PUBLICATION 915
REVISED 1973

DISEASES, INSECTS AND MITES OF STONE FRUITS

Agriculture Canada

Copies of this publication may be obtained from
INFORMATION DIVISION
CANADA DEPARTMENT OF AGRICULTURE
OTTAWA
K1A 0C7

Printed 1954
Revised 1962, 1967, 1973
Reprinted 1975

10M-38173-9:75
Cat. No. A43-915

Printed by IMPRIMERIE JACQUES-CARTIER INC.
Contract No. 03KT-01A05-5-38173

CONTENTS

DISEASES, INSECTS AND MITES OF STONE FRUITS

G. GORDON DUSTAN[1] AND THOMAS R. DAVIDSON
Research Station, Vineland Station, Ontario

In Canada, peaches, apricots, plums, and cherries are grown chiefly in the southern regions of Ontario and British Columbia. A few plums and cherries are grown in Quebec and the Maritime Provinces, and a very few peaches in Nova Scotia. Various insects, mites, nematodes, and diseases affect the quality of the fruit, reduce yield, and weaken trees.

In the first two editions of this publication, in 1954 and 1962, specific directions were given for using various insecticides, fungicides, and nematicides for the control of insects, diseases, and nematodes. Control recommendations change so often, as new pesticides are found, that we have omitted from the present publication the names of the materials to use. Consult your local spray guides and spray services for this information and for further directions on the latest control measures.

Your spray guide will also tell you how to combine compatible insecticides and fungicides in the same spray for insect and disease control. Remember, you will not obtain good control with sprays or dusts unless you apply them at the proper time, and thoroughly cover all parts of the trees.

The cultural and sanitary practices of orchard management recommended in this publication will help to control some of the pests. However, all stone-fruit crops require at least a few applications of fungicides and insecticides each year, and occasionally they need special applications for outbreaks of some of the less common pests.

SPRAY CALENDARS: Ontario Ministry of Agriculture and Food publication No. 360, **Fruit Production Recommendations,** and British Columbia Department of Agriculture publication **Tree-fruit Production Guide, Interior Districts** give detailed information on pesticides. These publications also include aids on fertilizers, herbicides, fruit thinners, and other orchard practices. They are revised each year so that the grower can be given the most recent information available.

[1] Retired.

CAUTIONS: Follow closely all the cautions listed on the pesticide label. Some of the treatments require an interval between the last application and harvest. The interval varies with the material used, the number of applications, and the amount applied. Keep to the interval given in order to avoid residues that would render the fruit unfit for sale.

SPRAYER OPERATION: Ontario Ministry of Agriculture and Food publication No. 373, **Orchard Sprayers—A Guide for Ontario Growers,** gives a great deal of valuable information on sprayer performance, spray application and the problems involved. The information provided is equally applicable outside Ontario.

BACTERIAL AND FUNGAL DISEASES

BROWN ROT *Monilinia fructicola* (Wint.) Honey; *Monilinia laxa* (Aderh. & Ruhl.) Honey. Brown rot is a fungus disease that affects all stone fruits. Its destructive capabilities are well known to growers, dealers, processors, shippers, and consumers. All share in the losses when the rot develops on fruit in orchard, packing shed, and warehouse, in transit or at market. In some seasons the disease may be epidemic and losses heavy. Wet, humid weather favors rapid development and spread of brown rot. In British Columbia the disease is common in the Kootenay area, particularly on sweet cherries, and also in the coastal district. In recent years *M. fructicola* has produced serious infection throughout the Okanagan Valley. In Ontario it is a common and important disease in all areas.

Symptoms—Brown rot causes blossom blight, twig blight, twig canker, and fruit rot. Infected blossoms wilt, shrivel, and die and become covered with a grayish mold. On peaches and apricots the infection may spread into the twig and form a brownish, oval canker that may enlarge to girdle the twig and kill it. On cherries the fruit stem often rots.

The disease appears on the fruit as a small, circular brown spot that increases rapidly in size and eventually involves the entire fruit in a soft rot (Fig. 1). Small grayish tufts of innumerable spores of the fungus appear over the surface of the rotted area. Finally the fruit is reduced to a shriveled black mummy that may drop or stay on the twig throughout the winter.

Cause—The fungus that causes this disease lives over winter in the old mummied fruits on the twigs, in cankers, or in rotted fruits on the ground. In the spring it produces two types of spores. One type is produced on the surface of cankers and mummified

fruits on the trees and the other in clumps of small, brown, cup-shaped mushroom growths, termed apothecia (Fig. 2), that arise from mummies partly covered with soil. Either type of spore may infect the blossoms. Spores formed on blighted blossoms provide the source of infection for ripening fruit.

Control—Orchard sanitation is essential in the control of brown rot. Remove and destroy any mummied fruits that remain on the trees at the time of pruning. Prune out any cankered or dead twigs that remain from the previous year. Cultivate the orchard before bloom to keep spores from forming on mummies buried in the soil. These practices prevent infection of the blossoms.

At harvest, avoid injuries to the fruit such as bruises, punctures, and tears in the skin, because wounds are ideal sites for infection. Pick only sound fruit. Dispose of culls and rotted fruits promptly by burying them in a deep pit. Precool and keep fruit in cold storage until it reaches its destination. Follow the spray program given in your local spray calendar, making the first application as the blossoms open. If prolonged wet weather occurs during bloom, repeat the application.

The cover sprays prevent insect injuries that are so often followed by rot. The timing of these sprays, particularly for peaches, varies from season to season, with locality, and with variety. Consult your agricultural representative or provincial specialist for specific recommendations.

Fig. 1. Brown rot of plums.

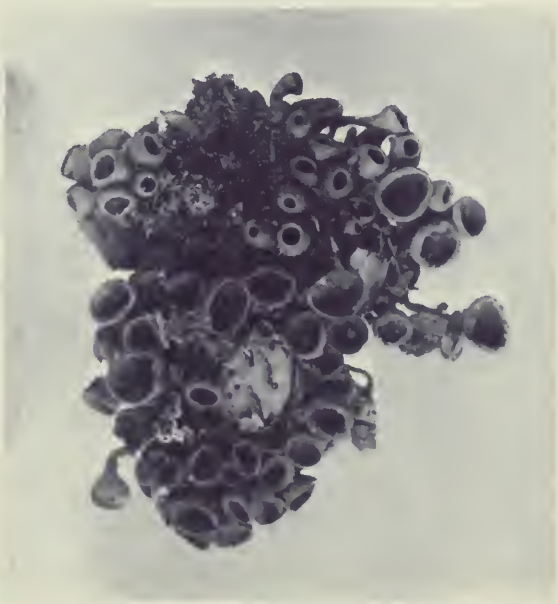

Fig. 2. Apothecia of the brown rot fungus produced on a mummied fruit.

Aim to keep the fruit protected with fungicide as it matures. Apply the preharvest sprays 3 to 4 weeks before harvest and again just before picking. If the weather is wet during harvest, make additional applications. Thorough coverage is necessary. A postharvest fruit dip is sometimes recommended. Consult your local production guides.

RHIZOPUS ROT *Rhizopus nigricans* Ehr. This disease causes a serious postharvest rot of stone fruits, especially peaches, in transit and storage. The fungus attacks most easily at breaks or bruises in the fruit skin caused by insects or careless handling. It grows very rapidly, especially under warm humid conditions and soon covers the fruit with a branching silky web topped by numerous black spore balls. The best control is preventative. Care in handling of harvested fruit is very important. Cool fruit as soon as possible after picking. Preharvest sprays and postharvest dips are recommended. Consult local spray guides.

LEAF CURL *Taphrina deformans* (Berk.) Tul. Leaf curl is an important fungus disease of the foliage of peach and nectarine. It occurs wherever these fruits are grown and may cause serious defoliation. Twigs and fruit are sometimes affected. Repeated annual attacks greatly weaken the trees.

Symptoms—Infected leaves (Fig. 3) are thickened, swollen, variously distorted, curled, and they assume reddish to purplish tints. When the fungus fruits, the swollen areas on the upper surfaces of the leaves become tinged with white. The leaves later turn yellow or brown and drop. Some leaves may be only partly affected.

Cause—Spores of the fungus are produced on the infected leaves and become lodged on the twigs, where they remain throughout the summer, fall, and winter. The spores are washed into the opening buds the following spring. Infection occurs mainly during a short period when the leaf buds are swelling and opening. As the leaves grow they become much less susceptible to infection.

Control—Spray either in late fall after the leaves have fallen or in the early spring before leaf buds swell. Suitable fungicides for either fall or spring application are listed in local spray guides. Success depends on proper timing and thorough coverage of all twig growth.

PEACH CANKER *Valsa cincta* Fr. Canker is a common disease of peach and apricot in Ontario. Few orchards are free from its damaging effects. Many trees are seriously impaired by canker on the

trunk, in the main crotch, on the limbs, and on the branches, and they are often broken from the weight of crop or during storms. In British Columbia, this disease has only been reported as occurring in the coastal regions.

Symptoms—The cankers appear first as sunken areas in the wood that exude a copious flow of gum. Later the bark shrivels and separates from the underlying wood and from the surrounding healthy bark. The cankers increase in size each year and become unsightly rough swellings (Fig. 4). Many twigs and branches die back as a result of cankers that completely girdle them.

Cause—The cankers result from a fungus infection that takes place in the dormant season, particularly in the late fall or early winter. Infection of small twigs can occur through leaf scars. In larger branches, wounds of any kind, broken branches and pruning stubs are ideal points of entry for the fungus. Winter injuries and sunscalds also make ideal entry sites. The fungus becomes established in dead wood and invades the surrounding tissues to form the canker. Fruiting bodies of the fungus appear as small pimples on the surface of the infected area. Though the cankers are not caused by the lesser peach tree borer, they are favorite points of

Fig. 3. Terminal growth of peach infected with leaf curl.

Fig. 4. Peach canker, the result of infection of a pruning stub. Diseased bark and wood have been removed.

attack for this insect. The larvae feed in the cankered areas and prevent healing, thus helping the fungus to produce a larger canker.

Control—The following practices aid greatly in the prevention of canker.

- Prune in March or April or later if possible to promote early healing of wounds. Prune older trees first and younger trees last. Do not prune in the late fall or early winter.
- Make pruning cuts close to supporting wood. Otherwise, stubs die back and form favorable sites for infection.
- Remove dead wood at pruning time. If any is overlooked or develops later, remove it by the end of June. Cut well below the dead areas. Gather all prunings and destroy them as soon as possible.
- Cease orchard cultivation early, not later than the first week in July, to promote early maturity of the wood.
- Consider carefully the fertilizer requirements of the orchard. Maintain thrifty and vigorous growth. It is important, however, to avoid overstimulation and late-season growth.
- Apply sprays to protect the twigs from brown rot and the oriental fruit moth. Control the peach tree borers.
- Avoid injuries to the trees when cultivating or harvesting.
- Apply protective sprays as recommended in regional spray guides.
- Cut out cankers on trunks and main structural limbs of younger trees in the spring. Remove all brown, discolored bark. Treat the wound with a disinfectant and apply a wound dressing as recommended in spray guides.

INK SPOT, OR SCAB, OF PEACH *Fusicladium carpophium* (Thuem.) Oud. In Ontario this disease is troublesome only in certain orchards and on a few varieties of peaches. It causes blemishes on the surface of the fruit that detract greatly from its appearance. The disease is not known to occur in British Columbia.

Symptoms—Symptoms appear on the fruit as small, circular green spots mostly clustered around the stem end but also extending over the exposed side of the fruit (Fig. 5). The spots may be very numerous and join to form a dark, green, velvety blotch and crack the skin, Infection also occurs on the twigs, causing inconspicuous, small, olive-brown, superficial lesions. Indefinite pale green or brown spots are also found on the underside of the leaf.

Cause—The fungus overwinters in the twig lesions that were formed the previous year. In the spring, masses of spores are produced on these lesions and are washed and splashed to the fruit, twigs, and leaves where new infections occur.

Fig. 5. Peaches infected with ink spot, or scab.

Control—Add a recommended fungicide to the regular shuck-fall application. Repeat the fungicidal spray 10 days or 2 weeks later if scab is a serious problem. Consult local spray guides for details.

BACTERIAL SPOT *Xanthomonas pruni* (E. F. Sm.) Dowson. This disease affects peach, plum, apricot, and nectarine in Ontario but is not known to be present in the Okanagan and Kootenay districts of British Columbia. It affects leaves, fruit, and twigs. It may cause considerable defoliation early in the season and reduce the yield and quality of fruit. The disease is more common in warm, humid areas than in cool, dry ones. It is usually more common and severe in orchards on soil of low fertility than in those on fertile soil.

Symptoms—The disease appears on the leaves as small, irregular, water-soaked areas that soon turn purple or brown. Often the spots break away from the healthy tissue, drop out, and give a 'shot-hole' effect. Affected leaves turn yellow and drop. On the fruit, small, circular brown spots appear and pitting and cracking occur near the spots (Fig. 6). Gum may exude from the injured areas after rainy weather. On the twigs, dark-purplish to black, slightly sunken, circular to elliptical lesions are formed.

Cause—This disease is caused by a bacterium. The organism winters in twig lesions and in the terminal buds. In the spring, bacteria ooze from the enlarging lesions and are spread by rain to developing leaves, twigs, and green fruit.

Control—Follow a cultural and fertilizing program to promote good vigor. Trees in poor vigor are more susceptible to the disease. Spraying is not an effective means of control.

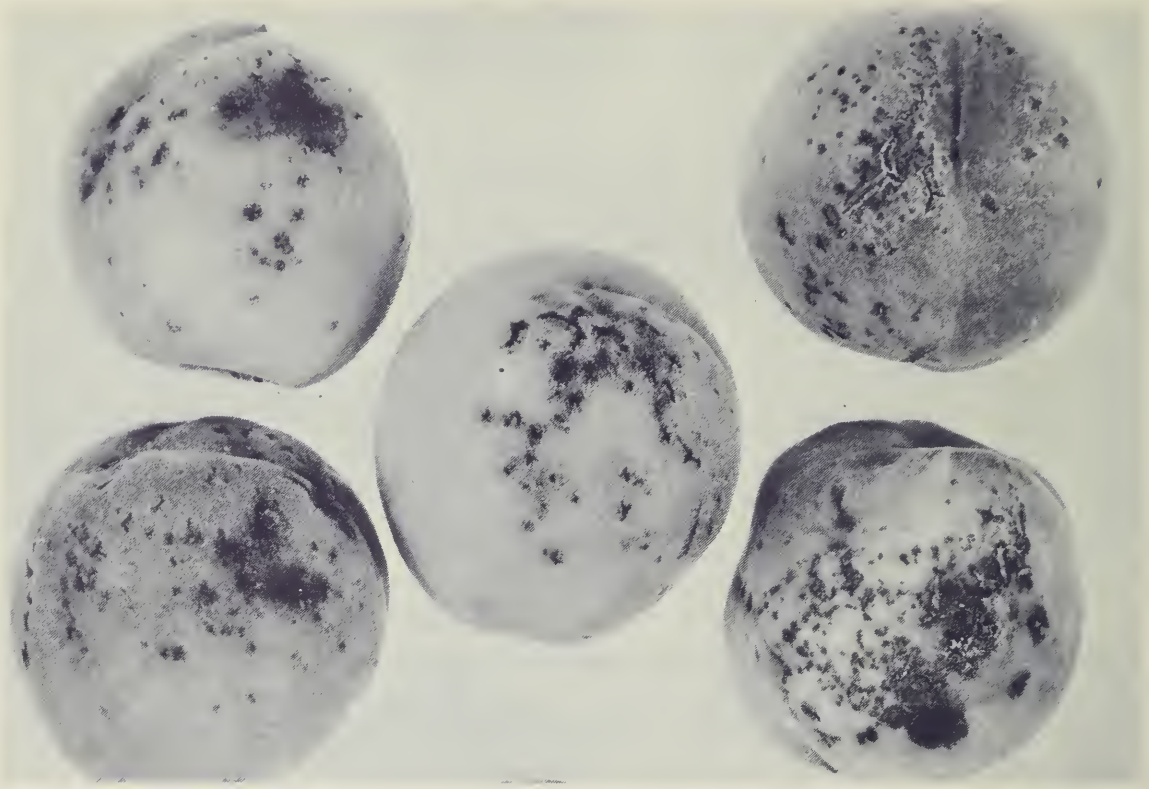

Fig. 6. Peaches infected with bacterial spot. Severely infected fruits show skin cracks.

BACTERIAL CANKER *Pseudomonas syringae* van Hall and *Pseudomonas mors-prunorum* Wormald. This disease is most severe on sweet cherry and apricot, but it also affects all other stone fruits. In British Columbia's coastal region it can be severe on sweet cherry and apricot and occasionally so on prune and plum. It has not been reported a problem in the Okanagan Valley. In Ontario sweet cherry is severely affected; apricot and sour cherry somewhat less so. In Nova Scotia it is a severe disease of sweet cherry and also occurs on sour cherry, peach and plum.

Symptoms—The most obvious symptom is the bare-branch or leggy condition caused by extensive killing of leaf and flower buds and spurs on wood 2 years of age or older (Fig. 7). Cankers—dark sunken areas from ½ inch (13 mm) in size, around dead buds or spurs, to very large ones on main branches or in the crotch angles—exude an amber gum. The bacteria destroy and plug the conducting tissues in wood just below the bark. Dark-brown streaks of dead tissue may extend up and down the branches for a considerable distance beyond a visible canker. Leaf and flower spurs or entire branches wilt and die.

In the spring leaf infections develop as small purplish spots surrounded by a halo of light-green tissue. These spots become

Fig. 7. Bacterial canker infection. Note the numerous dead fruiting spurs.

irregular in shape, turn brown and drop out leaving the leaves very tattered.

Cause—Bacterial canker is caused by two species of bacteria that live during the summer on the surface of leaves. In the fall, at leaf-drop time, the bacteria lodge around the bud scales and some enter the twigs through the leaf scars. The bacteria are active during the cool weather of early winter and establish cankers at this time. The bacteria become active again in the very early spring well ahead of plant growth, so that cankers are well developed at bud break.

Control—No really satisfactory control measures are known. However, properly timed, special sprays in the fall will help prevent extensive damage. Consult local spray guides for the recommended procedure in your area.

POWDERY MILDEW OF PEACH *Sphaerotheca pannosa* (Wallr. ex Fr.) Lév. This disease is common and may be serious in some districts of British Columbia. It is most common where there is dense, succulent growth and in closely planted orchards. In Ontario it is rarely of economic importance in commercial orchards but is often found on young trees in nursery plantings.

Symptoms—White fungus patches appear on the twigs, foliage, and the sides of the fruit in late spring or early summer. The leaves are generally pale, slender, and more or less distorted. The spots on the fruit turn a tan color and form hard, russeted areas. The skin may crack.

Cause—The fungus responsible for the mildew overwinters on the surface of the affected parts and around the buds. Spores produced on the diseased tissues are the source of new infections.

Control—Apply a sulfur fungicide when the shucks are free from the fruit and again 14 days later. In nursery plantings apply sulfur sprays or dust frequently. Add a spreader to the spray to obtain good coverage.

POWDERY MILDEW OF CHERRY *Podosphaera clandestina* (Wallr. ex Fr.) Lév. Powdery mildew of sweet cherry occurs periodically in British Columbia but rarely in Ontario. It is most common on succulent water sprouts and on lower limbs hanging in the rank growth of a cover crop. The most important loss is from infected fruit. The disease is common on sour cherry in Ontario, and in the Okanagan Valley of British Columbia, especially where organic fungicides have been used in the spray program. In nursery plantings, it is common and serious on both sweet and sour cherries.

Symptoms—White, powdery, fungus growth develops on terminal leaves and on twigs but may not become abundant until late summer. Infected leaves are generally pale, slender, more or less distorted, and curled upwards. The twigs are stunted. The fruit is sometimes misshapen.

Cause—The causal fungus overwinters on the surface of the affected parts and in and about the buds. Spores produced on the diseased tissues are the source of new infections.

Control—Sweet cherries: Apply a sulfur fungicide at shuckfall and again 10 days later. Remove infected shoots and keep the cover crop or weed growth beneath the trees low.

Sour cherries: Add a recommended fungicide to the first, second, and third cover sprays applied for the control of leaf spot. Do not use sulfur when temperatures are high. In nursery plantings, apply a sulfur spray or dust frequently. Add a spreader to the spray to improve wetting. Consult spray guides for latest recommendations.

VERTICILLIUM WILT *Verticillium albo-atrum* Reinke & Berth. and *V. dahliae* Kleb. Verticillium wilt affects stone-fruit trees in both the Okanagan Valley and Ontario. The disease causes wilting and defoliation. It attacks mainly trees less than 10 years old. It is most common on apricot, peach, sweet cherry, and sour cherry trees and may occur also in almond, plum, and prune trees. Infected trees remain stunted and unproductive for several years. Often many of the branches on one side of the tree are killed. The disease

is sometimes fatal in sweet and sour cherries but rarely in other stone fruits.

Symptoms—The symptoms do not develop until July or August. The first indication of infection is a wilting of the foliage on all or, more commonly, part of the tree (Fig. 8). Later the leaves turn pale green or yellow and drop. Leaf fall may be sudden and is often the first symptom noticed. The trunk, branches, and twigs show no external evidence of the disease. However, if an affected branch is cut off and a smooth cross-section examined, a ring or partial ring of dark-brown wood will be found. In longitudinal section the discoloration appears as successive brown streaks.

Cause—The causal fungus lives in the soil, where it may persist for 15 years or more. Infection takes place through the feeding rootlets. It progresses into the trunk and thence into the branches, where it may advance up one side, clogging the conductive vessels; or it may girdle the stem. The disease is favored by wet cool soil in the spring. It is seldom apparent, however, until hot dry weather in summer.

Control—For new orchards select well-drained sites or provide adequate drainage. Do not plant an orchard immediately following crops of potatoes, tomatoes, eggplants, peppers, strawberries, or raspberries. Do not interplant these crops in a young orchard, as they favor increase of the fungus in the soil. Eliminate such weeds as shepherd's-purse, lamb's-quarters, nightshade,

Fig. 8. Peach tree infected with verticillium wilt.

and related species that are also hosts of this disease. A thick grass or legume cover crop is recommended in some areas. Where verticillium is a problem, treatment of the planting site with a soil fumigant in the fall prior to orchard planting promotes good growth and reduces wilt in young trees. Fertilize at the lowest rate of nitrogenous fertilizer necessary to provide normal tree growth. Excessive growth aids the disease. Consult your agricultural representative for specific recommendations.

CROWN AND ROOT GALL *Agrobacterium tumefaciens* (E. F. Sm. & Towns.) Conn. This disease attacks many different plants as well as fruit trees. It is common on nursery trees. The crown and roots are usually affected, though occasionally aerial galls occur on the trunk. The disease occurs in all fruit-producing districts in Canada.

Symptoms—The disease is readily recognized by the wartlike tumors or swellings at the crown or on the roots. The galls are at first light in color and soft in texture but later turn dark and become hard. They may vary from the size of a pea to that of a softball and are usually irregular in outline.

Cause—Crown and root gall is caused by a bacterium that lives in the soil. It attacks crowns and roots that have been injured at planting, during cultivation, or by insects.

Control—Do not plant gall-infected trees. Avoid injuries to the underground parts of the trees.

CORYNEUM BLIGHT *Stigmina carpophila* (Lév.) M. B. Ellis. This disease is common on apricot and peach in the Okanagan Valley, and in the Kootenay and Creston districts of British Columbia, but is of minor importance in Ontario. It is most severe in orchards where air drainage is poor.

Symptoms—On apricot, the most distinctive symptoms occur on the fruits. Small purple-brown spots with light centers appear when the young fruit is about ½ inch (13 mm) in diameter. Each spot is raised slightly above the fruit surface. The spots tend to be most numerous on the upper side of the fruit (Fig. 9). Brown spots may also occur on the leaves but the affected tissue soon falls out, leaving a 'shot-hole' effect. Leaf and flower buds may be affected and can be detected by their shiny-black appearance. Very small cankers sometimes form on the small twigs.

On peach, fruits, leaves, twigs, and large limbs are attacked. Fruit spots are larger than those on apricots and they exude gum freely. The tissues of infected fruit develop unevenly and the fruit becomes misshapen. Shot holes in the leaves are generally more

Fig. 9. Coryneum blight on apricot.

pronounced than on apricot. On young twigs, black cankers develop that produce masses of gum after rains. The twig cankers eventually turn light gray. Cankers occur also on large limbs and on trunks and exude large amounts of gum in wet weather. When the infection is severe, branches and sometimes the trees die.

In the Kootenay region of British Columbia, sweet cherry trees interplanted with diseased peaches or apricots may suffer coarse necrotic leaf spotting and then defoliation.

Cause—This disease is caused by a fungus that overwinters chiefly in the dormant buds on apricot, and in the cankers on the twigs and branches on peach. Spores are produced from the time trees bloom until fall. They are washed by rain over the surface of the fruit, leaves, and branches. In summer these spores infect both fruit and foliage. Apparently all twig and limb cankers develop in the fall. The affected buds may produce spores for 2 successive years and the cankers for at least 3 years.

Control—Remove all dead wood and cankered twigs when pruning. Spray in the early fall and again at the shuck-fall stage with fungicide spray, as recommended in your local spray guides.

BLACK KNOT OF PLUMS AND CHERRIES *Dibotryon morbosum* (Schw.) Theiss. & Syd. This is a destructive disease of plums. Infected trees are stunted. Branches and limbs may be

girdled and killed by the knots. The disease affects many species of both wild and cultivated plums and cherries and it has been reported on peach. In Ontario it is common in small, neglected plantings. Occasionally it is serious in commercial orchards. In British Columbia it is found commonly at the coast but rarely in the Kootenay and has been found occasionally in the Okanagan Valley on imported, newly planted trees, but it has never progressed further on such trees nor has it spread to others. It is common and serious in Nova Scotia.

Symptoms—This disease is distinguished by the rough, elongated, hard, black swellings on infected twigs, branches, and limbs (Fig. 10). The swellings or knots vary from ¼ inch (6 mm) to 8 inches (20 cm) in length and from ¼ to 1½ inches (6 to 38 mm) in diameter. They are usually more common on the smaller twigs. New infections are indicated by slight olive-green swellings and cracks in the wood. The knots enlarge considerably and become hard and black in the second year. Often a white to pinkish mold spreads over the surface of the knot.

Cause—The fungus that causes the disease grows in the tissues of the wood. It produces two types of spores. Summer spores are on the surfaces of the newly formed knots, and winter spores, in minute fruiting bodies in mature knots. The winter

Fig. 10. Black knot infection on plum.

spores begin new infections just before full bloom. The 'roots' of the fungus extend several inches beyond the knot.

Control—During the winter, prune out all shoots and small branches that are swollen. Prune at least 3 to 4 inches (7.6 to 10 cm) below the visible swelling. Remove larger knots on older branches or limbs by cutting out the diseased area down to the wood and for a distance of 3 to 4 inches (7.6 to 10 cm) above and below the knot. Cover the wound with a dressing, as described for peach canker. Destroy all the prunings. Remove any clumps of wild plums or cherries near the orchard. Apply the following: a delayed dormant spray, a prebloom spray, and the regular shuck and cover sprays with the fungicide recommended in your local spray guide.

PLUM POCKETS *Taphrina communis* (Sadeb.) Gies. Plum pockets is an important fungus disease of Japanese plums in Nova Scotia. In Ontario it occurs on some hardy varieties of plums but is rarely of economic importance. The disease affects the fruit and to some extent the foliage and twigs.

Symptoms—The disease first appears as small white blisters on the fruit. These enlarge rapidly as the fruit develops. The fruit increases greatly in size, withers, becomes hollow, and is covered with a grayish powder. Affected twigs are swollen and distorted. The leaves are malformed and curled.

Cause—Spores of the fungus overwinter on the twigs and buds. Infection occurs shortly after the blossom buds open. Cool wet conditions during early bloom are necessary for infection.

Control—Apply a dormant spray either in the fall or in early spring.

LEAF SPOT OR SHOT-HOLE OF CHERRIES AND PLUMS *Coccomyces* spp. *(Higginsia* spp.*)* Leaf spot affects the foliage of sour cherries and to a lesser extent sweet cherries, and causes premature leaf fall. It may develop rapidly in midseason and cause almost complete defoliation by early fall. If many leaves fall the trees may die back and be considerably weakened the following year. The disease is common and serious in Ontario, common in the Kootenay district, but not known to be present in the Okanagan Valley. It is common and serious in nursery plantings. In plums and prunes, this disease can produce a serious shot-hole condition of the leaves.

Symptons—In cherries, the disease causes many minute, red to purplish-black spots on the leaves, which turn yellow and

fall. On the undersides of the leaves are slightly raised, waxy, fruiting pustules of the fungus. Sometimes the spots drop out and the leaf has a shot-hole appearance. In plums and prunes, the brownish to purple spots that develop drop out, producing a shot-hole effect. Severely affected leaves may be completely skeletonized. In sour cherries, the presence of spotting distinguishes this disease from cherry yellows virus.

Cause—The fungus that causes this disease continues to live in the infected leaves after they fall to the ground. In the spring, about blossom time, spores are produced that are the source of new infections. On the undersides of newly infected leaves the fungus forms spores freely. These spores are spread by rain from leaf to leaf.

Control—For sour cherries, follow a spray program consisting of a petal fall, shuck fall, and three cover sprays at intervals of 10 to 12 days, and a postharvest spray soon after picking. Your local spray guide gives details on recommended sprays. Eradicants are suggested in the third cover and postharvest applications, in orchards where leaf spot is difficult to control. Thorough coverage of the undersides of the leaves is necessary.

For susceptible sweet-cherry varieties, in addition to the regular spray program, apply a postharvest spray as recommended for your area.

On plums the regular spray program gives adequate control of leaf spot.

NOTE: For additional information, consult *Bacterial and Fungous Diseases of Fruit Trees,* Plant Pathology Circular No. 12, British Columbia Department of Agriculture.

VIRUS AND MYCOPLASMA DISEASES

A number of important virus diseases affect stone fruits. These diseases are systemic troubles, the infective agents being present in the sap of the trees. Infected trees may have symptoms of varying severity from season to season, but they never fully recover, nor can they be cured by application of sprays. All viruses can be spread by use of infected understock or budwood. Many are spread by insects that feed on the leaves or twigs. Some are spread from tree to tree by pollen. Others are carried through the soil by fungi, nematodes, or cultivation equipment. Virus diseases are often difficult to diagnose. Bring suspected cases to the attention of your nearest plant pathologist.

Until very recently, mycoplasmas were considered to be viruses because they produce diseases that are very similar to virus diseases. All the diseases produced by these agents are spread from plant to plant by leafhoppers. They are susceptible to heat and some can be controlled by chemical treatment. X-disease and western X-disease of cherry and peach are caused by mycoplasmas.

SWEET CHERRIES Virus diseases of sweet cherries are tatter leaf, little cherry, rasp leaf, mottle leaf, twisted leaf, and Lambert mottle.

Tatter leaf is fairly common in Ontario and occasionally in British Columbia orchards. It causes a mild mottling, stunting, extensive necrosis, and tattering of the early foliage. These symptoms often appear on only part of the tree. Some cherry trees carry the virus without developing any leaf symptoms.

Little cherry is a serious disease in the Kootenay district of British Columbia. A recent outbreak in the Okanagan Valley has apparently been eradicated by removal of affected trees. No symptoms appear on the foliage of the more common commercial varieties, but the fruit is abnormally small and tends to be angular and pointed in shape, dull and light in color, and insipid in flavor. For more information on this disease, consult the B.C. Department of Agriculture, Plant Pathology Branch publication **Little Cherry Disease, a Renewed Threat to British Columbia Fruit Districts.**

Small bitter disease, or western X-disease, has occurred in scattered sweet cherry trees in the southern Okanagan Valley. When cherries are grown on Mazzard understock, the effect of western X upon the individual cherry fruit is similar to that of little cherry, except that affected fruits have a distinctly bitter taste instead of being insipid. Generally, western X-disease invades only part of the tree. Healthy and affected fruits can develop side by side, even in the same cluster. Sweet and sour cherries on *P. mahaleb* understock wilt and decline rapidly after infection. The symptoms of X-disease in Eastern Canada are the same as those of western X-disease in British Columbia.

Rasp leaf, found in Ontario and British Columbia, is characterized by small, narrow, markedly distorted leaves. A series of outgrowths that form toothed ridges on either side of the midribs and veins is associated with this disease. The virus causing rasp leaf is transmitted by nematodes. Affected areas in the orchard should not be replanted with fruit trees unless fumigated (see Disorders Due to Nematodes).

Mottle leaf occurs in a severe form in the Kootenay district of British Columbia. It causes yellowish mottling of the leaves and serious stunting of Bing cherries. Most other cultivars are highly tolerant of this virus disease. A mild form occurs in the Okanagan Valley.

Twisted leaf appears spasmodically in scattered orchards of the Okanagan and neighboring valleys. Affected trees are often stunted. The foliage is distorted (Fig. 11) and necrotic areas develop on the midribs and veins. The causal virus is native to and widespread in the native chokecherry, which should be removed from orchard areas wherever possible. It is probably the same as the virus that causes ring pox in apricot.

Another very similar disease, caused by the tomato bushy stunt virus, has been observed on a few sweet cherry trees in Ontario and British Columbia. The trees are very stunted and the foliage is much distorted due to necrosis of leaf midribs and veins. Blossom blight is extensive. Fruits, borne on short stems, are misshapen and pitted.

Lambert mottle causes burning of the leaves, defoliation, and death of twigs and branches. The Lambert and Sam varieties are most seriously affected. It has caused serious losses in some orchards in the Okanagan Valley.

SOUR CHERRIES Virus diseases of sour cherries include cherry yellows, green ring yellows, and necrotic ring spot.

Cherry yellows is common in Ontario and British Columbia. Initial symptoms of cherry yellows are very similiar to those described for necrotic ring spot in the next section. The most striking recurrent symptom (Fig. 12) is a green and yellow mottling of the leaves, which later drop. Leaf drop occurs about 3 to 4 weeks

Fig. 11. Twisted leaf of sweet cherries.

Fig. 12. Leaves with yellow and green mottle of cherry yellows virus.

after petal fall and may last for 10 days. Leaf mottling varies greatly and ranges from a light green to almost complete yellowing. The yellowing is different from that caused by the fungus leaf spot in having no spots or fruiting pustules on the lower surface of the leaf. Other symptoms include reduced spur growth and bare willowy twigs with large terminal leaves. Affected trees, especially young ones, grow slowly. They yield less and less, though the fruit is usually large and of good quality.

Green ring mottle, which is found occasionally in Ontario and British Columbia, is similar to cherry yellows except that the leaves are yellowed with complete or partial dark-green rings. Fruit produced by affected trees is deformed, pitted, and not marketable.

Necrotic ring spot is the most common virus disease of sour cherry in Ontario and British Columbia. The initial symptoms include a delay in leafing, thinness of foliage, irregular minute yellowish and necrotic spots, ring patterns, and 'shot-holes' on the first leaves (Fig. 13). These first symptoms vary considerably in severity. Also they may affect only a few branches or the entire tree. In later years the trees may have only slight symptoms.

APRICOTS Ring pox causes various surface blemishes and plugs of black necrotic tissue on the fruit (Fig. 14). Frequently there are brown dead spots in the flesh. The disease occurs in the Okanagan and Similkameen valleys of British Columbia and is caused by the same virus as twisted leaf of cherry. The virus is often carried in

Fig. 13. Leaves of sour cherry with necrosis and 'shot-holing' of necrotic ring spot virus.

Fig. 14. Ring pox virus on apricot.

native chokecherry, which should be eliminated from orchard areas.

PEACHES Virus and mycoplasma diseases of peaches are yellows, little peach, X-disease, and western X-disease.

Yellows, once a serious disease in Ontario, is now seldom found. The leaves of affected trees become yellowish, fold inward, and tend to roll and droop downwards. Thin, willowy shoots with small, narrow, pale leaves grow upright from the main limbs. The fruit ripens prematurely, is highly colored, and has red streaks in the flesh. This coloring is pronounced around the pit. The tree may die in a few years.

Little peach, a destructive disease of peach, is rarely seen in Ontario. The foliage symptoms are similar to those of peach yellows, that is, a yellowing and clustering of the leaves. The crowded leaves tend to droop and bend inward or curl towards the branches. The fruit is smaller than normal and ripens later. The pits are reduced in size and the seeds may not develop.

X-disease in Ontario and western X-disease in British Columbia are similar diseases that are reported occasionally. The symptoms are a mottling and reddish-purple spotting of the leaves. The spots die and fall out, leaving a 'shot-hole' effect. Later the leaves on affected branches drop except those at the tips. This symptom distinguishes the disease. Yields are seriously reduced and the fruit is unsalable. An interesting point in connection with X-disease is that it spreads readily from the chokecherry to peach but not from peach to peach. Chokecherry, therefore,

should be eradicated from the vicinity of peach and cherry orchards.

PRUNES The symptoms of prune dwarf are distinctive. Leaves of infected trees are small, narrow, rugose, and glazed in appearance. Terminal growth is reduced, internodes are shortened, and the foliage is clustered. These symptoms may appear on only a few branches. Few fruits mature. The disease occurs in both British Columbia and Ontario.

PRUNUS STEM PITTING This virus disease affects all stone fruits. In the eastern United States it is most prevalent in peach and apricot, whereas in Ontario it is most common in sour cherry. In the spring infected trees are often very slow to leaf out and may collapse and die at this time. Others leaf normally but begin to decline with the stress of maturing fruit. Fruits color early but fail to develop fully as the tree dies. The most characteristic symptoms of prunus stem pitting are found on the lower trunk near the soil line where bark may be much thickened and spongy. The wood beneath this bark has pits varying from small shallow depressions to deep grooves, furrows, and ridges. The pits are usually most numerous near the graft union (Fig. 15). In some trees the attachment of the roots to the base of the trunk is weak. Such trees are much stunted and very poorly anchored. This disease is caused by the tomato ringspot virus, which is transmitted by a nematode.

Fig. 15. Trunk of 3-year-old peach tree (bark removed) infected with prunus stem pitting. Note numerous small pits extending above and below the union.

CONTROL OF VIRUS AND MYCOPLASMA DISEASES

Remove trees that show symptoms of peach yellows, little peach, X-disease, little cherry, green ring mottle, twisted leaf, Lambert mottle, apricot ring pox, rasp leaf, prunus stem pitting, or prune dwarf. These diseases seriously affect productivity, and infected trees may serve as reservoirs from which further spread can take place. Before planting a new orchard, or before replacing missing trees in an existing orchard, complete or site fumigation to kill vectors of virus diseases is recommended.

If possible, obtain virus-free budded stock or obtain budwood for nursery propagation from a healthy source. The Canada Department of Agriculture Research Station at Vineland Station, Ontario, maintains true-to-name Foundation stock of most commercial varieties of tree fruits that are free from all known viruses. Small amounts of budwood are available from this source. Larger amounts of budwood, especially of sweet and sour cherries, can be obtained from virus-tested trees maintained by the Horticultural Research Institute of Ontario, Vineland Station, Ontario. The British Columbia Fruit Growers' Association budwood certification scheme, with headquarters at the Research Station, Summerland, British Columbia, provides budwood of most of the commercial varieties of tree fruits at nominal cost. This material is certified true-to-name, and is as free as possible from virus infection. A similar organization, the Western Ontario Fruit Testing Association, with headquarters at the Research Station, Harrow was formed in Ontario in 1965.

Locate new sour cherry orchards as far away as possible from diseased trees. They should be at least 200 yards (180 m) away, though a shorter distance may give some protection. In orchards 5 years old or younger, replace trees that become infected with cherry yellows or necrotic ring spot. Make solid uniform plantings of high-quality nursery stock that is as virus-free as obtainable. Do not attempt to rejuvenate an old orchard by replacing trees. Replacements soon become infected, and, as most viruses have a more severe effect on young trees than on older ones, the growth of such replacements is greatly reduced. Many of them never grow sufficiently to become economically productive.

DISORDERS DUE TO NEMATODES

Nematodes are very small, thread- or worm-like animals that are from 1/64 to 1/8 inch (0.4 to 3 mm) long. They live mostly in soil. Most of the many species in soil feed on other microorganisms and organic debris. A few, however, attack the roots of plants. The only symptom of attack may be reduced growth and vitality of the plant.

PEACH REPLANT FAILURE It is often difficult to establish new plantings of peach on old orchard sites in Essex, Kent, and Lambton counties in southwestern Ontario. Failure has been most serious on coarse sandy soils during hot, dry summers. This problem has been encountered occasionally in the Niagara Peninsula.

No orchard replant problems have been reported in British Columbia. Root lesion nematodes introduced to the root zones of fruit trees in an Okanagan Valley orchard did not increase in numbers or cause tree injury during a 15-year trial.

Symptoms—The aboveground symptoms range from slight stunting and a mild yellowing of leaves to almost complete cessation of growth and later death. The roots have discolored, dead areas. The tree appears to grow well at first, but after a few weeks to over a year the new roots die back to their points of origin on the old roots and the tree dies. Usually trees do not die from the disorder after the second growing season.

Cause—Peach replant failure is a complex disorder in which a root-lesion nematode, *Pratylenchus penetrans* (Cobb) Filip. & Stekh., is the primary parasite. As nematodes enter a young root, they kill the plant cells and cause dead areas. Soil bacteria and fungi soon invade these areas, the root dies, and the plant is weakened. The disorder is aggravated by drought and competition from weeds.

Control—The problem can be prevented by good cultural practices and, where necessary, by soil fumigation with a nematicide in the fall before planting. Further suggestions are as follows:

- Buy the best nursery stock available to ensure vitality.
- When planting, put good topsoil around the roots and tamp it well so that the trees will resist a firm pull.
- Immediately after planting, prune to balance the top with the root system.
- Immediately after planting, apply one of the following: a starter solution such as 10-52-17 (9 pounds in 120 gallons (3.740 kg/500 litres) of water) at the rate of 2 gallons (9 litres) per tree; or 2 ounces (56 g) of ammonium nitrate per tree lightly worked into the soil.
- Cultivate often enough to prevent all weed growth until mid-July. Weed control around young trees is important not only because of competition for moisture and nutrients but also because most weeds are good hosts for the nematodes. Even slight weed growth will allow the nematodes to survive.
- After mid-July plant a cover crop such as perennial rye grass which is a poor host for the root-lesion nematode.
- Irrigate during dry weather.

Detailed directions on soil fumigation to control nematodes can be obtained from your agricultural representative, district agriculturalist, or local spray guides. Fumigation is particularly important in sandy soils and in orchards in which replanting has failed. The fumigant must be applied to a depth of 6 to 8 inches (15 to 20 cm) in strips 10 feet (3 m) wide along the tree-row site. The next spring, plant a row of trees in the center of each fumigated strip, with 20 feet (6 m) between rows. For more details inquire at the Research Station at Vineland Station, Ontario. Soil fumigation can also be done by custom operators.

CHERRY REPLANT PROBLEM For a number of years it has been difficult to plant new sour cherry trees on old orchard sites in the Niagara Peninsula. The problem is most severe where an orchard has been neglected.

Symptoms—The young trees are retarded and stunted. The leaves appear to be lighter in color than usual and the margins roll upward. The leaf symptoms are similar to those of potash deficiency. The roots are discolored and have dead areas and very few feeder roots. The trees do not respond to fertilizer treatments. Some trees die.

Cause—The problem appears to be another complex disorder involving the root-lesion nematode *Pratylenchus penetrans,* soil bacteria, and fungi.

Control—Follow the recommendation given for peach replant failure.

NONPARASITIC DISORDERS

HEAT SPOT OF PRUNES AND PLUMS High temperatures at a certain stage of maturation may cause fruit to become purplish and exude clear gum. The spots usually appear 5 to 8 days after hot periods. Summer cover crops help to reduce this type of injury.

BLODGETT SPOT This disorder of Early Italian prune and possibly a few other varieties is a problem in British Columbia. In the early summer leaf spots varying in size from 1-2 mm to large blotches, and irregular dead areas develop quickly. An indistinct mottle often accompanies the leaf spotting. Defoliation may be extensive. Heavy fruit drop or a yield of poor fruits results. The disorder is believed to be caused by a genetic abnormality because it is bud-perpetuated but no disease organism has been associated with it. This, or a very similar condition, has been reported from Ontario. To avoid this problem growers should use certified nursery stock.

WINTER INJURY Winter injury may take any one of several forms: killing of fruit buds, dieback of twigs or branches, sunscald, bark splitting, crown and root rot, and internal necrosis.

The buds may be killed by unusually low temperatures during the normal period of dormancy or by frosts after unseasonably warm weather activates the buds.

Twigs may die back because of inadequare ripening of the wood in the fall. The wood may not ripen because of excess soil moisture, late fertilization, or prolonged cultivation, all of which promote late growth in the fall.

Sunscald occurs on limbs and trunks as a result of freezing temperatures followed by bright warm sunshine in the late winter. This type of injury is common and is often found on the southwest sides of the trees. The injury may be recognized by depressed or flattened areas that exude gum.

The crown and roots may be injured during the winter if the tissues are not properly hardened. The tree may grow poorly or die. Poor drainage increases susceptibility to crown injuries.

Severe frosts may affect the heartwood without injuring the cambium or sapwood and cause internal necrosis or blackheart. The tree is not damaged appreciably though it is exposed to the inroads of wood-destroying fungi.

A sudden pronounced drop in temperature to near zero may cause bark splitting on trunks.

The type and severity of winter injury depend on the degree of hardening of the tree or parts of the tree at the time of critical temperatures. Factors that influence dormancy and hardiness are soil type, fertility of soil and fertilizing practices, drainage, cover crops, cultivation practices, and the inherent hardiness of the variety. To lessen the danger of winter injury it is wise to follow those cultural practices that promote early hardening.

MINERAL DEFICIENCIES These are difficult to diagnose because the symptoms can be very similar to those induced by virus diseases, and pesticides or herbicides.

The publication **Mineral Deficiencies and Other Disorders of Fruit Trees,** B.C. Department of Agriculture, Plant Pathology Circular No. 1, describes some mineral deficiency disorders.

The best way to determine nutrient requirements of fruit trees is by leaf analysis. In British Columbia, a leaf analysis service is operated jointly by the British Columbia Fruit Growers Association, the British Columbia Department of Agriculture, and the Canada Agriculture Research Station at Summerland. The Ontario leaf analysis service is under the direction of extension specialists of the Ontario Ministry of Agriculture and Food and the Horticultural Research Institute of Ontario at Vineland Station. In British Columbia and Ontario there is a fee for this service. Consult your local extension specialist for details.

INSECTS

ORIENTAL FRUIT MOTH *Grapholitha molesta* (Busck). Ontario is the only fruit-growing area in Canada in which the oriental fruit moth is known to occur. It was introduced from Japan into the United States and was first found there in 1916. It was first found in Ontario in 1925, and it soon became the most destructive pest of peach. It is also very injurious to quince and occasionally to some varieties of pear. It may infest, though never seriously, apples, plums, and cherries.

Injury—The larva attacks both the twigs and the fruit of its main host, the peach. Early in the season while the trees are growing rapidly, most of the larvae enter the twigs, boring into the tips and tunneling downward until they reach harder woody tissue; then they come out and enter other twigs. The tip of the infested twig wilts and dies (Fig. 16). In midsummer, when the twigs are beginning to harden, many partly grown larvae leave the twigs and attack the fruit; there they usually feed near the surface, producing large masses of gum mixed with sawdustlike castings or frass (Fig. 17, left).

Newly hatched larvae have difficulty in entering the hard green fruit. Some of them feed on the soft tissue of the stem and later enter the flesh. About 3 or 4 weeks before it is ripe, the fruit begins to soften, it no longer produces gum when it is wounded, and the young larvae can enter it readily. They usually tunnel to the pit, around which they feed and leave many particles of brown frass (Fig. 17, right). The newly hatched larva is so small that its entry hole is seldom noticed, and some larvae enter through the stem, so that wormy peaches often cannot be detected until

Fig. 16. Injured peach twig showing the wilted tip above the feeding tunnel made by the larva of the oriental fruit moth.

they are opened. Fruit with this concealed injury is especially objectionable because it cannot be culled at packing time and therefore it reaches the consumer.

Habits and life history—The oriental fruit moth usually has three generations annually in Ontario. It passes the winter as a full-grown larva in a cocoon in crevices of the rough bark of the trees, in weed stems and trash on the soil, in fruit containers, and about packing sheds and barns. In the spring the larva changes into a pupa and then into a dark grayish-brown moth with a wingspan of about ½ inch (13 mm). The moths begin to emerge about the time Elberta peach blossom buds show pink and they continue for about 2 months, though they usually emerge in greatest numbers about the last week of May. The eggs are laid on the leaves and most of the larvae hatch in early June. Most of these first-generation larvae bore into the twigs, only a few attacking the fruit.

The stages of pupa, moth, and egg are again passed. The second-generation larvae begin to hatch in late June and usually hatch in greatest numbers between July 10 and 20. As previously mentioned, larvae at this time of the year attack both the twigs and fruit of peach.

The third-generation larvae appear about mid-August and often continue to hatch in large numbers until mid-September. It is this generation that is largely responsible for wormy fruit at harvest, often with little or no external sign of injury.

The times of occurrence of the generations vary somewhat from season to season, depending on weather conditions. Usually,

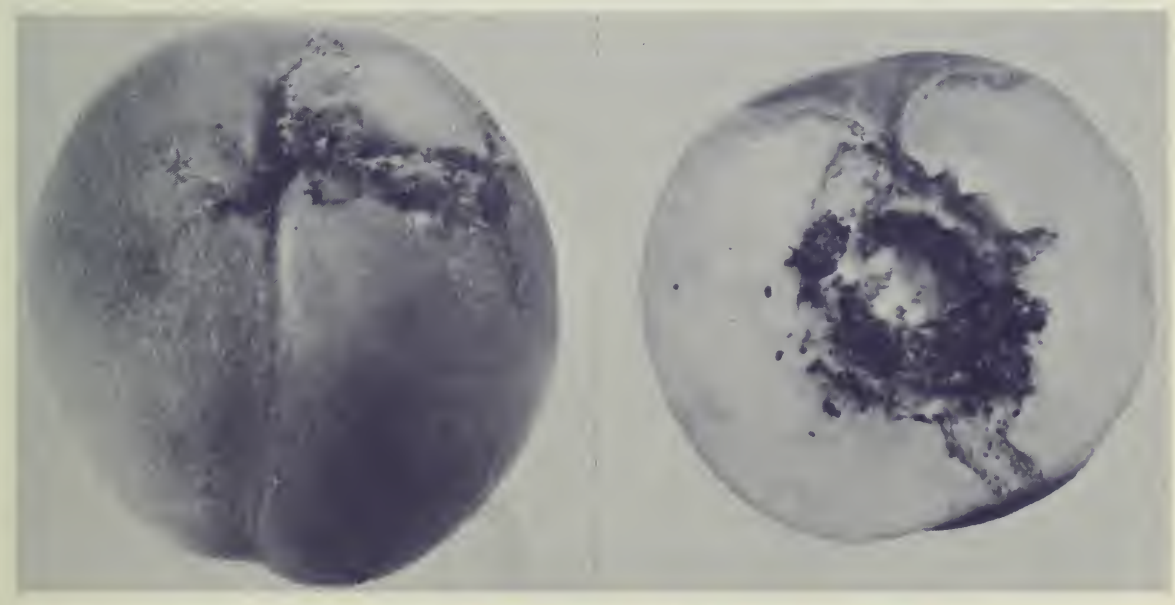

Fig. 17. Conspicuous type of injury caused by larva of the oriental fruit moth feeding on a green peach during midsummer (left). Internal injury caused by larva feeding inside a ripe peach (right).

most of the third-generation larvae that become full grown spin cocoons and remain in these over winter. However, in exceptionally warm seasons, some of them transform to pupae and adults, and these may produce a few eggs and larvae late in the season.

Kieffer and, to a lesser extent, Anjou pears are occasionally injured seriously by this insect in Ontario. Kieffer pears usually escape serious injury unless there is exceptionally warm weather in late September and early October, after peaches have been harvested.

Control—The abundance and destructiveness of the moth vary greatly from year to year and, to a lesser extent, from district to district, depending on weather conditions, parasites, and control by insecticides. The most important parasite is *Macrocentrus ancylivorus* Rohwer, which was introduced from New Jersey in 1929. It destroys many of the first- and second-generation larvae and is a valuable aid in control, especially in the Niagara Peninsula where it is more abundant than in Essex County.

Three or four applications of an insecticide are needed each year in most peach orchards in Ontario to control this insect. Consult the Ontario spray guide for peaches for the latest recommendations on control.

PEACH TWIG BORER *Anarsia lineatella* Zell. This insect occurs throughout the Okanagan Valley of British Columbia, where it often causes serious injury to peach, apricot, plum, and prune. It is also found in Ontario.

Injury—The peach twig borer causes two types of injury. First, the larvae tunnel the buds and terminal shoots in early summer. The injured twigs wilt and die, producing the typical 'flags' so often seen in stone-fruit orchards throughout the Okanagan Valley. Second, the next generation of larvae infests the fruit, particularly of peaches and apricots. The larvae generally attack the fruit at the stem end, where they cause superficial damage, but may bore right into the hearts of split-stone peaches and feed on the kernels.

Habits and life history—The larva is chocolate brown and about half an inch (13 mm) long when fully grown. It overwinters in the second or third instar in a silk-lined burrow, usually in a crotch of 3-year-old wood. The burrow can be recognized by the column or 'chimney' of frass. The overwintered larvae leave their hibernation quarters about the time when peach buds are at the pink stage. At first they move freely over the tree, feeding here and there before settling on one bud or twig. The larvae pupate about mid-May under loose pieces of bark, and 2 or 3 weeks later the small steel-gray moths emerge. The pearly white eggs are laid singly on young twigs, and from these eggs larvae hatch and attack the fruit and terminal growth. A second generation of

moths occurs in August and the larvae of this generation overwinter.

Control—Where control is needed on peaches, plums, or prunes in British Columbia, spray at the pink stage of peach bud development or when 75% of the peach petals have fallen. Use a material recommended in your local spray guide. In Ontario, sprays for oriental fruit moth will also control twig borer.

PLUM CURCULIO *Conotrachelus nenuphar* (Hbst.). The plum curculio, a native weevil, is a serious pest of all stone fruits, and to a lesser extent of apple and pear. It is found in all fruit-growing areas of Eastern Canada, but is economically important as a stone-fruit pest only in Ontario; it does not occur in British Columbia. It is usually most troublesome in orchards near woods, thickets, tall grass, or weedy areas that provide favorable winter quarters.

Injury—The overwintered adult beetles attack the fruit soon after it forms. They eat holes through the skin, feed on the pulp beneath, and make distinctive crescent-shaped wounds in the skin (Fig. 18, left) when laying eggs. The larvae, or grubs, feed on the flesh of the fruit, usually next to the pit (Fig. 18, right). Infested fruits usually fall prematurely, although cherries remain on the tree until ripe and often rotten. Beetles of the summer generation begin to emerge in late July and feed on the ripening fruit,

Fig. 18. Egg-laying scar of the plum curculio on plum (left). Larva feeding inside a plum (right).

chewing holes through the skin and eating the pulp, but this injury is seldom serious. Brown rot is more difficult to control where curculio injury is present because the rot may enter the fruit through the holes made by the beetles.

Habits and life history—The adult beetle, about 1/5 inch (5 mm) long, is grayish black, rough, and humpbacked. It has a conspicuous beak or snout, at the end of which are biting mouthparts. The larva, usually found in a curved position near the pit of the fruit, is a legless, whitish grub with a brown head. When full grown it is about 1/3 inch (8 mm) long.

Curculios overwinter as adults under debris or just beneath the surface of the soil in or near the orchard. When the weather warms in the spring, they leave their winter quarters and move into the trees. This movement usually begins about the time plum petals are falling and continues throughout May and part of June. Egg laying starts about the time the shucks are falling and continues until early August, although most of the eggs are laid in June. The small grubs hatch from the eggs in 5 to 10 days. They mature in the flesh of the fruit about 21 days after the eggs are laid, then leave the fruit and enter the soil; there they pupate in earthen cells about 1 inch (25 mm) below the surface. The adults of the summer brood emerge from these cells from late July to late October or early November. They feed on the fruit until the approach of winter, when they seek hibernating quarters. Only one generation a year occurs in Ontario.

Control—In Ontario, annual applications of a poison are needed to control the plum curculio in practically all cherry, plum, and apricot orchards and in most of the smaller peach orchards. In some large peach orchards it is necessary to spray only the outside few rows adjoining favorable winter quarters of the beetles. Apply two sprays, 8 to 14 days apart, on peaches and apricots when about half the shucks have split, and on cherries and plums when most of the shucks have fallen from the fruits. The curculio adults emerge and attack the fruit when the temperature is above 55° F, so apply the first spray a day or two early if the temperature is high when the shucks are splitting or starting to fall. Lengthen the interval between the sprays by 2 or 3 days during cool weather. Consult the Ontario spray guide for the materials and amounts to use on the different fruits.

LESSER PEACH TREE BORER *Synanthedon pictipes* (G. & R.). This species of borer usually attacks the upper part of the trunk and the crotches and larger branches of peach trees. It sometimes enters the trunk near ground level on older trees, where it may be mistaken for the peach tree borer. It does not occur in British Columbia, but in Ontario it causes serious injury to peach and occasionally attacks the trunks of plum trees that have suffered winter injury.

Injury—The larvae injure trees by boring in the inner bark and outer layers of wood, mainly in wounded and cankered areas. Masses of gum and castings (Fig. 19) accumulate in and near the burrows. Injury may be more serious on smaller than on larger trees and limbs, especially when several borers are present in one area. The greatest injury occurs when the main crotch of the trunk becomes infested by several borers.

This borer may enter healthy bark if the surface is rough enough to provide shelter for newly hatched larvae, but usually it enters tissue damaged by a canker or a wound caused by mechanical or winter injury. Though peach canker, a fungus disease, is not caused by the lesser peach tree borer, the borer helps to spread the disease to healthy tissue, and thus increases the infected areas.

Habits and life history—The lesser peach tree borer completes its life cycle in 1 year in Ontario. It passes the winter as a partly grown larva in the feeding tunnel in the bark. The larva continues feeding in the spring, and when mature it pupates within a cocoon between early May and late August. The cocoon is inside the burrow but close to the surface so that the pupa can push itself partly into the open before the moth emerges. The moth is a little smaller than the adult of the peach tree borer and the female lacks the orange band on the abdomen.

The moths emerge from the latter part of May until late August in Ontario. In the Niagara Peninsula, the peak of emergence usually occurs between June 25 and July 9. The oval,

Fig. 19. Injury to a peach branch by the lesser peach tree borer.

reddish-brown eggs are laid in cracks and crevices of wounds on the trunk and branches. The females are attracted to the wounded areas but they do not lay their eggs in the gummy portions of the wounds. The young larvae feed on the inner bark and prefer the callous tissue about the margins of the wounds. The larvae continue feeding until cold weather in the fall.

Control—Make three applications of an insecticide recommended in the Ontario spray guide. Apply the first spray 5 to 10 days after shuck fall, the second 3 weeks later, and the third 3 weeks after the second. Use a coarse spray with gun or broom at 250 to 300 pounds (1724 to 2069 kPa) pressure, and direct it at the scaffold limbs and trunk down to the ground.

Losses from this insect can be reduced by good husbandry. Keep the trees as free as possible from mechanical wounds, winter injury, crotch separations, and cankers.

Winter injury in the form of bark splitting on the trunk provides a favorable area for egg laying and larval development. Probably the most important factor in preventing winter injury is regulation of the amount of nitrogen available to the tree. If the cultivation and fertilization are designed to ensure proper hardening before cold weather occurs, the tree will be much less susceptible to winter injury and subsequent attack by this borer.

PEACH TREE BORER *Sanninoidea exitiosa* (Say). The peach tree borer is an important pest of peach in Canada, and is present in almost every orchard. Sometimes it attacks plum, cherry, and apricot trees.

Injury—The larvae feed in irregular tunnels in the bark and outer wood of the trunk and main roots near the ground surface. The injured areas produce a great deal of gum, usually containing castings from the borers.

A peach tree about 8 or more years old can tolerate several borers without any noticeable effect on growth or size of the crop. As many as 16 borers have been found feeding on a tree that survived and bore fruit the following season. However, the borer damages younger trees seriously, and kills many of those under 3 years. Some years it causes heavy losses in nursery rows by killing the stock or lowering its grade.

Habits and life history—The newly hatched larvae enter the tree by boring into the bark of the trunk at or near the ground level. They feed there (Fig. 20) and make a distinctive mound of castings around the entrance hole. The larva is whitish, has a dark-brown head and plate behind the head, and when mature is 1 inch (2.5 cm) long.

Some of the borers complete their life cycle in 1 year and others require 2 years. Both groups pass the winter as larvae in cases at or near ground level, or in the feeding burrows.

The larvae resume feeding in the spring, either in the old tunnels or in new ones. When mature, in late June or during July, they make light-brown cocoons near the surface of the soil within 3 inches (7.6 cm) of the trunks or in the feeding tunnel. They pupate in the cocoon and the adults begin to emerge in July. The adult is a beautiful blue-black, clear-winged moth. The female (Fig. 21) has a conspicuous orange crossband on the abdomen.

In Ontario, the moths emerge from about mid-July until early September, the peak of emergence occurring about the first of August. The eggs are laid on the ground, the trunk, and the foliage. They hatch in about 12 days and the young larvae bore into the bark of the trunk near the ground level.

Control—Preferably use sprays to control this borer. In Ontario, use the same three sprays recommended in the spray guide for the control of the lesser peach tree borer. In British Columbia, apply two trunk sprays using a recommended insecticide.

You may also control this borer in Ontario and British Columbia by soil treatments, as directed in your local spray guides.

SHOT-HOLE BORER *Scolytus rugulosus* (Ratz.). The shot-hole borer infests all kinds of fruit trees, but is most destructive to peach, cherry, and plum.

Fig. 20. A grub of the peach tree borer feeding in tunnel at base of peach tree.

Fig. 21. Adult female moth of the peach tree borer.

Injury—The small, reddish-black beetles breed only in dead or dying trees, but their attacks may weaken healthy trees and if continued may kill them. The presence of this borer is indicated by numerous small holes, resembling punctures made by fine shot, in the trunk and branches, and by conspicuous masses of gum that exude from these holes (Fig. 22).

Habits and life history—The winter is passed as larvae, or grubs, in passages beneath the bark. In Ontario the adult beetles emerge in June, burrow into dead or sickly trees, make tunnels beneath the bark, and deposit their eggs in these. The small white grubs that hatch from the eggs tunnel between the bark and the wood, and change to pupae and later to beetles. Adult borers of the second generation start to emerge from the trees about the middle of August and lay the eggs that produce the overwintering generation of grubs.

Control—The most important step in preventing infestations of the shot-hole borer is to remove and destroy dead and dying fruit trees and branches. Burn such trees and trimmings by early June, before the new brood of beetles begins to emerge. Serious outbreaks have often begun in piles of orchard firewood left lying all season near fruit trees. Where such wood cannot be disposed of before June, store it in sheds or cellars with windows and doors kept closed to prevent the beetles from reaching the trees in the orchard.

Slightly injured trees may be saved by rather severe pruning, thorough cultivation, and the application of a quick-acting fertilizer such as ammonium nitrate.

Fig. 22. Injury by the shot-hole borer, showing gum exuding from the holes in the bark.

CHERRY FRUIT FLY *Rhagoletis cingulata* (Loew), **WESTERN CHERRY FRUIT FLY** *Rhagolilis indifferens* Curran, and **BLACK CHERRY FRUIT FLY** *Rhagoletis fausta* (O.S.). In Canada there are three species of cherry fruit flies whose maggots may damage the fruit seriously. The adults, which are a little smaller than the house fly, have different markings on the abdomen and wings (Fig. 23). The cherry fruit fly is the more abundant and has three white crossbands on the abdomen of the male and four on the female. The abdomen of the black cherry fruit fly is entirely black. The western cherry fruit fly, a new pest of interior British Columbia, is very similar to the common cherry fruit fly.

Late cherries are usually much more heavily infested than early varieties.

Injury—The maggots feed near the pit (Fig. 24) and destroy much of the flesh of the fruit. Infested fruits may appear to be uninjured, but when opened show broken-down brown areas where the maggots are feeding. Sometimes the skin of the fruit shrivels on one side over the injured area, and a small hole may appear in the skin. Brown rot starting in wormy fruit often spreads to other fruit.

Habits and life history—These insects spend most of the year in the dormant or pupal stage a short distance below the surface of the soil. The flies begin to emerge in June, about the time the first sign of red color appears on early sour cherries. The black-bodied species emerges a few days earlier than the other species in Eastern Canada, and about 10 days later on Vancouver Island. In the Okanagan Valley, the flies begin to emerge in late May or early June; and in the Columbia and Kootenay valleys, about 2 weeks later. The flies move about on the foliage of cherries and

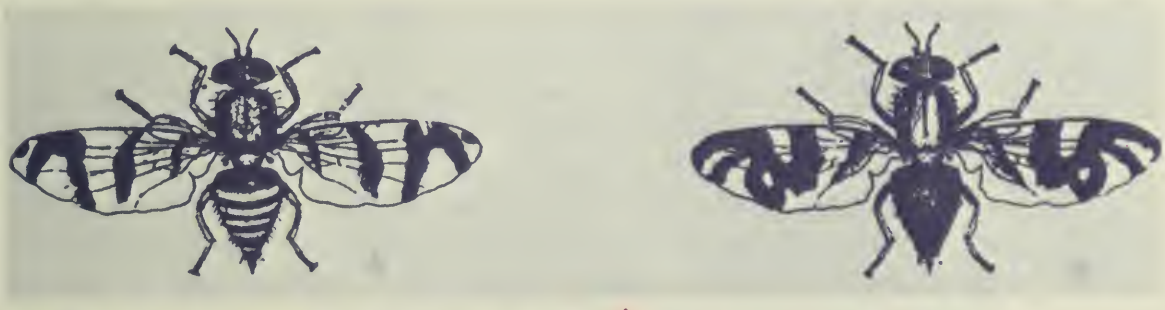

Fig. 23. A female of the cherry fruit fly (left) and a female of the black cherry fruit fly (right), much enlarged. (After Caesar.)

Fig. 24. Injury by the cherry fruit fly. A maggot feeding next to the pit in the cherry on the right.

other fruit trees for several days before laying eggs. These are inserted in the fruit so that they usually protrude slightly from the surface. The eggs hatch in about 5 days and the young maggots work their way to the pit, where they feed on the pulp. They grow rapidly and mature about the time the fruit is ripe or a little later. Then they leave the fruit and enter the soil, where they change to the pupal stage and remain until the following June.

Control—Good control of cherry fruit flies can be obtained by killing the flies before they lay many eggs in the fruit. Control is more difficult in orchards near unsprayed cherry trees.

Apply the following sprays in Ontario: two sprays, the first about 12 days after the shucks have fallen, and the second on sour cherries 10 days later and on sweet cherries when the earliest varieties are beginning to color. In the Kootenay district of British Columbia: two sprays, the first about June 10 and the second 10 days later. In the coastal districts of British Columbia; three sprays at 10-day intervals, starting the last week of June.

Consult your local spray guides for materials to use.

CHERRY FRUITWORM *Grapholitha packardi* Zell. This insect is a pest of sweet and sour cherries on Vancouver Island and to a lesser extent in the lower Fraser Valley and the interior of British Columbia. In the Okanagan Valley it has become a problem only in the Kelowna district. It is present in Ontario but rarely causes appreciable injury.

Injury—The larva bores into the fruit shortly after hatching. It leaves small, brownish trails under the skin of the cherry. Mature fruits are generally distorted or 'monkey-faced,' with roughened and blackish areas. Sometimes there is very little external sign that the fruit is wormy until the larva leaves it, when the exit hole can be seen.

Habits and life history—The cherry fruitworm has one generation a year. The adult is a small, grayish moth with a wing-spread of about ¼ inch (6 mm). It appears in the orchards in British Columbia during the last week of May or in early June, depending on the season and the locality. The flattened, circular eggs are laid singly on the cherries, usually in the crease near the apex. The eggs hatch in about 11 days and the young larvae bore into the fruit and feed between the flesh and the pit. At first the larvae are white with black heads but they become tinted with pink as they mature. They are fully grown in about 3 weeks and are then almost ¾ inch (19 mm) long. Then they leave the cherries and search for suitable places to hibernate. They spin nests under pieces of loose bark or bore into the stubs of pruned branches. Here they remain until the following May; then they pupate, and later emerge as adult moths.

Control—In the interior of British Columbia where control may be needed, spray sweet cherries during the first week of June using a recommended insecticide.

In the coastal districts of British Columbia, control this insect by the same three sprays recommended for the control of cherry fruit flies (page 40) using a material given in the local spray guide.

APPLE MAGGOT *Rhagoletis pomonella* (Walsh). The apple maggot is a native North American insect that has been a serious pest of apples in Eastern Canada for about 75 years. It does not occur in British Columbia. Since 1953, it has become a serious pest of European varieties of plums and prunes in the Niagara Peninsula, and in New York State. The infestation varies greatly from orchard to orchard and is more severe in the eastern half of the Peninsula. Over 25% of the prune crop has been ruined by the maggot in some orchards. Japanese varieties of plums are not attacked.

Injury—The flies make small punctures in the skin of the fruit when laying their eggs during July and August. The maggots tunnel through the flesh of the fruit and usually do most of their feeding near the pit. As the fruit ripens, the infested parts of the flesh collapse. Almost all infested plums and prunes drop from the trees before they are ripe enough to harvest.

Habits and life history—The adult is a black, two-winged fly that is a little smaller than a house fly. The female has four white stripes on the abdomen and the male three. Each wing has four distinct, zigzag black stripes. The young are white, legless maggots with tapering bodies and small, indistinct heads. Plum curculio larvae have conspicuous brown heads. They are found in prunes earlier in the season than apple maggots.

The apple maggot spends the winter in brown puparia in the soil under the trees. The puparia resemble grains of wheat. The flies emerge from late June or early July until about mid-August or later, depending on the season. Most of them usually emerge during the last 2 weeks of July. The flies feed on moisture and small particles on the foliage, and may be seen walking or resting on sunny parts of the tree. They begin to lay eggs about 8 to 10 days after they emerge. The maggots feed in the fruit and most of them mature in the fallen fruit during the latter half of August and the first half of September or later; then they leave the fruit, enter the soil, and change to pupae. There is a single generation each year in Ontario, though a few pupae may remain in the soil until the second summer.

Control—In plum and prune orchards where the apple maggot is troublesome, apply two or three sprays. Apply the first

spray in July about a week after the flies start to emerge, and the other sprays at 10-day intervals. Spray all trees in your plum orchard and all apple, hawthorn, and plum trees within 200 yards (180 m) of it; also, if any other trees or hedges border the orchard, spray the side next to the orchard. It may take you 2 years to obtain good control of very heavy infestations.

Consult your local spray service for the latest information on when to spray and what to use.

PEAR-SLUG *Caliroa cerasi* (L.). This insect attacks sweet and sour cherries more commonly than pear, and it is occasionally troublesome on plum. It is of little importance most years but periodically becomes very abundant and causes severe injury in unsprayed orchards.

Injury—The larvae, or slugs, skeletonize the leaves (Fig. 25) by feeding on the green tissue of the upper surface, which leaves an unbroken network of veins. The skeletonized areas turn brown, and when abundant make the tree look as if it had been swept by fire. The reduction in leaf surface weakens the tree and interferes with the growth of the fruit and the development of fruit buds.

Habits and life history—The larvae are black, covered with slime, and distinctly enlarged at the head end. They are about ½ inch (13 mm) long when full grown and pass the winter in this stage in earthen cells just below the surface of the soil. They pupate in the spring. The adults, black sawflies about ¼ inch (6 mm) long, appear soon after the blossoms fall and lay their eggs in slits that they cut in the leaves. The slugs from these eggs feed from about mid-June until early in July, when they are full-grown; then they drop to the ground and enter the soil. Many of these slugs remain in the soil until the following spring; the remainder pupate and change to adults in late July and August and lay eggs that produce a second generation in August and September. When these slugs are mature they enter the soil for the winter. The second generation is usually much smaller and less destructive than the first.

Control—This insect is easily controlled and does not become a pest where insecticides are applied early in the season for other insects. If needed, a special spray of a recommended material may be applied. Watch young, nonbearing trees that usually are not sprayed with an insecticide, and spray them if slugs threaten to become abundant. It is seldom necessary to spray for the second generation in August or September.

TARNISHED PLANT BUG AND OTHER LYGUS BUGS The tarnished plant bug, *Lygus lineolaris* (Beauv.), is a pest of peaches in all peach-growing districts in Canada. It is most destructive in British Columbia, where related bugs, *Lygus elisus* Van D. and

L. hesperus (Kngt.), also occur. All these are known as lygus bugs; their habits, injury, and control are similar.

Injury—As soon as the petals fall the adult bugs puncture the very small fruits and make them drop, or become scarred or deformed if they remain on the tree. Such injury, called 'cat-facing,' is often serious in British Columbia but is rare in Ontario. Adult bugs of the next generation may attack the fruit later in the spring, causing many shallow, gummy scars (Fig. 26). This is the type of injury usually seen in Ontario.

The tarnished plant bug often breeds in great numbers on pigweed in Ontario orchards. When the pigweed is mown in late summer, the bugs may attack the fruit on low-hanging limbs, causing curly strings of clear gum to exude from their punctures.

These bugs may cause young shoots to become distorted, especially on peach nursery stock, by feeding on the tips.

Habits and life history—The adults vary in color from greenish to light brown, with darker markings, and are nearly 1 inch (2.5 cm) long. They overwinter under fallen leaves and among long grass and other debris, either in woods and waste land or in the orchard if there is sufficient shelter, and emerge about the time the peach buds begin to swell. After they have fed for a time on peach or other plants, the adults lay their eggs in a great variety of plants, chiefly herbaceous, including such cover crops as clovers.

Fig. 25. Pear-slugs feeding on a cherry leaf.

Fig. 26. Peach injured by the tarnished plant bug.

There may be two generations of the tarnished plant bug each year in some parts of Canada. The adults go into winter quarters in the late fall.

Control—In Ontario, injury from the tarnished plant bug is too scarce and erratic to justify regular control measures. However, one spray is recommended when the insects threaten to be troublesome. As the best time to apply this spray varies each year, consult your local spray service for the latest directions. In orchards in British Columbia, where control is needed, spray when 75% of the petals have fallen. Use a recommended material.

OAK PLANT BUGS *Lygocoris quercalbrae* Knight and *L. omnivagus* Knight, and **HICKORY PLANT BUG** *Lygocoris caryae* Knight. The two species of oak plant bugs and the hickory plant bug are important pests in some peach orchards in Ontario near oak and hickory trees.

Injury—These bugs are among those that cause the scarring of peaches called 'cat-facing.' During late June and early July the adult bugs puncture the young fruits and suck the juices. Strings of gum exude from the punctures, and as the fruit grows it develops large, shallow, brown scars that resemble the injury by the tarnished plant bug (Fig. 26).

Habits and life history—The oak plant bugs breed on oak, and the hickory plant bug on hickory and occasionally on walnut. The three species have similar habits. The eggs are inserted in the twigs of oak and hickory and remain there over winter. They hatch in the spring and the young, or nymphs, feed by puncturing the foliage. The adults mature in June and may disperse to other trees in the vicinity, including peach, to feed for a short time before returning to their original hosts to lay their eggs.

Control—Cut down all oaks and hickories within at least 200 yards (180 m) of your orchard. It is seldom necessary to remove walnuts, but do not plant them near peaches. If oak and hickory trees cannot be removed, spray the peaches about June 15 and again 10 days later. In unusually late seasons the sprays may be correspondingly delayed. If the sources of infestation are valuable shade or nut-bearing trees, such as walnuts, spray them in early June. Use a recommended insecticide.

GREEN STINK BUG *Acrosternum hilare* (Say). In Ontario and British Columbia peaches may be attacked occasionally by fhe green stink bug. The injury is seldom serious and is usually confined to trees bordering woodlands, though it may be more widespread in years when the bug is unusually abundant.

Injury—The adult bugs injure the fruit by sucking the juices. Injured peaches have sunken areas or pits and may be badly distorted (Fig. 27). When the fruit is attacked near maturity, the

injury may appear as shallow, water-soaked depressions, and the unbroken skin does not have the dark-brown scars or masses of gum that are characteristic of injury by other kinds of bugs.

Habits and life history—The adults are flat, shield-shaped, bright-green bugs about ½ to ⅝ inch (13 to 16 mm) long. They emit the stink bug odor when handled. They overwinter among fallen leaves and other debris, chiefly in woods, and emerge in the spring to lay their eggs on various wild trees and shrubs, such as elder, basswood, wild cherry, and dogwood. The nymphs, or young, feed on the fruits of these hosts. Rarely, eggs are laid and the nymphs feed on peach, but most injury is produced by bugs that breed on wild plants and disperse to the orchards after they have matured in August and September.

Control—Attacks by this bug are usually too sporadic to warrant control measures. In the few orchards where injury occurs often, removal of the wild hosts, especially elder, should help. In Ontario, no cases of extensive damage have been noticed in recent years.

BLACK CHERRY APHID *Myzus cerasi* (F.). This sucking insect, or plant louse, occurs in large numbers every few years on sweet cherry and causes serious injury unless controlled. It is less common and injurious on sour cherry.

Injury—The aphids attack the leaves as soon as the buds burst and they continue to feed as long as the growth remains succulent. They thrive especially on the soft growth of suckers. Infested sweet cherry leaves curl and cluster (Fig. 28), then

Fig. 27. Peach injured by the green stink bug.

Fig. 28. Black cherry aphids feeding on leaves and fruit of sweet cherry.

they turn yellow and die. The leaves of sour cherry do not curl when attacked but are stunted. The aphids also feed on the fruit and secrete a sticky honeydew that makes the fruit unfit for sale unless it is washed.

Habits and life history—The insect and its eggs are black. The eggs are laid in the fall on the bark of cherry trees, chiefly near the bases of the buds, and they pass the winter there. They hatch in the spring when the buds are ready to burst, and the nymphs feed on the green tips. There may be several generations on the cherry trees; then most of the aphids migrate to peppergrass (*Lepidium densiflorum* Schrad.) and related plants. In the fall, the winged forms of this aphid fly back to the cherry trees and lay their eggs.

Control—In Ontario and British Columbia, the preferred treatment for sweet cherries is to spray with a material to kill the eggs before the buds swell.

If you do not apply a dormant spray on sweet cherries you may control this aphid by spraying with a recommended insecticide between the time the buds burst (green-tip stage) and just before the blossoms open, or during the summer if needed.

Only sour cherry orchards where the black cherry aphid is regularly troublesome require the dormant spray. Sour cherries are less often infested than sweet cherries, and the aphid can easily be controlled later if an infestation develops, because the infested leaves do not curl as they do on sweet cherry trees.

In Ontario, if aphids become troublesome on sour cherry, apply a special spray of one of the insecticides recommended for sweet cherry in your local spray guide.

PLUM APHIDS Plum trees are often attacked by aphids that cluster in dense colonies on the tender shoots and leaves. Four species are common. The mealy plum aphid, *Hyalopterus pruni* (Geoff.), the most troublesome species, is greenish and is covered with a fine white powder. The hop aphid, *Phorodon humuli* (Schr.). is also green but is free from the powdery coating. The thistle aphid, *Brachycaudus cardui* (L.), is a very shiny green and black insect; and the waterlily aphid, *Rhopalosiphum nymphaeae* (L.), is brown.

Injury—The aphids, by sucking the sap, weaken the trees and reduce their growth. Some species cause marked curling of the leaves. They produce a sticky liquid called honeydew, which, with a sooty fungus that grows in it, often gets on the fruit and makes it unfit for sale.

Habits and life history—The four species pass the winter as eggs on the bark of plum trees. The eggs hatch early in the spring and the young aphids feed on the opening buds and later

the leaves. They continue to feed and multiply rapidly. By midsummer, if conditions are favorable, the foliage may be covered with masses of aphids. As the summer progresses, winged forms are produced. These migrate to secondary host plants; for example, the mealy plum aphid flies to reed canarygrass or cattail. The aphids feed on the secondary host plants until late fall, when winged forms are produced that return to plum; here they give birth to the females that lay the winter eggs.

Control—In Ontario, aphids will seldom be troublesome on plum if you spray for plum curculio, as recommended in the Ontario spray guide. If a special spray is required, use one of the materials recommended for the summer control of the black cherry aphid.

In British Columbia, apply a dormant spray of a recommended material after growth has begun. Spray thoroughly to cover the tips of the twigs on the tops of the trees.

Predators often feed on the colonies of aphids, and these beneficial insects may destroy the aphids in a comparatively short time.

GREEN PEACH APHID *Myzus persicae* (Sulz.). The green peach aphid has a wide variety of hosts and, as the name implies, one of these is peach. It is probably present in all peach orchards in Canada, but only in British Columbia does it sometimes become troublesome enough to need control measures.

Injury—The eggs hatch early in the season and the aphids feed on the leaves, blossoms, and newly formed fruits. One symptom of attack is fruit dropping; another, sometimes later, is leaf curling.

Habits and life history—This aphid spends only a short time on peach during the spring before producing winged aphids that fly to other host plants. It returns to peach trees in the fall to lay overwintering eggs.

Control—In British Columbia, when needed, spray just before the blossoms open with a recommended material.

A COTTONY SCALE OF PEACH *Pulvinaria vitis* (L.). This insect has been present in peach orchards in the Niagara Peninsula since 1925, and periodically it has been abundant enough to cause serious injury in some orchards. The outbreak that occurred between 1946 and 1954 was prolonged, apparently, because the general use of DDT in peach orchards killed the parasites of the scale. This insect is of little or no importance in Essex County, Ontario. The same or a closely related species occurs in British Columbia.

Injury—The scales suck the sap from the leaves and small twigs, and, when very abundant, seriously weaken the tree. The most conspicuous and serious injury is a smutting of the fruit by a black mold (Fig. 29) that develops in the honeydew secreted by the insect. Heavily smutted fruit is unfit for sale.

Habits and life history—The partly grown females spend the winter on small twigs and branches. They grow rapidly in the spring, and about the time peach blossom petals have fallen they start to lay their eggs in snow-white ovisacs (Fig. 30) that protrude from under the scales. A female may lay several thousand eggs. Heavily infested trees look as if they were decorated with popcorn. Hatching usually starts during the latter half of June and continues for 2 or 3 weeks. The white ovisacs may remain conspicuous long after the eggs have hatched. The newly hatched young crawl from the egg mass to the leaves and to the bark of

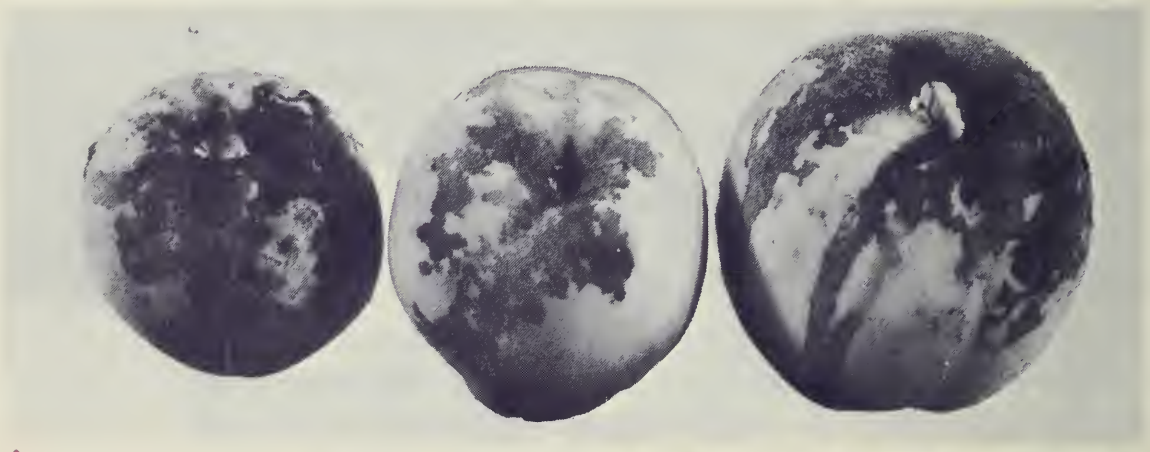

Fig. 29. Peaches smutted by a black fungus in the honeydew produced by cottony peach scales.

Fig. 30. Egg masses of the cottony peach scale on a peach twig.

the smaller twigs, where they settle, insert their beaks, and feed on the plant sap. They soon develop a thick waxy covering that resembles peach bark in color. While they are feeding, the scales secrete the honeydew that, as previously mentioned, is indirectly responsible for the smutting of the fruit and foliage. Most of the scales that settle on the leaves move to the twigs and branches by September.

Control—In Ontario, a spray of dormant oil every 3 or 4 years, before growth starts in the spring, usually prevents an infestation of this scale. In orchards where there is appreciable smutting of the fruit the previous year, or where fresh white ovisacs are abundant in late May and early June, apply a spray when the egg-hatching period is about half over (late June), and repeat the application at the end of the hatching period (early July). Consult your local spray service for exact dates and materials to use.

LECANIUM SCALES *Lecanium* spp. These large soft-bodied scales (one of which is commonly called the European fruit lecanium) attack many kinds of trees and shrubs. In Ontario they are pests of plum, especially of the Japanese varieties, and to a lesser extent of peach, apricot, and grape. In British Columbia they are most troublesome on apricot.

Injury—The insects pierce the tissue and suck the sap, and, if abundant for 2 or 3 years, they may kill the branches they attack. Moreover, they exude a sticky honeydew on which a black mold develops; this makes heavily infested trees unsightly.

Habits and life history—The insects pass the winter as immature, spindle-shaped, flat scales, about $\frac{1}{25}$ to $\frac{1}{16}$ inch (1 to 1.5 mm) long, on the undersides of the small branches. They feed in the warm spring weather and by late May or early June are full grown and about the size of small peas (Fig. 31).

Fig. 31. The European fruit lecanium on Japanese plum.

At maturity the female scale lays many small eggs, which fill the cavity beneath the shell. The eggs require about 1 month to hatch and the young scales crawl to the foliage, where they feed until fall; then they move to the young branches for the winter.

Control—Applications of dormant oil every 3 or 4 years usually prevent trouble from these scales. To control heavy infestations in Ontario, spray with a recommended material when practically all the eggs have hatched (about July 15). In British Columbia, spray in early August. Consult your local spray service for the latest information on when to spray and what to use.

SAN JOSE SCALE *Aspidiotus perniciosus* Comst. Before 1918 this scale was probably the most serious pest of stone fruits in southern Ontario, but control measures have made it of minor importance though it can still be injurious in neglected orchards. The scale also occurs in British Columbia.

Injury—The San Jose scale infests all common orchard fruit trees except sour cherry. The insects suck the sap from the bark, leaves, and fruit, by means of their piercing and sucking mouthparts. When they are very abundant they may almost completely cover the bark, and by draining the sap weaken and eventually kill the tree. Infested fruit has a spotted or mottled appearance, usually with a reddish area around each scale.

Habits and life history—This scale differs from the other scales on fruit trees in being circular and in having a small nipple in a hollow at its center. The insect beneath the scaly covering is bright yellow, soft, and somewhat pear-shaped. The scales pass the winter in the black, immature stage. In late May the males, tiny two-winged insects, emerge and fertilize the females. The females continue to grow for about a month and then commence to give birth to yellowish young. After wandering around for a short time, they settle down to feed and cover themselves with the waxy substance that forms their protective scale. Females continue to reproduce for about a month and may each produce as many as 400 offspring. In Ontario, one complete generation a year, a nearly complete second, and probably a partial third are produced.

Control—In Ontario, spray just before buds burst and in British Columbia, before growth starts in the spring using a dormant-type spray as recommended in your local spray guide.

EUROPEAN FRUIT SCALE *Aspidiotus ostreaeformis* Curtis. This scale, which is similar to the San Jose scale in life history and habits, is occasionally abundant on plum in Ontario, especially in neglected orchards. It also occurs on apple in both Ontario and

British Columbia. It differs from the San Jose scale in its slightly eccentric shape and in its light yellowish to orange cap, usually set a little to one side. Injury and methods of control are similar to those for the San Jose scale.

POTATO LEAFHOPPER *Empoasca fabae* (Harr.). This small, bright-green leafhopper is a pest of plum in Eastern Canada. It feeds on the undersides of the new leaves, where it sucks the sap from the veins and causes the trouble known as hopperburn. Nursery stock is especially subject to attack, and the new growth of bearing trees often has many curled leaves with hopperburn in July and August.

Injury—This leafhopper damages only young leaves on rapidly growing shoots. The leaves curl downward and inward at the tips and margins, giving a crumpled appearance. When extensive feeding is taking place in hot dry weather, the tips and margins wilt and may turn brown and die. Trees that are heavily attacked, especially in the nursery row, are severely stunted.

Habits and life history—This insect does not overwinter in Canada. The adults come from the Unites States each year and appear on the trees in mid-June. They lay their eggs in the main veins and petioles of the leaves, and shortly afterwards the young nymphs appear. There are two or more generations a year in Ontario, and both nymphs and adults remain on the foilage as long as succulent growth is available. The adults are active, swift fliers, and the nymphs run quickly with a sideways motion when disturbed.

Control—Special control measures are seldom needed in plum orchards. Spray plum nursery stock when the adult leafhoppers are first seen on the foliage (about June 20 in Ontario). Repeat the application in 2 weeks, and again 2 weeks later. The sprays for leafhopper may result in an outbreak of mites so a miticide should be added. Consult your local spray service for materials to use.

LEAFHOPPERS IN BRITISH COLUMBIA Several species of leafhoppers often injure prune and plum trees in the interior of British Columbia, but are seldom numerous on apricot, peach, or cherry trees. These insects feed on and injure the foliage, which becomes whitened or mottled in appearance. When the injury is severe the fruit may be reduced in size and spotted with excrement, and the buds may be directly affected.

Some species of leafhoppers overwinter as adults under leaves and other debris, and others overwinter as eggs inserted in the bark of twigs and small branches of the host plants. Summer eggs are laid in the veins and stems of leaves of various plants.

There may be one or more generations a year, depending on the species.

Control—If leafhoppers are very numerous and are reducing the vitality of the trees in the Okanagan and Similkameen valleys, spray with a material recommended by your spray service.

GRASSHOPPERS IN BRITISH COLUMBIA Several species of grasshoppers are pests in the orchards of British Columbia. The more important are the red-legged grasshopper, *Melanoplus femurrubrum* (DeG.), the two-striped grasshopper, *M. bivittatus* (Say), and the migratory grasshopper, *M. biliturātus* (Walker).

Injury—Even light infestations of these species occasionally cause considerable loss when they nibble at the fruit and make it unfit for market. Heavier infestations do correspondingly more damage to the fruit and may also destroy cover crops.

Habits and life history—The three main species have similar life histories and habits. The eggs are laid in the soil in clusters, or 'pods', mainly during August and September. These remain in the ground all winter. The eggs hatch usually in late May or early June, sometimes considerably earlier or later, according to the season. The young grasshoppers, or nymphs, which closely resemble the adults, require 6 or 7 weeks to reach full size. After an early spring and continuing warm weather, adults begin to appear during the third week of June and most of them are fully grown by early July. They are ready to lay eggs within a few weeks after maturity. When spring is backward and cool weather continues into summer, the adults appear correspondingly later and a few nymphs may be found even during the fall. There is only one generation a year in Canada.

Control—If the orchard is cultivated and kept free from weeds, very few eggs will be laid in it and control measures will not be necessary except when grasshoppers move in from adjacent fields. If a cover crop is grown, spray it with an insecticide recommended by your local spray service.

CUTWORMS Some species of cutworms often damage small fruit trees in the fruit-growing areas of British Columbia and occasionally in Ontario. The red-backed cutworm, *Euxoa ochrogaster* (Guen.), usually causes the damage in British Columbia.

Injury—These cutworms are particularly destructive to young fruit trees. In the spring they climb the trees and they tunnel in or entirely devour the tender opening buds. Sometimes most of the buds are destroyed and the tree dies.

Habits and life history—The species that cause most concern to fruit growers are soft-bodied, dull-colored, hairless cater-

pillars. When fully grown they are 1½ to 2 inches (38 to 50 mm) long and nearly as thick as an ordinary lead pencil. They do their damage in May and June. Toward the end of June they form reddish-brown pupal cases in the soil and in these they gradually change into moths. The moths emerge from the pupal cases from the middle to the end of July. They are active only at night, when many of them gather around lights. They have a wingspan of about 1½ inches (38 mm). The eggs are laid in late summer and autumn. The more important pest species pass the winter in the egg stage.

Control—You may control cutworms by spraying or dusting the trunk of the tree and the ground at the base of the tree with an insecticide, or you may use a poisoned bait. Consult your spray service for materials and how to prepare the bait.

ROSE CHAFER *Macrodactylus subspinosus* (F.). The rose chafer is occasionally injurious to stone fruits, especially peach, in southern Ontario. It breeds only in light sandy soil.

Injury—This insect feeds on the blossoms, fruits, and leaves of many plants. It skeletonizes the leaves and makes holes in the fruit of peach and other stone fruits. Large numbers of chafers are sometimes found clustering on one fruit.

Habits and life history—The adult, which injures the fruit and foliage (Fig. 32), is a slender, long-legged, yellowish-brown or fawn-colored beetle about ⅜ inch (9.5 mm) long. It is very sluggish in its movements. It lays eggs during June in grassland and weedy areas of light sandy soil. The grubs feed on the roots of grass and weeds throughout the summer and are almost full grown by fall. They spend the winter in the soil and change to

Fig. 32. The rose chafer feeding on peaches.

pupae the following May. The adult beetles begin to emerge in early June, and are usually present in large numbers for about 3 weeks.

Control—On sandy areas where this insect is troublesome, much can be done to control it if a community effort is made to reduce its breeding grounds in waste land by cultivation, reforestation, or the sowing of alfalfa or sweet-clover.

Many of the insects are destroyed in the soil if the breeding areas are thoroughly plowed and disked in late May or early June, and again in late July. Late fall plowing also helps to reduce their numbers. Orchards and vineyards should be kept well cultivated.

If you see the beetles feeding on fruit trees apply a spray or a dust. As the beetles may continue to move into the orchard from their breeding areas, a second spray or dust may be needed. Consult your spray service for materials to use.

A PEST OF JAPANESE PLUM *Swammerdamia caesiella* Hbn. This European moth was first found in North America in 1956 in a Japanese plum orchard near Queenston in the Niagara Peninsula. It has since spread at least 30 miles (48 km), though the infestation is heavier in the eastern half of the Peninsula. It is only a minor pest.

Injury—In Ontario the larvae have been observed feeding only on Japanese plum, *Prunus salicina* Lindl., and its hybrids; and on myrobalan plum, *P. cerasifera* Ehrh., commonly used as rootstock, and its ornamental, purple-leafed variety, *atropurpurea* Jaeg.

The partly grown, overwintered larvae start to feed on the opening leaves and blossoms in late April or early May; later they also feed to a slight extent on some of the newly formed fruits. They spin a web that, in heavy infestations, may cover the blossom and leaf clusters and hold the petals, unset fruits, and fruit-shucks on the tree long after thay have fallen from uninfested trees. Larvae of later generations feed by mining into the leaf tissue during their first instar, then feeding on the under surface of the leaves. They skeletonize them but leave the upper surfaces intact. Because of their small size, the larvae, even when abundant, seldom injure more than about an eighth of the surface of infested leaves.

Habits and life history—The body of the larva is creamy tan to light brown, with a central, narrow brown stripe and two white bands along the back, and a white stripe on each side; when fully grown the larva is about $\frac{5}{16}$ inch (8 mm) long. The larvae pupate on the trees, in fragile cocoons of white silk. The adult moths are a light, silvery bronze-gray, and are slightly less than ¼ inch (6 mm) long. They rest on the trunks and main branches of the trees during the brightest part of the day and fly in the late afternoon and early evening. They lay small, flattened somewhat

transparent eggs, usually only one at a time, along the midrib and veins on the undersides of the leaves.

There are three generations a year in Ontario. During September and October second-instar larvae of the last generation spin hibernacula, where they spend the winter, in crevices on the twigs, branches, and trunks. The hibernacula, about ⅛ inch (3 mm) long, are made of shining white silk and are very conspicuous on the dark bark of the trees.

Control—Control measures are not recommended because, during the 10 years since it was discovered in Ontario, the damage, even in the few heavily infested orchards, has not appreciably affected the vigor of the trees or the size and quality of the fruit.

MITES

Mites are usually much smaller than insects. The head, thorax, and abdomen of an insect are quite distinct whereas those of a mite are not. Two groups of mites, the spider mites and the rust mites, attack fruit trees. The spider mites, such as the European red mite, the two-spotted spider mite, and the McDaniel mite, are just large enough to be seen readily with the naked eye. The rust mites, also called eriophyid mites, include the plum rust mite and the peach silver mite, and are so small that a magnifying glass is needed to see them.

In recent years, the spider mites have become more abundant and difficult to control on fruit trees because some materials have destroyed many of their natural enemies, and because mites in many orchards in Ontario and British Columbia have developed strains that are resistant to some of the miticides that originally gave excellent control. This is especially so for the European red mite, which can no longer be controlled by parathion in most peach and plum orchards in Ontario where this material has been used for several years.

Recommendations for the use of miticides on the different fruit crops usually vary from year to year and from district to district as new materials or methods of use are developed. Consult your local spray guides for the latest details on the use of miticides.

EUROPEAN RED MITE *Panonychus ulmi* (Koch.) The European red mite, probably introduced into Canada on imported nursery stock, was observed first in Ontario in 1912. It is present in all tree-fruit areas of Canada, and has become one of the most important fruit pests.

Injury—This mite attacks most fruit trees, but is most injurious to plum, peach, apple, sour cherry, and pear. Sweet cherry

is commonly attacked but is rarely seriously injured. The mite punctures the tissues of the leaves and removes the plant juices. It feeds on both surfaces of the leaves. If the infestation is light, the foliage is speckled in appearance; if it is heavy, the leaves become pallid, tough, often bronzed, and from a distance appear to be coated with dust. In very heavy infestations many of the leaves drop, growth of the wood is retarded, fruit buds are weakened, and the size of the fruit is reduced and its quality impaired. Many eggs may be laid on the ripening fruit in the fall, spoiling its appearance.

Habits and life history—The mite spends the winter in the egg stage on the bark of the tree, mainly in crevices in rough bark and in the axils of shoots and spurs. The egg is round with a hairlike process about as long as the egg is wide. When newly laid the egg is pearly to pink in color, and later it becomes a dull dark red.

The overwintered eggs begin to hatch about the time European plums are in full bloom. The young mites crawl to the leaves and start to feed. They molt three times before reaching the adult stage. The first-generation adults start to lay eggs about the time the shucks begin to fall from early varieties of plums. Three to six or more generations occur each year, depending on the temperature. The generations overlap and all stages can be found on the trees at any time during the summer. Hot, dry weather favors the increase of this mite.

The adult female is elliptical in outline and carmine in color. It has four rows of long, curved, stiff bristles on the back, each borne on a conspicuous whitish tubercle. The adult male is considerably smaller than the female.

Control—In Ontario, this mite is troublesome most years in many peach and plum orchards. Apply an oil emulsion before the buds burst to kill the overwintered eggs, followed by a miticide just before the petals open; or use the prebloom miticide spray followed by a second spray when the shucks are about 50% split on peach or have mostly fallen from plum.

Consult your local spray guides for materials to use.

An early season preventive spray program is not recommended on sour cherry. If mites become troublesome, spray during the summer with one of the recommended materials.

In British Columbia, prebloom sprays give good control, but because the mite is not troublesome every year on stone fruits a summer spray may be all that is needed. Consult your local spray service for materials to use.

TWO-SPOTTED SPIDER MITE *Tetranychus urticae* Koch. The two-spotted spider mite has only recently been found in appreciable numbers on stone-fruit trees in Canada, though it has

long been a serious pest in greenhouses and on strawberry and raspberry. The two-spotted mite has been found in a number of peach orchards where pesticides have destroyed mite predators, but seldom in sufficient numbers to cause serious injury. It has occasionally been found in large numbers on sour cherry trees. A closely related species, *T. canadensis* (McG.), is equally as common as *T. urticae* on peach in Ontario.

Injury—This mite causes injury similar to that of the European red mite except that it feeds only on the lower surfaces of the leaves.

Habits and life history—The mite winters as an adult female in crevices of the bark of the trees and on plants and trash on the ground. The overwintering adults are bright orange.

The females begin to lay eggs in the spring, as soon as the temperature permits. The eggs are pale green or colorless and are laid on weeds and on the leaves of trees. The summer feeding forms of the mite are pale yellow or greenish and have two conspicuous dark spots on the back. There are several generations a year; usually the mites are most numerous in August or September, about a month later than the European red mite. The two-spotted spider mite spins a fine thread; when the mite is very abundant this gives a silvery sheen to the tree.

Control—Dormant sprays do not control this mite as it does not spend the winter in the egg stage. If an infestation develops, apply one or two sprays of a recommended material during the summer.

McDANIEL SPIDER MITE *Tetranychus mcdanieli* McG. The mite that was formerly called the Pacific mite has been found to be, in reality, the McDaniel mite. It was first found in British Columbia in 1939 and has since spread throughout the major fruit-growing areas of that province. It also occurs in Manitoba. The mite attacks practically all fruit trees and a wide variety of weeds and other herbaceous plants, including the usual cover crops. It so closely resembles the two-spotted spider mite that they can be distinguished only by a specialist.

Injury—This mite feeds upon both the upper and lower surfaces of the leaves by puncturing the leaf tissue and removing the sap, so that, in severe infestations, the foliage becomes brown and papery. The injury to the leaves results in undersized and poorly flavored fruit. A heavy infestation can defoliate a tree and cause a poor crop of fruit the following year.

Habits and life history—The mite overwinters as a bright, amber-colored adult female beneath refuse around the base of the tree or beneath bark scales on the trunk. In March, about the

time apple buds are bursting, and for perhaps a month thereafter, the mites move to weeds or cover crops or to the unfolding leaves of fruit trees. There they feed and lay minute, round, transparent eggs. The life cycle is completed in about 2 weeks and several generations are produced during the season.

The mites multiply very rapidly and are most numerous during July and August. An infestation then is most readily distinguished by the presence of the fine but profuse webbing that the mites spin on the foliage.

The mites begin to go into their winter quarters in late summer. Then the webbing they make may be so profuse that it resembles cellophane. They shelter beneath this webbing in conspicuous orange-yellow clumps, each consisting of hundreds of individuals.

Control—Where control is needed, spray during the summer with a material recommended by your local spray service.

PLUM RUST MITE *Vasates fockeui* (Nal. & Trt.). At least two species of extremely small, eriophyid mites attack European plums, especially damson and prune varieties. Japanese varieties of plum appear to be immune. The most important species is the plum rust mite, and a less common one is *Diptacus gigantorhynchus* (Nal.).

Injury—On nursery stock the mites congregate mainly on the young terminal foliage, feeding on the lower surfaces and causing the leaves to curl, usually upward, and become dwarfed. The lower surfaces of the leaves become brown or bronze and scurfy. On bearing trees the mites are often found in large numbers on both the lower and upper surfaces of older leaves. The curling is not so pronounced as on nursery stock, but some bronzing and pale greenish-brown blotching, which is more or less inconspicuous, indicate the feeding of the mites.

Habits and life history—The adult mites are minute, wormlike, pale to brownish-yellow creatures that can just be seen with the naked eye when placed on a black background. The females overwinter in the cavities of shrunken buds or in the margins of the outer scales of healthy buds. They leave winter quarters when the buds have partly expanded in the spring, scattering over and feeding on the expanding foliage for a few days before laying eggs. Usually the mites are most numerous during late July, just before the tree growth stops. However, as long as succulent growth remains, they continue to breed freely until late in the season. The egg is flattened and slightly elliptical and glued closely to the leaf. It requires from 2 to 15 days to hatch, depending on the temperature. There are two immature stages. The time required from hatching to maturity is 2 to 18 days, usually 3 to 4 days in midsummer.

Control—Where this mite is troublesome, spray both bearing and nonbearing trees during the dormant period before the buds swell in the spring with 10 gallons of lime sulfur in 90 gallons of water (metric ratio: 11.1 litres per 100 litres of water). Consult your local spray service for other materials that may be used during the growing season.

PEACH SILVER MITE *Vasates cornutus* (Banks). This tiny rust mite feeds on both surfaces of peach leaves and gives them a silvery sheen. At one time it was present in most peach orchards but it has almost disappeared since the use of sulfur became general. If substitutes for sulfur are used to control peach diseases, this mite may again increase, though it is unlikely that it will cause appreciable damage to the trees.

ACKNOWLEDGMENTS

This revision was prepared with the assistance of the directors and research officers of the research stations at Vineland Station and Harrow, Ontario; Kentville, Nova Scotia; and Summerland and Sidney, British Columbia. Particular mention should be made of the assistance of A. J. Hansen, H. F. Madsen, C. F. Marks, J. H. H. Phillips, and M. F. Welsh.

G. C. Chamberlain and G. G. Dustan were the authors of the original publication in 1954 and the first revision in 1962. The second revision in 1967 was prepared by G. G. Dustan and T. R. Davidson. The present revision was prepared by T. R. Davidson.

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	x 25	**millimetre**	**(mm)**
foot	x 30	**centimetre**	**(cm)**
yard	x 0.9	**metre**	**(m)**
mile	x 1.6	**kilometre**	**(km)**
AREA			
square inch	x 6.5	**square centimetre**	**(cm^2)**
square foot	x 0.09	**square metre**	**(m^2)**
acre	x 0.40	**hectare**	**(ha)**
VOLUME			
cubic inch	x 16	**cubic centimetre**	**(cm^3)**
cubic foot	x 28	**cubic decimetre**	**(dm^3)**
cubic yard	x 0.8	**cubic metre**	**(m^3)**
fluid ounce	x 28	**millilitre**	**(mℓ)**
pint	x 0.57	**litre**	**(ℓ)**
quart	x 1.1	**litre**	**(ℓ)**
gallon	x 4.5	**litre**	**(ℓ)**
bushel	x 0.36	**hectolitre**	**(hℓ)**
WEIGHT			
ounce	x 28	**gram**	**(g)**
pound	x 0.45	**kilogram**	**(kg)**
short ton (2000 lb)	x 0.9	**tonne**	**(t)**
TEMPERATURE			
degree fahrenheit	°F-32 x 0.56 (or °F-32 x 5/9)	**degree Celsius**	**(°C)**
PRESSURE			
pounds per square inch	x 6.9	**kilopascal**	**(kPa)**
POWER			
horsepower	x 746	**watt**	**(W)**
	x 0.75	**kilowatt**	**(kW)**
SPEED			
feet per second	x 0.30	**metres per second**	**(m/s)**
miles per hour	x 1.6	**kilometres per hour**	**(km/h)**
AGRICULTURE			
bushels per acre	x 0.90	**hectolitres per hectare**	**(hℓ/ha)**
gallons per acre	x 11.23	**litres per hectare**	**(ℓ/ha)**
quarts per acre	x 2.8	**litres per hectare**	**(ℓ/ha)**
pints per acre	x 1.4	**litres per hectare**	**(ℓ/ha)**
fluid ounces per acre	x 70	**millilitres per hectare**	**(mℓ/ha)**
tons per acre	x 2.24	**tonnes per hectare**	**(t/ha)**
pounds per acre	x 1.12	**kilograms per hectare**	**(kg/ha)**
ounces per acre	x 70	**grams per hectare**	**(g/ha)**
plants per acre	x 2.47	**plants per hectare**	**(plants/ha)**

Examples: 2 miles x 1.6 = 3. 2 km; 15 bu/ac x 0.90 = 13.5 hℓ/ha

INFORMATION
Edifice Sir John Carling Building
930 Carling Avenue
Ottawa, Ontario
K1A 0C7