

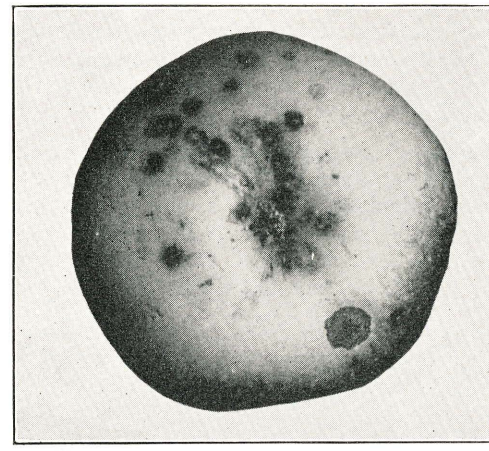


Figure 62.—Spotting caused by the presence of San Jose Scale on the fruit.

Distinct from the sunscald that has just been mentioned is storage scald. This, too, gives the fruit a scalded appearance (see Plate 6) and, similarly, is in no way related to insect or fungus attack. It develops mainly on the uncolored sides of apples and pears, that is, where the underlying or ground color is not masked by an overlying blush or stripe. Production methods that favor the maturing of poorly colored fruit and premature picking are contributory causes, though its appearance in storage can be prevented or considerably delayed by the use of oiled paper wrappers.

Baldwin Spot, Cork, Drouth Spot, Bitter Pit. These names and several others are applied to various types of a group of disorders that apparently are more or less related and that are found principally in the flesh of the apple, though something of a similar nature is sometimes found in the plum. These diseases are characterized by the development of brownish, rather dry corky spots in the flesh of the fruit, sometimes close to the surface, sometimes at or near the core, sometimes more or less evenly distributed throughout the flesh (see Plate 8). The names themselves are more or less descriptive of the lesions. The exact cause or causes of these disorders are not known, though there is some reason to believe that they are generally associated with local or temporary water deficits within the plant. They are not caused by fungus or insect attacks. Definite remedial

Figure 63.—Partly grown peaches showing injury caused by peach thrips.

measures are not known. The selection of deep, well drained soils and the use of those cultural practices that tend to conserve moisture are mentioned as the best known means of prevention.

What is considered by some as a related disorder, that, however, is more likely to develop in storage than in the orchard, is known as internal browning or internal "breakdown." The first of these two terms serves to describe the trouble rather accurately. It is pictured in Plate 6.

Spots.—Various types of spots are found on fruits of different kinds. Some are caused by fungi, some by bacteria and others are due to non-parasitic causes. These spots, unlike scab, are usually caused by a killing of a portion of the surface tissue and the diseased area penetrates to a greater depth into the fruits. Peaches are subject to a bacterial spot which is characterized by small, reddish-brown, dead areas which

Figure 64.—Work of the false tarnished plant bug on pears.

are at first smooth but later cracked over the surface. Peach blight, a fungous disease, also attacks peaches. Spots caused by this disease have a light colored center surrounded by a red ring. Another fungous disease attacks the quince, producing round, slightly sunken, reddish-brown spots which are usually less than a quarter of an inch in diameter. Apples are attacked by still other spot diseases, most of which appear in storage. Most of the fungous and bacterial spots can be controlled by sprays and good cultural methods.

Apples are also attacked by a spot for which no definite cause is known. This has been called Jonathan spot because of the extreme susceptibility of the Jonathan to this trouble though it is by no means confined to this variety. The spots are small, dark colored, and little more than skin deep. Plate 7 shows some of these spots on fruits of the Northern Spy variety and Plate 7 E and F shows the more characteristic spots as they appear on the Jonathan. The disease, if it appears at all, usually develops after the fruit is harvested and Jonathan apples

in storage should be inspected frequently and disposed of as soon as possible after the appearance of the disease.

Hail Injury.—Injuries of fruit occasioned by hail take the form of round sunken spots of varying sizes on the exposed side of the fruit. The skin is usually not discolored but the flesh beneath turns brown and becomes more or less corky. Two hail-pecked apples are shown in Figure 75.

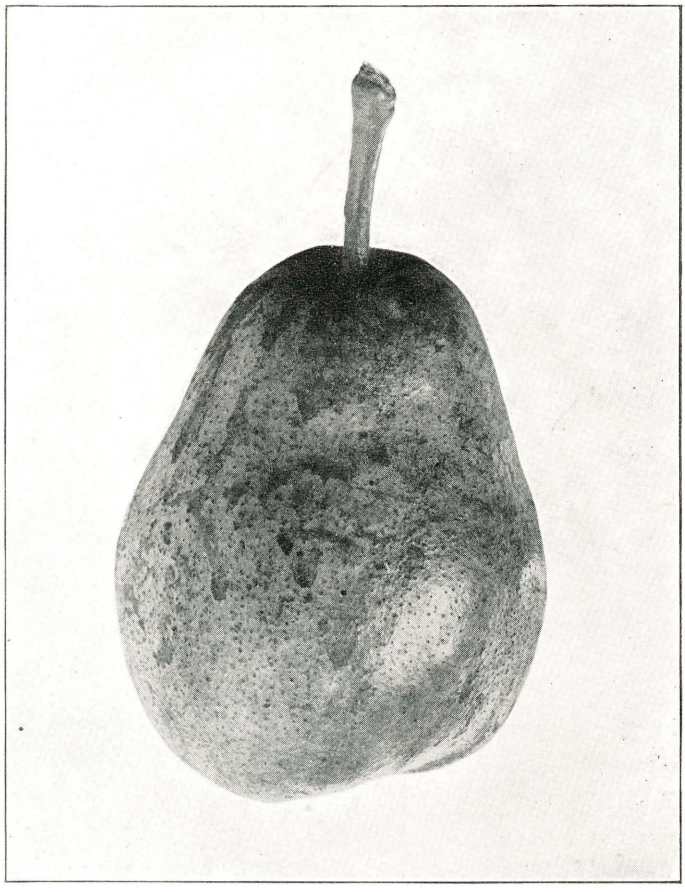


Figure 65.—A pear discolored by a sooty mold growing on the honeydew secreted by psylla nymphs. (Photograph furnished by Wm. A. Ross.)

Fruit Cracking.—Any one of several things may cause fruits of certain kinds to crack. Heavy rains late during the growing season following a long-continued drouth may cause more or less splitting, especially of stone fruits and apples. Cracks due to this cause are clean-edged, that is, no fungus or other lesions are associated with the flesh crack, though the exposed flesh soon becomes subject to decay because of the

entrance of wound-rot fungi. Sweet cherries (see Figure 76) are especially subject to cracking at or shortly before maturity when atmospheric humidity is high. It is difficult if not impossible to reduce materially the cracking that is due to soil moisture or atmospheric conditions, though cultural practices that provide more uniform soil moisture conditions are of some aid. Not infrequently, very severe attacks of scab cause apples, pears, and peaches to crack. The beginning of some of these cracks is shown in Figure 67. In these cases, of course, the characteristic lesions of the fungi are associated with the crack. Prevention lies in the control of the fungi in question. Under certain environmental conditions the application of either Bordeaux mixture or the lime-sulphur spray to apples leads to cracking that closely resembles that caused by scab.

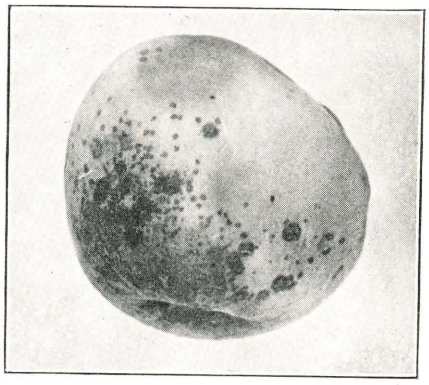


Figure 66.—Scab spots on a nearly mature peach.

Russeting.—It is normal for the fruits of certain varieties of pears and apples to be more or less completely russeted. This condition of the surface is likewise found in many other varieties that are not characteristically russeted, especially during seasons or in sections of high atmospheric humidity. Russeted patches or areas on the apple and pear are sometimes caused by or at least associated with scab lesions that heal over and sometimes they represent healed-over scars made by surface-eating insects (see Figure 81). The application of certain spray materials, especially Bordeaux mixture, accentuates the trouble. It has been found that the use of dusting materials results in less fruit russeting than the use of liquid sprays carrying the same active ingredients. In general it may be said that from this standpoint greater care is required in the selection of spray materials for a moist than for a dry climate.

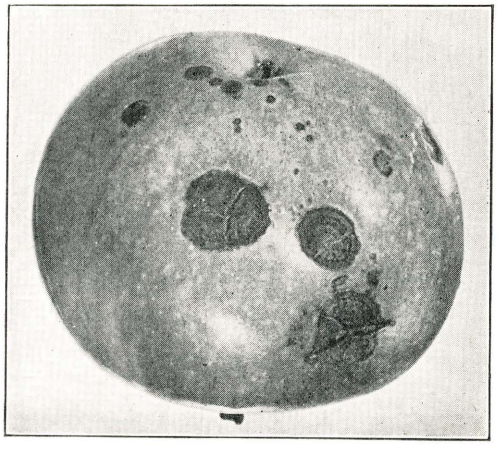


Figure 67.—Apple scab. Note the cracks in the larger lesions. The pear and quince are also subject to scab.

Frost Rings. The russet bands or rings that are sometimes found

around the blossom end of fruits, particularly apples and pears, are in most cases due to frost occurring during or shortly after the period of fruit setting. A frost band of this kind on a pear is shown in Figure 78. The russet scar on an apple shown in Figure 77 was probably caused by frost shortly after fruit setting. Frost injuries of the same type are not uncommon in plums.

Wartiness.—Associated with the russeting that may be due either to scab, spray injury or unfavorable weather conditions is often an unevenness of surface that in extreme cases is rather accurately described by the term wartiness (see Figure 79). When due to high humidity little can be done to prevent it except through the use of varieties that are not susceptible to this form of injury. When due to scab attack or to the use of certain spray materials, the condition can be largely prevented through proper spraying treatments.

Limb Rub.—Surface blemishes in which the skin turns brown, is sometime roughened or russeted (see Figure 80) or sometimes is left smooth and glossy as in a mild case of sunscald, are due to limb rub. The blemishes may be serious enough to lower the grade of a fruit because of appearance but seldom injure the fleshy tissues. Making the tree reasonably open by means of pruning is the only preventive.

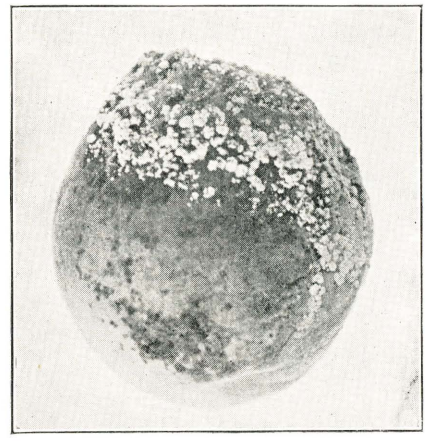


Figure 68.—Brown rot on the peach. This decay also occurs on the other stone fruits.

Wind Bruises. — High winds shortly before harvest may result in considerable bruising of both sweet and sour cherries. The bruised spots turn brown and present the appearance of local infection of the brown rot fungus. The quality of the fruit is really not seriously injured but its market value is lowered because of its appearance. Windbreaks that protect the orchard and very light pruning that leaves the tops of the trees comparatively dense are the only known means of preventing this trouble.

Watercore.—This term rather accurately describes a condition of flesh in the apple sometimes developing as the fruit approaches maturity and sometimes after it has been placed in storage. It is not, however, always limited to the core. The injured tissues become water-logged or water-soaked and often hard and glassy (see A and B, Plate 7). Badly infected fruits are practically unsalable. Certain varieties, such as King, are especially susceptible. Investigations lead to the conclusion that intense sunshine during the ripening period is an important contributing factor. Delayed harvesting apparently increases the amount of watercore. No satisfactory control measures are known.

Figure 69.—Plum pockets. Note the puffy balloon-like appearance of the fruits. The lower specimen that has been sectioned shows that they are hollow.

Plum Pockets.—A disease more or less closely related to that causing leaf curl in peaches attacks the partly-grown fruit of certain species of plums. The disease causes a puffed-up balloon-like appearance that is rather accurately described by the name plum pockets (See Figure 69). The fungus infects the twigs as well as the fruits of the plum and where it once gains a foothold severe cutting back, as well as thorough spraying, should be resorted to.

Figure 70.—Sooty blotch on the apple. This disease also occurs on the pear.

"Buttons."—The term "buttons" is applied by many growers to the small, partly-developed fruits of certain peach varieties that persist instead of falling at the time of the usual June drop. They may remain on the trees long after the normal season for maturing and they may never soften. They are seedless and are usually due to improper pollination.

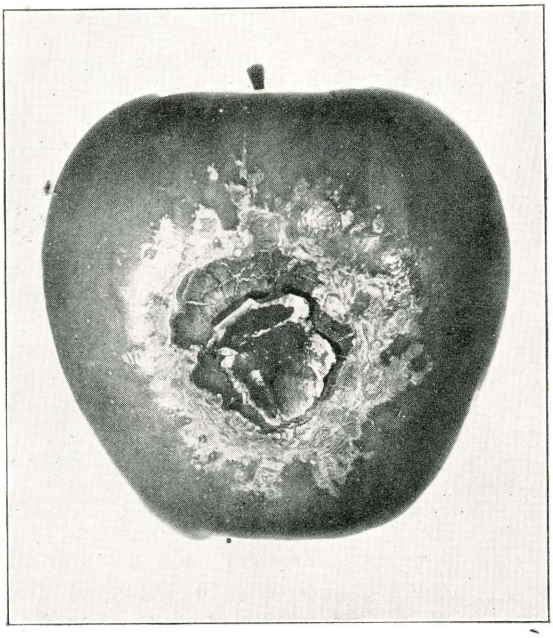


Figure 71.—Sunscald on apple. This injury usually occurs on fruit on the south and west sides of the tree and only on the exposed sides of the fruit. Frequently it is accentuated by spraying with certain materials.

AVOIDING TROUBLE

Many of the most serious difficulties encountered in the development and management of the orchard are due to poor soil or to poor location, and can be avoided by planting the orchard only where conditions are at least reasonably favorable. In the first place, orchard soils should be reasonably fertile. If they are not, the use of fertilizers must be constantly resorted to in order to make the trees grow vigorously and bear

heavily. More important still the soil should be deep, porous, and well drained in order to permit deep rooting and to reduce to a minimum injury from drouth. So far as possible orchards should be located on sites that are somewhat higher than near-by or surrounding areas so as to provide good air drainage and to insure a certain comparative degree of freedom from frost and winter injuries.

Soil management methods should be such as will make the trees grow vigorously during the early part of the growing season and will then check growth and induce a proper maturity of the wood in late summer and fall.

Good sanitation about the orchard helps in the control of many pests but for the commercial control of most of them thorough and timely spraying is necessary. Unless there is a very good reason for its modification to meet special conditions the regular spraying schedules recommended by the Experiment Station for the various fruits should be followed.

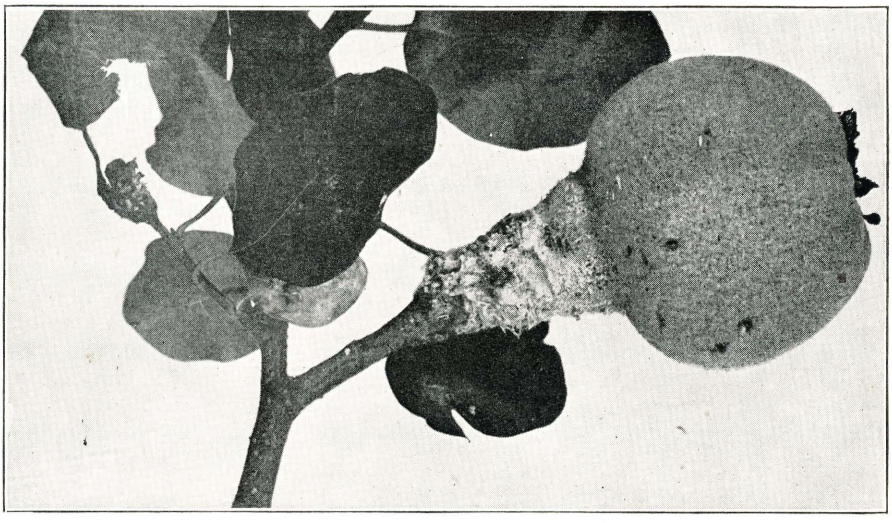


Figure 72.—Rust on the quince.

Suggestions for Avoiding Disorders of the Apple and the Pear

Before growth starts apply the dormant or delayed dormant spray, if scale is present. If scale is not present, this is not necessary.

As growth is starting or just before, repair any crown injuries, sunscald, or crotch cankers, or similar injuries by scraping, disinfecting and painting; and, where necessary, bridge graft.

At about the same time apply sulphate of ammonia or nitrate of soda if there is evidence of the need of fertilizers.

In sections where climbing cutworms cause trouble band the trunks with cotton batting or with tree tanglefoot about the time the buds start to open.

Apply the "pre-pink," "pink" or cluster bud, calyx and "ten day" sprays at the right time. Use the right combinations of materials and do the work thoroughly. (Consult the spray schedules recommended by the Experiment Station.)

In case of an orchard under a clean cultivation system of soil management plow either before the blossom buds open or wait until after the fruit has set before plowing.

See that the orchard is provided with plenty of bees during the blossoming period.

The "four-week" and second brood codling moth sprays should be timed accurately and applied thoroughly. In the pear orchard an extra application for psylla may be necessary. (Consult the spray schedule recommended by the Experiment Station). Other than spraying, orchard maintenance during this early summer period is largely a matter of cultivation or of mowing the sod-mulch crop, as the case may be.

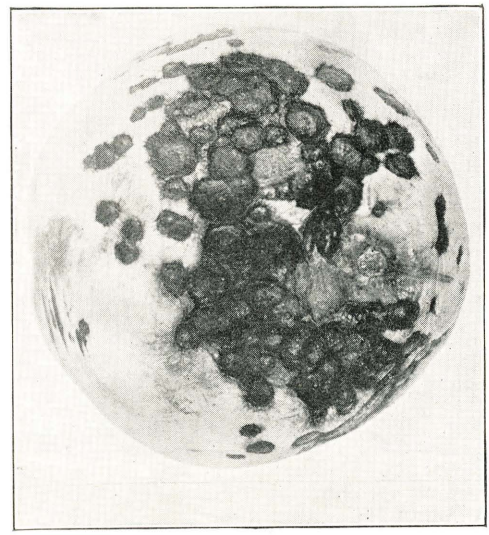


Figure 73.—The leaf blight of the quince as it appears on the fruit.

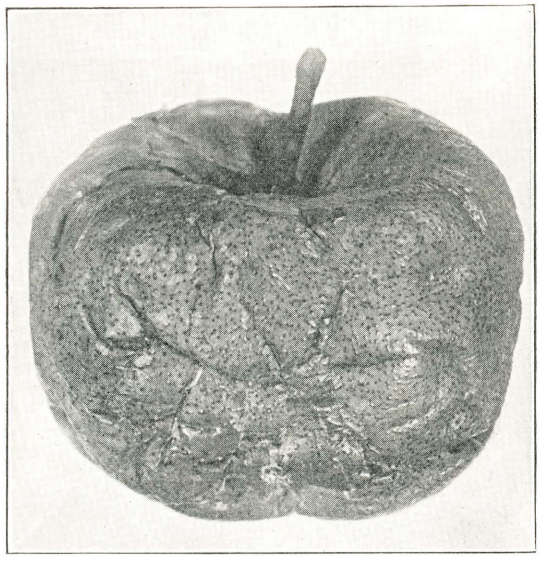


Figure 74.—An apple completely decayed by the black rot fungus. Note the wrinkling of the skin due to the gradual drying out of the fruit. The skin comes to have a leathery texture. The small dots are the spore pustules of the fungus.

In early August sow a cover crop, preferably oats, if the orchard is under cultivation.

Before freezing weather comes in the fall

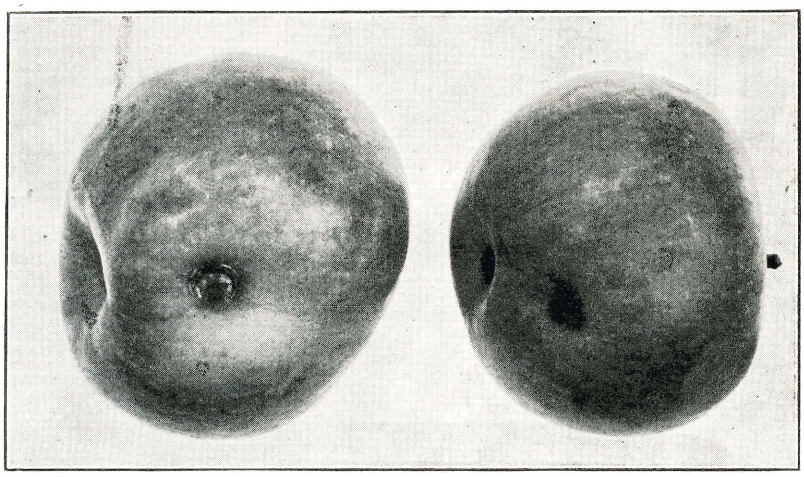


Figure 75.—Hail-pecked apples. In one the skin has been broken, but a corky layer has been formed beneath and there is little likelihood of invasion by any of the fungi which cause decay.

Figure 76.—Growth cracks in the cherry.

provide all young trees with wire or wood veneer protectors against rabbits. Replacing the soil immediately about the crowns to a depth of four to six inches with coarse cinders, with friable soil filling in the open spaces between them, is a good protective measure against mice.

After the leaves are off in the fall inspect the trees thoroughly and remove and destroy all fire blight cankers, disinfecting and painting the wounds.

Figure 77.—Frost marking on apple. Frost injury may also take the form of russet bands encircling the fruit, such as is shown in Figure 78, and it is found on most kinds of tree fruits.

Suggestions for Avoiding Disorders of the Peach

Before growth starts apply a scale-peach leaf curl spray. (Consult the spray schedules recommended by the Experiment Station.) It is good practice to finish pruning before time to apply this spray.

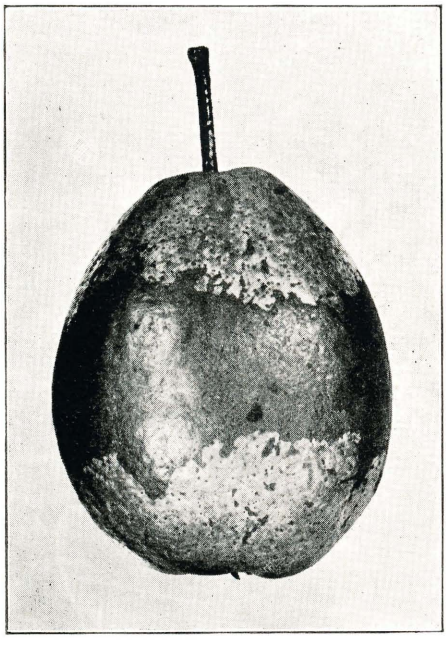


Figure 78.—A frost band on pear. Generally the band is closer to the blossom end than it appears in this photograph.

As growth is starting apply sulphate of ammonia or nitrate of soda where careful diagnosis indicates soil nutrient deficiencies.

Plow before the blossoms open or wait until after the fruit has set before plowing.

See that the orchard is provided with plenty of bees during the blossoming period.

In sections where climbing cutworms cause trouble band the trunks with cotton batting or with tree tanglefoot about the time the buds start to open.

Put on the first curculio spray or dust applications when the "shuck" is being shed. Consult the spray schedules recommended by the Experiment Station for the timing of the other applications.

Cultivate shallow until about August first, when a cover crop, preferably oats, should be sown.

Thin the fruits to four to six inches apart, depending on variety, in late June or early July.

About September first treat the trees for borers with paradichlorobenzene. Remove the mounds containing this chemical about two weeks later, but remember that it is a good plan to draw up fresh soil around the trunks of the trees to replace these mounds.

Before freezing weather comes in the fall provide the trees with wire or wood veneer protectors against rabbits. Replacing the soil immediately about the crowns to a depth of four to six inches with coarse cinders, with friable soil filling in the open spaces between them, is a good protective measure against mice.

Figure 79.—Wart-like protuberances on an apple. These may result from any one of several causes, such as healed-over insect feeding wounds, limb-rub, localized spray burn, etc.

Throughout the growing season be on the watch for symptoms of peach yellows or little peach. Trees showing distinct symptoms of either of these diseases should be promptly removed from the orchard and destroyed.

Suggestions for Avoiding Disorders of the Plum

Before growth starts apply a dormant spray if scale is present. If scale is not present, this is not necessary.

As growth is starting apply sulphate of ammonia or nitrate of soda where careful diagnosis indicates soil nutrient deficiencies.

Plow either before the blossoms open or wait until after the fruit has set before plowing.

In sections where climbing cutworms cause trouble band the trunks with cotton batting or with tree tanglefoot about the time the buds start to open.

See that the orchard is provided with plenty of bees during the blossoming period.

Put on the first curculio spray or dust application within about ten days after the petals fall. Consult the spray schedules recommended by the Experiment Station for the timing of the other applications. With this fruit, protecting the foliage from the shot-hole fungus to prevent defoliation late in the season is very important.

Cultivate shallow until about August first, when a cover crop, preferably oats, should be sown.

Thin the fruits to two to three inches apart, depending on variety, in late June or early July.

Before freezing weather comes in the fall provide the trees with wire or wood veneer protectors against rabbits. Replacing the soil immediately about the crowns to a depth of four to six inches with coarse cinders, with friable soil filling in the open spaces between them, is a good protective measure against mice.

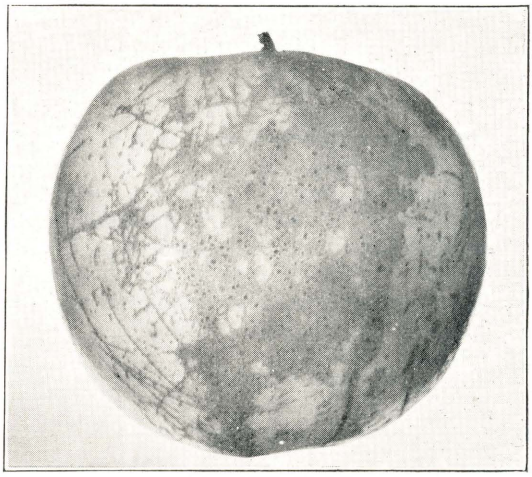


Figure 80.—A network of russet markings, such as is shown in this picture, often results from lightly rubbing against a twig or spur. It is impossible, however, always to distinguish between russeting due to limb rub and that due to spray injury.

Suggestions for Avoiding Disorders of the Cherry

As growth is starting apply sulphate of ammonia or nitrate of soda where careful diagnosis indicates soil nutrient deficiencies.

Plow either before the blossoms open or wait until after the fruit has set before plowing.

In sections where climbing cutworms cause trouble band the trunks with cotton batting or tree tanglefoot about the time the buds start to open.

See that the orchard is provided with plenty of bees during the blossoming period. This is particularly important in the sweet cherry orchard.

Put on the first curculio spray or dust application within ten days after the petals fall. Consult the spray schedules for the timing of the other applications. With this fruit protecting the foliage from the shot-hole fungus after harvest to prevent defoliation late in the season is very important.

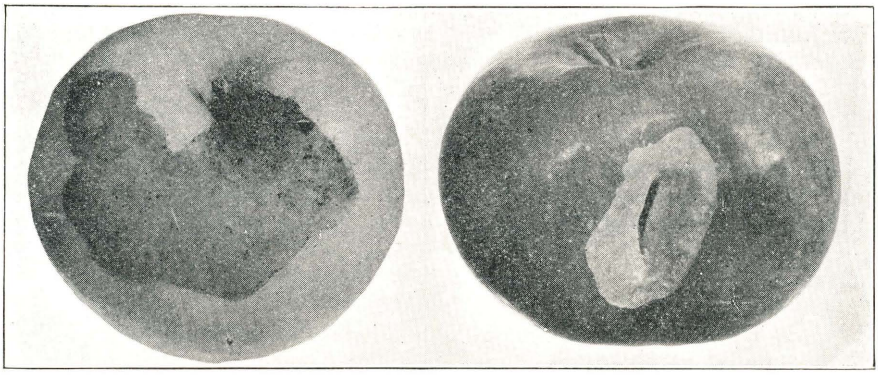


Figure 81.—Probably these scars were due to the feeding wounds or punctures of some insect before the fruit was a third grown. In the one case the wound has healed-over very successfully; in the other the wound has healed-over but the apple has been rather seriously deformed.

Cultivate shallow until about August first, when a cover crop, preferably oats, should be sown.

Before freezing weather comes in the fall provide the trees with wire or wood veneer protectors against rabbits. Replacing the soil immediately about the crowns to a depth of four to six inches with coarse cinders, with friable soil filling in the open spaces between them, is a good protective measure against mice.