A FIELD MANUAL OF TREE DISEASES IN THE MARITIMES REGION

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G. A. Van Sickle

FOREST RESEARCH LABORATORY
FREDERICTON, NEW BRUNSWICK
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INTRODUCTION

This is a field manual of the most common forest diseases in the Maritimes Region of Canada. It is hoped that an increased understanding of disease conditions may generate further interest in this field and assist Forest Insect and Disease Survey field staff, and co-operators in government and industry.

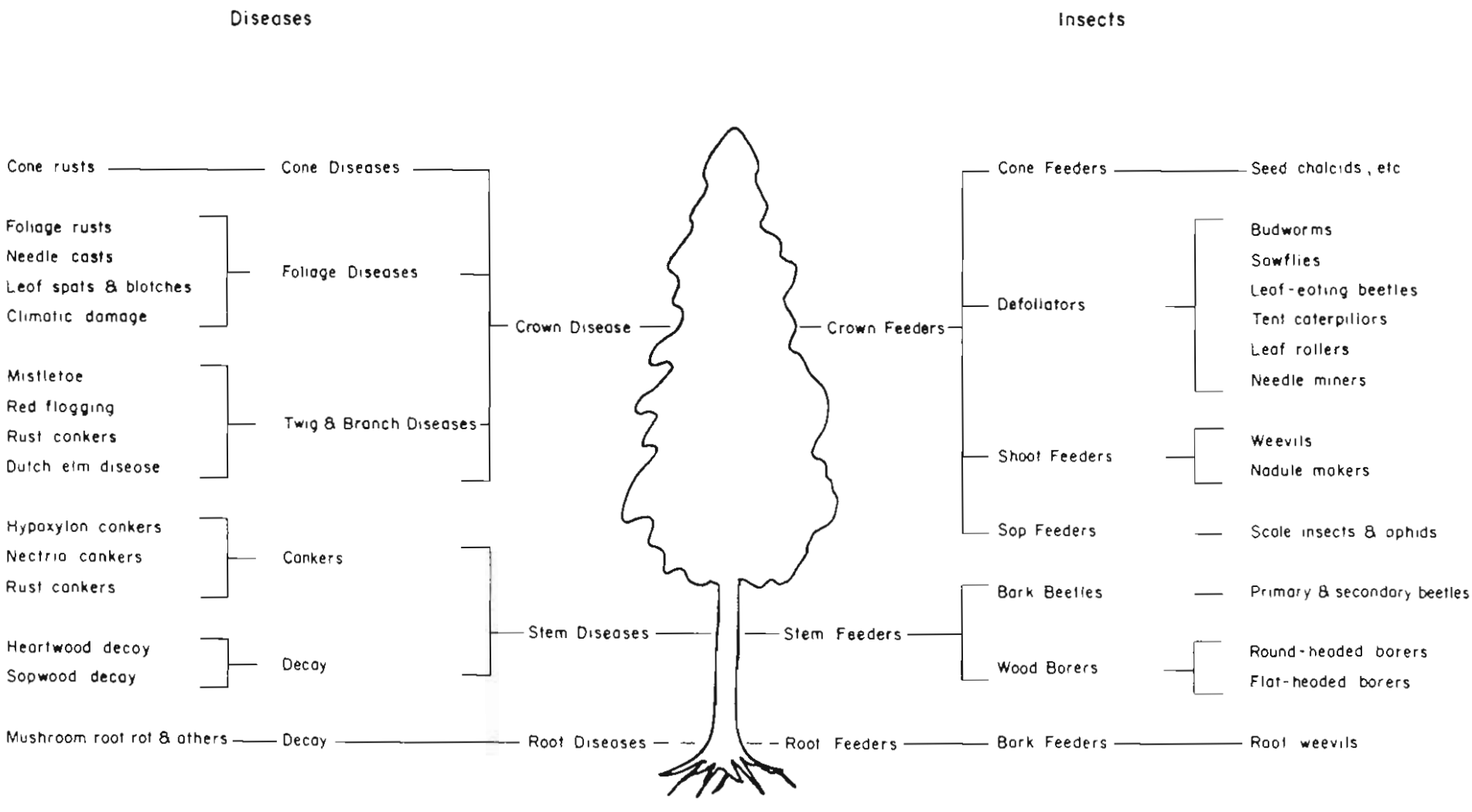
Since this is a field manual, arrangement of the diseases does not follow a strict taxonomic system. Rather, the diseases are classified according to the portion of the tree injured, i.e., crown, stem, or root. The Tree Damage Chart (Fig. 1) shows a further division of these zones and points out a marked similarity in insect and disease attacks. Individual diseases are treated in the same manner for easy comparisons between similar conditions. Photographs are used wherever possible to aid in recognition of disease conditions. These photos, with brief descriptions of major symptoms, provide for field identification of the most common diseases. The information on seasonal distribution, and the summary chart (page 39) indicate when each condition is likely to be most evident and in a stage which can be positively identified at the laboratory. However, seasonal and local variations may alter conditions considerably. A glossary of common terms and an index of common and scientific names are also included.

DEFINITION of FOREST PATHOLOGY and DISEASE

Forest pathology involves the study of tree diseases in the hope that serious losses may be reduced or prevented. The term tree disease, which may refer to many biological conditions, is best defined as: "any disturbance which interferes with the normal functions of the tree except those caused by fire or insects." This includes conditions which result from infections by fungi, parasitic plants, bacteria, and viruses, (infectious diseases); site deficiencies, climatic injuries, industrial fumes, and animals, (non-infectious diseases) as they affect shade and ornamental trees, nurseries, and natural forests, throughout their entire development.

Fig 1

TREE DAMAGE CHART



IMPORTANCE OF FOREST DISEASES

All diseases are not uniformly serious. Some diseases cause little noticeable damage to the trees. Others, by severely injuring leaves, twigs, branches, or roots, cause stunting or eventual mortality. Still others destroy or degrade manufactured wood products. Generally, forest tree diseases are considered important only if trees are killed or if there is considerable loss of wood volume and quality. With shade trees and shelterbelts only mortality or considerable dieback is important and wood volume loss is secondary.

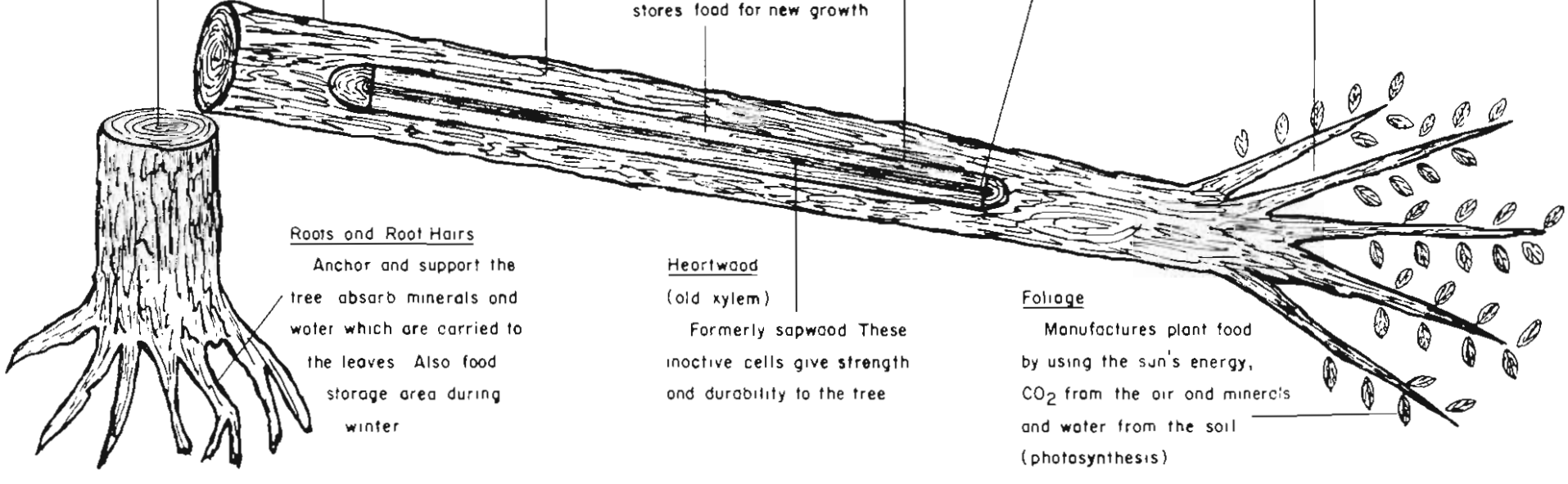
On the other hand some disease-causing organisms are extremely useful. Decomposition carried out by bacteria and fungi is necessary to: reduce large volumes of slash; return nutrients to the nutrient cycle; help maintain the CO_2 - O_2 balance necessary for plant and animal life, and aid in soil formation and maintenance.

Seldom is a tree attacked by a single agent for it exists in a complex biological community where there is an interaction between such factors as competition, environmental and soil conditions, and insects and diseases. Consequently it is difficult and probably not desirable to divorce any one factor from another. No matter what the damaging agent is, one may assess the immediate consequences by considering the function of the affected portion of the tree. Figure 2 illustrates the structures of the tree and their basic functions. The major parts of a tree and their most common diseases are discussed below. However, it must be remembered that some diseases may affect more than one part of the tree.

(i) Fruit Diseases

Cone rust and catkin deformation are the most serious fruit diseases in the Maritimes. With increased interest in forest regeneration and tree improvement programs, the insects and diseases which attack fruits and seeds are deemed more important. Serious seed losses directly affect the future crop. Reproduction may be affected indirectly by foliage and twig diseases which hinder flower and cone formation.

Fig. 2 TREE STRUCTURES AND THEIR FUNCTIONS



Outer bark
(periderm and dead phloem)
A protective covering.

Twigs and branches
Displays leaves in best position to receive sun's energy. Part of continuous "pipeline" from roots to leaves.

Inner bark
(phloem)
Plant foods from the leaves move through these cells to growth and storage areas in branches, trunk, and roots.

Cambium
Cell layer which each year divides and grows to produce new layers of wood and bark.

Annual Rings
Formed each year by the distinction of spring and summer wood.

Pith
A central core of simple cells.

Sapwood
(young xylem)
Carries water and nutrients from roots to the leaves, stores food for new growth

Roots and Root Hairs
Anchor and support the tree absorb minerals and water which are carried to the leaves Also food storage area during winter

Heartwood
(old xylem)
Formerly sapwood These inactive cells give strength and durability to the tree

Foliage
Manufactures plant food by using the sun's energy, CO_2 from the air and minerals and water from the soil (photosynthesis)

(ii) Foliage Diseases

The leaf or needle is the manufacturing centre for the plant's food supply. The energy of the sun, through the action of chlorophyll, unites hydrogen (carried to the leaf from the roots in the form of water) with carbon dioxide, from the atmosphere, to form plant sugars. These sugars are the food and building materials of all plants. Consequently, any condition which reduces the effective leaf area of a tree ultimately reduces its growth. It has been estimated that losses of timber resources from decreased growth exceed losses from mortality. With shade trees and Christmas trees the unsightly appearance caused by blights and leaf blotches may be more important than growth loss. Defoliation of any tree renders it less vigorous and more susceptible to attack by other disease organisms and insects.

Broad-leaved trees can recover even from severe defoliation and may produce a new crop of leaves the same year, with little apparent injury except reduced increment. Defoliation in late summer is generally less injurious than early summer defoliation. Conifers, on the other hand, succumb to defoliation more readily than hardwoods. Fortunately, complete defoliation is uncommon as most needle-inhabiting fungi attack either the current or older foliage, rarely both. Furthermore, conditions seldom extend over several years.

In short, if interference with normal food production is sufficiently severe, continuous, or frequently repeated, death of the whole plant occurs, whereas partial or less frequent disruptions cause reduced growth and branch dying.

(iii) Twig and Branch Diseases

Twigs and branches are part of the root to leaf "pipeline". They carry raw materials to, and manufactured products from, the leaves, and display the leaves for maximum absorption of the sun's energy. Diseases of the twig and branch system interfere with the sap flow and may cause stunting or if severe, even death. Certain disorders, such as mistletoe, disrupt the food flow causing large witches' brooms.

(iv) Stem Diseases

The stem is the supporting structure for the tree crown and is the connecting link between the roots and the leaves. It is the industrially valuable part of the tree. Consequently abnormalities in this region which cause reduced lumber and pulp values or death of immature trees are of considerable economic importance.

Cankers, which cause localized dead areas in the bark, sapwood, and cambial regions, are the most important stem diseases. These dead areas generally enlarge until the stem is girdled causing that part of the tree beyond the girdle to turn yellow or brown and die. Cankered trees are also more susceptible to breakage, and decay organisms frequently enter the tree through this weakened zone.

Of all disease agents wood decay, particularly in the heartwood, causes the highest losses in mature and overmature trees. It usually develops slowly and may not noticeably shorten the life of an affected tree. However, in terms of wood volume loss, decay is more serious than fire. The situation may not be as serious when overmature forests are under management. However, a different problem may arise since decay organisms often enter throught wounds which result from current forestry practices.

(v) Root Diseases

The roots provide support and anchorage and the means of water and mineral absorption for a tree. Any disease of the root zone interferes with these functions. In most cases this weakens the tree and secondary attack by other organisms or wind storms may kill it. Root disorders frequently result in branch dieback and a stag-headed condition.

Root rots caused by various wood-destroying fungi frequently extend into the valuable butt log. These rots may be introduced through old stumps, particularly in thinned areas. Fruiting bodies may often be seen on stumps or exposed roots.

However, not all root fungi are detrimental. Mycorrhizae, an association between fungal hyphae and roots of many higher plants, are beneficial to the host plant. Mycorrhizae are found on most of the hardwoods and most, if not all, conifers, and are thought to aid the host by increasing root absorption.

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IMPORTANT DISEASES of the MARITIMES REGION

(A.) Crown Diseases

(i) Fruit Diseases

Common name: Spruce cone rust.

Scientific name: *Chrysomyxa pirolata* Wint.

Hosts: Red spruce, white spruce, and black spruce. Alternate hosts are the wintergreens, (*Pyrola* spp. and *Moneses* spp.)

Symptoms: Cones yellowish often with orange rust spores on the cone surface and scales. Cones open prematurely.

Season: Late summer; pycnia and aecia on cone scales. Late spring - summer; uredia and telia on alternate hosts.

Importance: Can cause serious seed losses and affect regeneration of spruce.

Fig. 3: *Chrysomyxa pirolata*. Diseased spruce cones, partially opened showing the rust's orange-yellow aeciospores.

Common name: Catkin hypertrophy.

Scientific name: *Taphrina robinsoniana* Gies.

Hosts: Speckled alder.

Symptoms: Enlarged scales form one to many curled reddish "tongues" per cone. The "tongues" bear asci which produce spores. A yellow-orange powdery mildew (*Erysiphe aggregata* (Peck) Farl.) frequently occurs on the catkins as well.

Season: Late summer - autumn; on new cones. May be seen earlier on old cones which remain attached.

Importance: Can greatly reduce seed production. May be important in control or if alder is utilized.

Fig. 4: *Taphrina robinsoniana*. Alder catkins with curled, reddish "tongues".

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(ii) Foliage Diseases

(a) Leaf and Needle Rusts

Common name: Spruce needle rust.

Scientific name: Chrysomyxa ledicola Lagh.

Hosts: White spruce, black spruce, red spruce, and blue spruce. Alternate host is Labrador tea (Ledum Groenlandicum).

Symptoms: Orange-yellow pustules (aecia) and pycnia on new needles. If severe, trees may appear yellow. Scattered yellow spots that turn brown on upper surface of leaves of alternate host (uredia).

Season: Midsummer; aecin are formed on spruce, infect Labrador tea in late summer and early autumn.

Importance: May be a problem in forest nurseries, but some premature defoliation is not generally serious in more mature trees.

Fig. 5. Chrysomyxa ledicola. Red spruce needles with rust pustules; small leaf spots on Labrador tea (easily recognized by its very hairy lower leaf surface).

Common name: Pine needle rust.

Scientific name: Coleosporium asterum (Diet.) Syd.

Hosts: Two-needle pines, mainly jack pine, red pine, Scots pine, and lodgepole pine. Alternate hosts: asters and goldenrods (Aster spp. and Solidago spp.)

Symptoms: Small blisters (aecia) with orange aeciospores develop on individual pine needles. Small orange spots (uredia and telis) occur individually or in clusters on lower surface of leaves of aster or goldenrod.

Season: Spring and early summer; aecia on pine. Late summer on broad-leaved hosts.

Importance: Premature defoliation may cause some growth loss and weaken young trees, but is seldom serious.

Fig. 6. Coleosporium asterum. Needles of red pine with orange blisters, typical of needle rusts.

7A

7B

8A

8B

Common name: Balsam fir needle rust.

Scientific name: Pucciniastrum goeppertianum (Kuehn) Kleb. and P. epilobii Otth.

Hosts: Balsam fir is the coniferous host, while the broad-leaved alternate is blueberry (Vaccinium spp.) or occasionally fireweed (Epilobium spp.).

Symptoms: Orange-yellow tubular blisters (aecia) on individual new needles. Clumps of swollen branches (witches' broom) perennial on blueberry. Scattered or small groups of orange pustules on leaves of fireweed (uredia) becoming reddish-brown to black crusts (telia).

Season: Early spring-summer; telia in blueberry, witches' brooms evident all year; aecia on needles of balsam fir. Late summer-autumn; uredia and telia on fireweed.

Importance: Only serious when severe on young trees or seedlings. Also reduces blueberry production.

Fig. 7: Pucciniastrum spp. A. Balsam fir, with some needles bearing orange-yellow aecial pustules. B. P. goeppertianum. Witches' broom on blueberry.

Common name: Cedar and juniper leaf rusts.

Scientific name: Gymnosporangium spp.

Hosts: Coniferous hosts are the junipers. The alternate host of G. cornutum is mountain-ash. Broad-leaved hosts for other species of this rust (G. clavipes and G. clavariiforme) are chiefly the saskatoon or serviceberry (Amelanchier spp.).

Symptoms: Slight fusiform swellings with ridges or long hornlike projections (telia) appear on small juniper branches. On mountain-ash, circular yellow spots (pycnia) on top side of leaves are followed by aecia on the lower side.

Season: Early spring; telia on junipers. Late spring-summer; pycnia and aecia on broad-leaved hosts.

Importance: Likely to be significant only on ornamentals and shade trees.

Fig. 8: Gymnosporangium cornutum. A. American mountain-ash leaf with several pustules (pycnia). B. Lower surface of mountain-ash leaflet showing aecial stage on the broad-leaved host.

9A

9B

9C

Common name: Willow leaf rust.

Scientific name: *Melampsora epitea* Thuem.

Hosts: Willows are the broad-leaved hosts while balsam fir and tamarack are the coniferous hosts.

Symptoms: Small orange pustules (uredia or telia) occur individually or in clusters on the under surface of willow leaves. Yellow bands and orange aecia occur on needles of tamarack and fir.

Season: Late spring-summer; aecia on tamarack or fir needles. Summer; uredia and telia on willows.

Importance: Not considered economically important.

Common name: Ash rust.

Scientific name: *Puccinia sparganioides* Ell. & Barth.

Hosts: Black ash and white ash. The alternate host is cord or marsh grass (*Spartina* spp.).

Symptoms: Circular, orange, rust pustules (aecia) form on lower surface of ash leaves. May also distort petioles and small branches. Black "boat-shaped" telia, 1/8 - 1/4 inch long form on blades of cord grass which is found along margins of marshes or riverbanks.

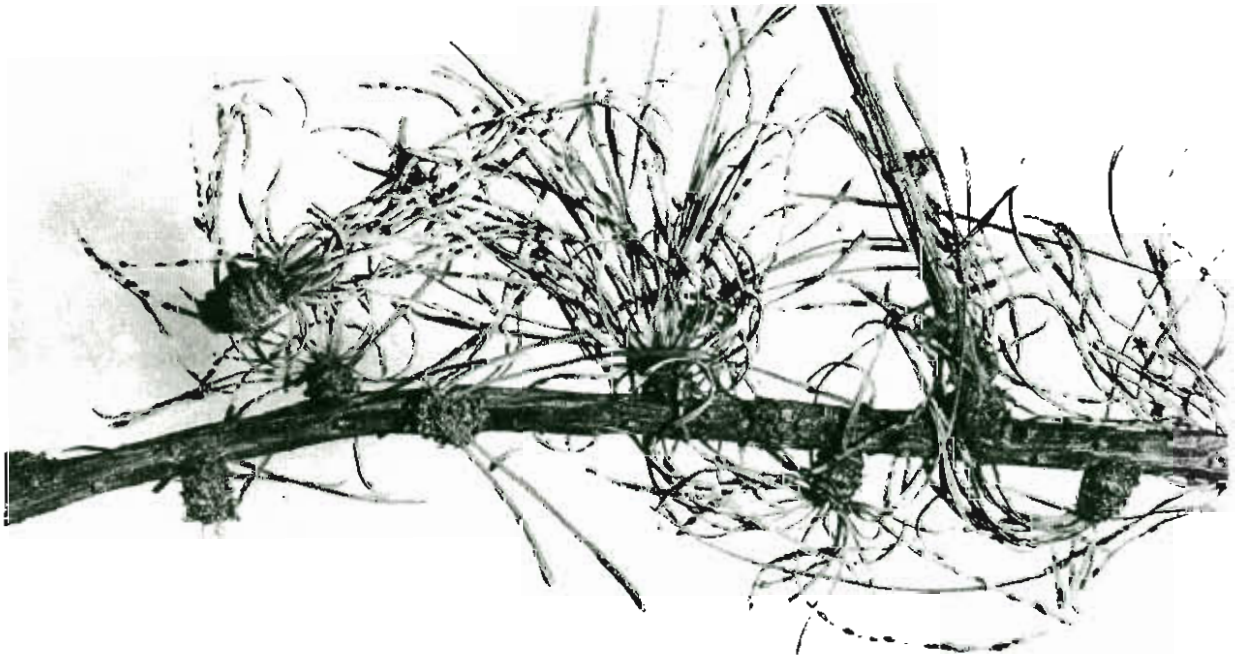
Season: Late spring - summer; aecia on ash leaves. Autumn and early spring; telia on cord grass.

Importance: Causes unsightly browning and distortion of leaves of shade trees. Severe infections can kill trees.

Fig. 9. *Puccinia sparganioides*, ash rust. A. Severely infected white ash leaf (note infected petiole in lower left corner). B. Cord grass, the alternate host of the rust. C. Black "boat-shaped" telia on blade of cord grass.

10A

10B



10C

(b) Needle Casts

Common name: Needle casts.

Scientific name: A number of different but closely related fungi cause this condition. A list with hosts follows:

Isthmiella faullii (Darker) Darker) Lirula mirabilis (Darker) Darker) Lirula nervata (Darker) Darker)	balsam fir
Davisomycella ampla (Davis) Darker	jack pine
Hypodermella laricis Tubeuf	tamarack
Lirula macrospora (Hartig) Darker	black, white, and red spruce

Symptoms: Infected needles are yellowish or red-brown. Sometimes confused with winter injury, but needle casts generally attack individual needles leaving a mixture of healthy and diseased needles. About midsummer a dark black fruiting body (hysterothecium) forms on infected needles. By autumn pine and fir shed these needles but tamarack and spruce retain most of them throughout the winter.

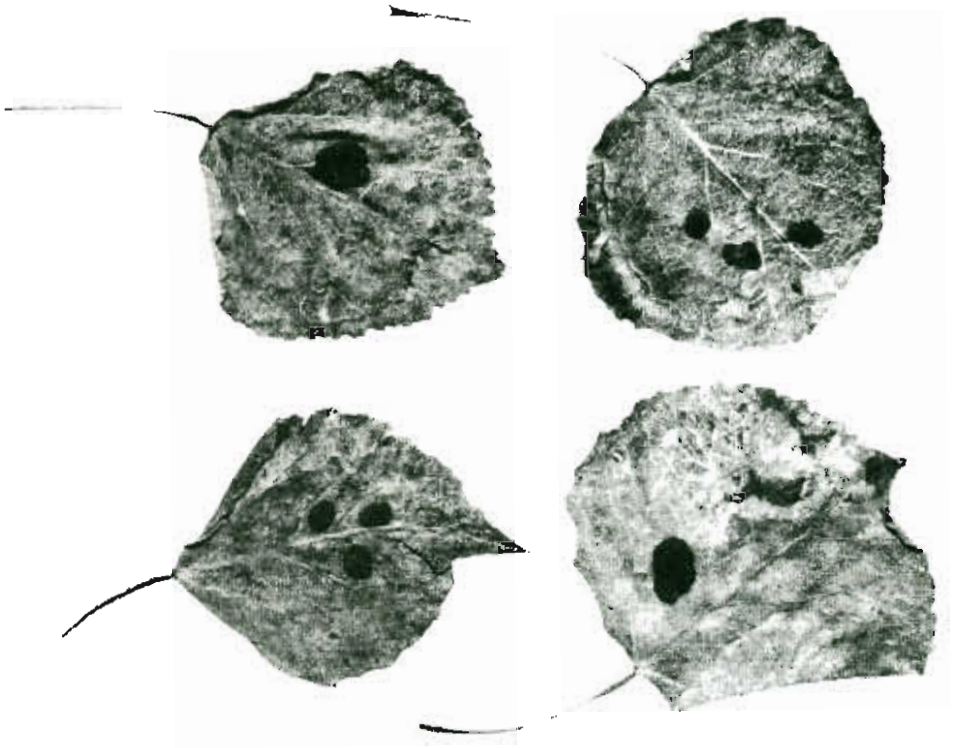
Example

Isthmiella faullii - Black line (hysterothecium) on under surface of old needles generally extends entire length of needle. During July spores are discharged, but infected young needles do not turn brown until the following spring. These brown needles overwinter again. During the third summer the black lines form and a new batch of spores are released. Other needle cast fungi have similar life cycles and symptoms.

Season: The black line fruiting bodies, necessary for positive identification, appear in midsummer.

Importance: Light infections with light needle losses cause little damage. Severe infections may reduce increment, degrade Christmas trees, and kill young seedlings.

Fig. 10. Needle casts. A. Lirula nervata on balsam fir, note black lines on lower surface of most needles. B. Davisomycella ampla on jack pine. C. Hypodermella laricis on tamarack.



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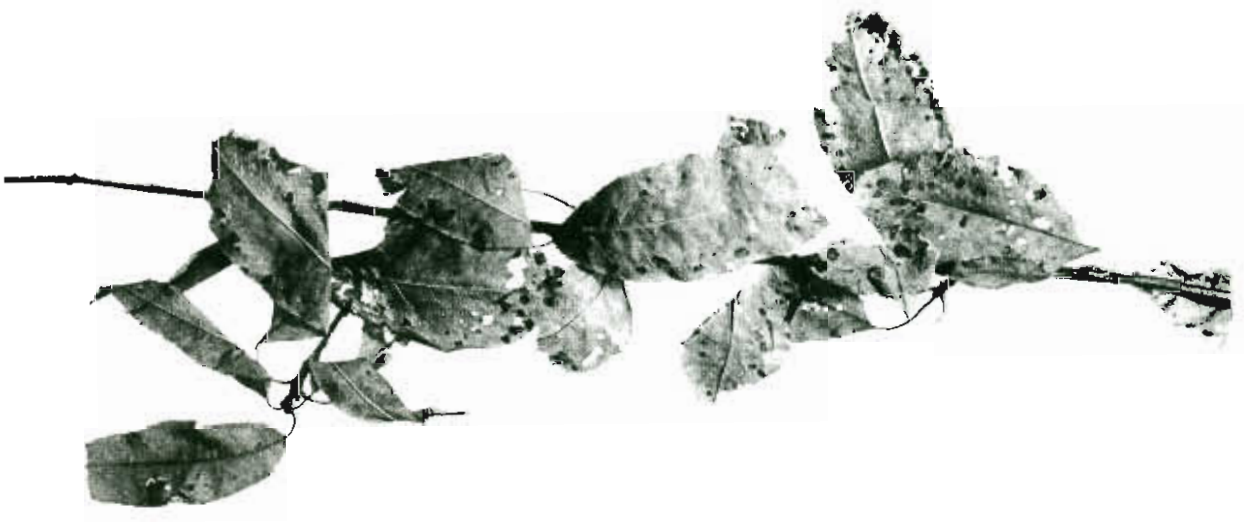


12

(c) Leaf Spots

Common name: Aspen ink spot.

Scientific name: Ciborinia whetzelii (Seav.) Seav.

Hosts: Trembling aspen, largetooth aspen, lombardy poplar, and other poplar hybrids.

Symptoms: One to many black circular or elliptical spots (sclerotia) 1/8 - 1/4 inch in diameter develop on individual leaves. If infection is severe, the leaf dies, turns brown, but remains attached until autumn. The sclerotia drop during summer leaving "shot-holes". The ink spots overwinter on the ground, mature in spring and infect the new leaves.

Season: Midsummer - autumn; sclerotia develop and shot-hole condition appears.

Importance: Reduces leaf area useful in photosynthesis. Unimportant except on shade trees.

Fig. 11. Ciborinia whetzelii. Aspen ink spot.

Common names: Cherry shot-hole, or leaf spot.

Scientific name: Coccomyces hiemalis Higgins

(Imperfect stage, Cylindrosporium spp.)

Hosts: Pin cherry and commercial cherry trees.

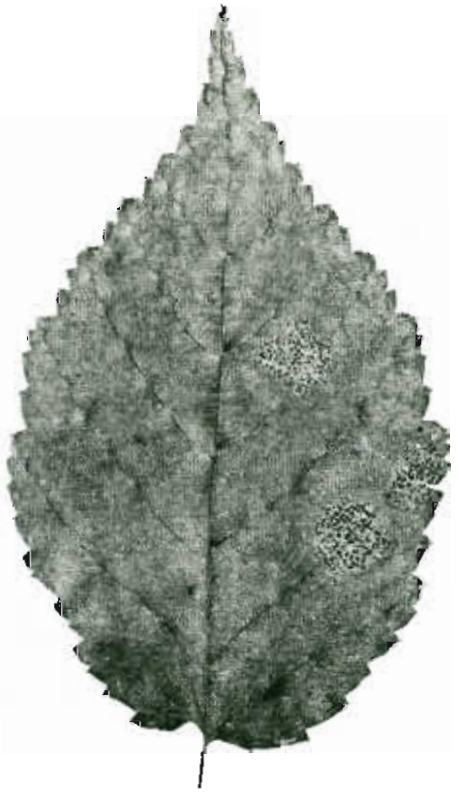
Symptoms: Purple, then brown, circular leaf spots fall out giving shot-hole effect. Premature defoliation results if lesions are numerous. Unlike aspen ink spot, this produces summer spores (conidia) which spread the disease in moist weather. The fungus overwinters on the ground and infects new leaves in the spring.

Season: Summer - autumn; brown spots develop and shot-hole condition appears.

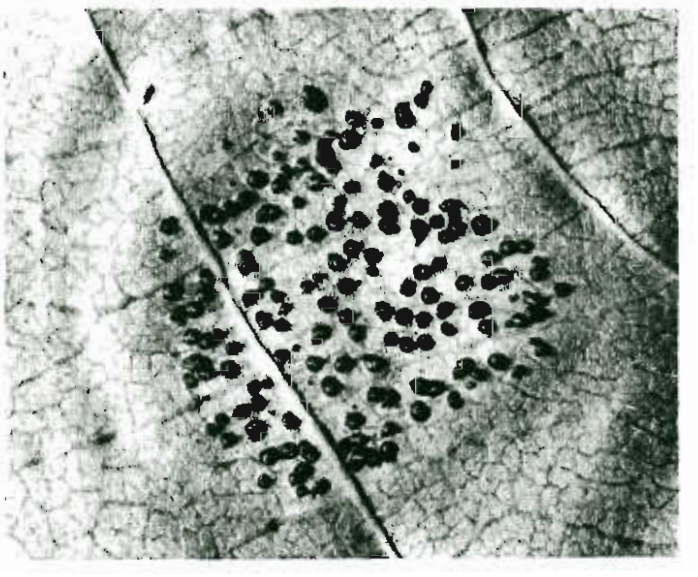
Importance: May cause premature defoliation, exposure to sunscald and reduced fruit crop. Not economically important on pin cherry but may be in cherry orchards.

Fig. 12. Coccomyces hiemalis, cherry shot-hole. Some dead leaf tissue has fallen out leaving the shot-hole effect.

13



14A



14B

Common name: Elm black leaf spot.

Scientific name: Gnomonia ulmea (Schw.) Thuem. (Imperfect stage, Gloeosporium ulmeum).

Hosts: White elm, and English and Chinese elms.

Symptoms: Small, but conspicuous, shiny black spots on leaves. If spots are numerous, leaves turn yellow and drop. Summer spores (conidia) are produced, and the fungus overwinters on fallen leaves or occasionally in dormant buds.

Season: Late spring - autumn; spots on elm leaves.

Importance: Spring defoliation can cause death of twigs, but the disease is more common and less serious toward autumn.

Fig. 13. Gnomonia ulmea, a very common leaf spot of elm.

Common name: Hazel leaf spot.

Scientific name: Gnomoniella coryli (Batsch ex Fr.) Sacc.

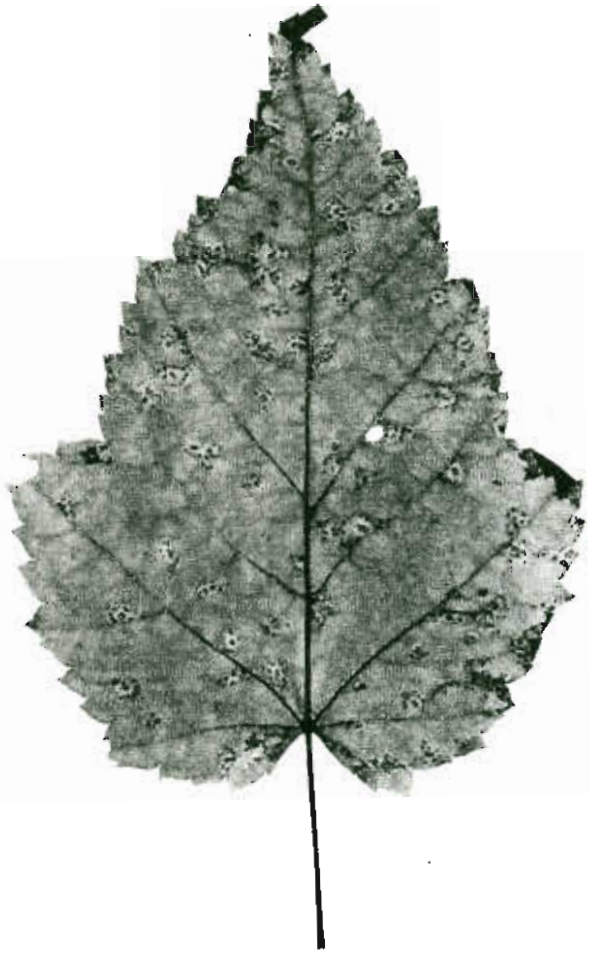
Hosts: Beaked hazel.

Symptoms: One or more black, circular, speckled spots on surface of leaves.

Season: Midsummer - autumn.

Importance: Of little importance.

Fig. 14. Gnomoniella coryli. A. A showy leaf spot on hazel. B. Single spot showing the numerous perithecia which create the speckled effect.



15

16

Common name: Maple leaf spot.

Scientific name: Phleospora aceris (Lib.) Sacc.

Hosts: Red maple, sugar maple, black maple, mountain maple, and striped maple.

Symptoms: Small, pin-head spots with dark brown margin and lighter centres develop in the leaves.

Season: Summer - autumn, particularly during moist seasons.

Importance: Of little importance.

Fig. 15. Phleospora aceris, small leaf spots on leaf of striped maple.

Common name: Maple leaf spot.

Scientific name: Phyllosticta minima (Berk. & Curt.) Ell. & Ev.

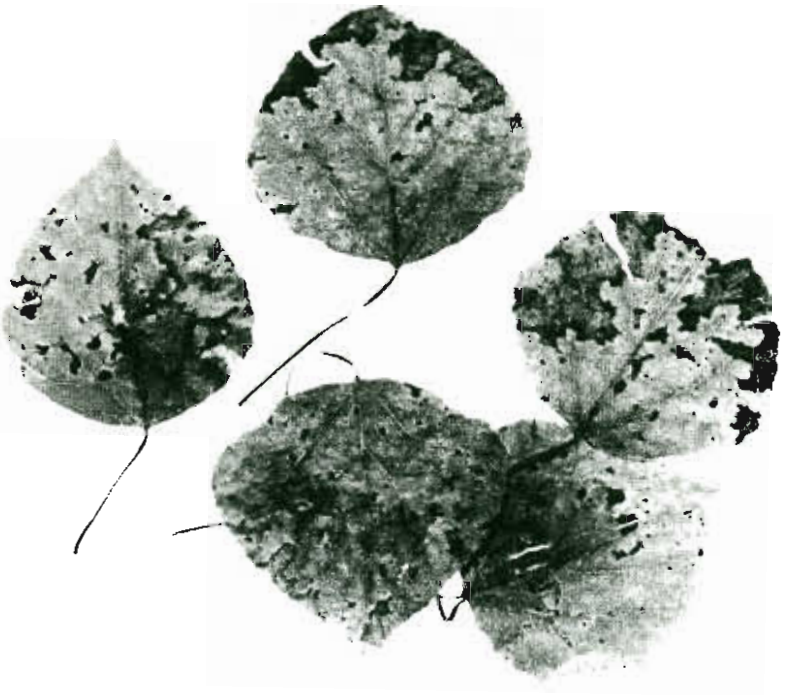
Hosts: Red maple, sugar maple, and mountain maple.

Symptoms: Spots are irregular, 1/4 inch or more across with brownish centres and purple-brown margins.

Season: Summer - autumn.

Importance: Of little importance.

Fig. 16. Phyllosticta minima, irregular-shaped spots on leaves of red maple.



17

18

Common name: Leaf spot.

Scientific name: *Drepanopeziza* spp.

Hosts: Trembling aspen, largetooth aspen, willow, birch, ash, and butternut.

Symptoms: Small brown spots with yellow margins. If numerous, spots coalesce forming irregular, discolored patches.

Season: Midsummer - autumn.

Importance: May cause some defoliation but generally not serious.

Fig. 17. *Drepanopeziza tremulae*, brown leaf spots and blotch on aspen leaves.

Common name: Maple tar spot.

Scientific name: *Rhytisma acerinum* (Pers.) Fr.

Hosts: Red maple, sugar maple.

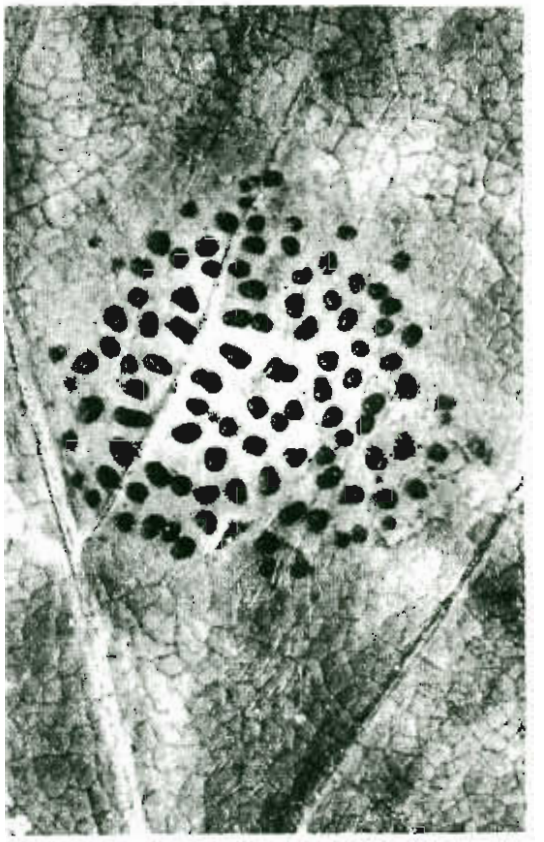
Symptoms: One or more black, thickened, raised, tarlike spots up to 1/2 inch in diameter may form on upper leaf surfaces. Light brown margins.

Season: Light yellow lesions develop in early spring followed by blackened stroma. Fungus overwinters on fallen leaves.

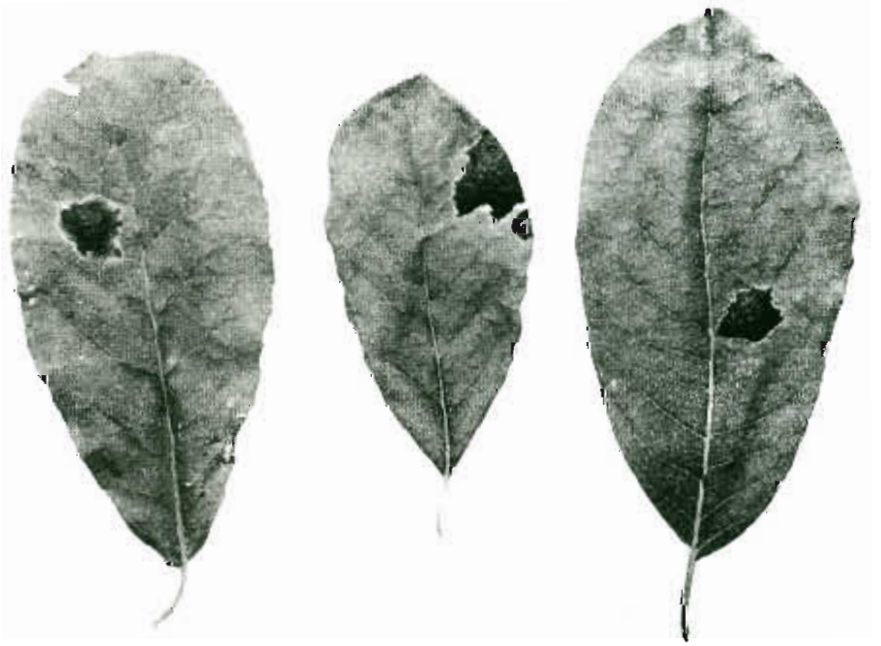
Importance: Causes leaf disfiguration and sometimes defoliation.

Fig. 18. *Rhytisma acerinum*, tar spots on a red maple leaf.

19A



19B



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Common name: Speckled tar spot of maple.

Scientific name: Rhytisma punctatum (Pers.) Fr.

Hosts: Red maple, sugar maple, and mountain maple.

Symptoms: Black, raised "pinhead sized" specks are formed in a yellowish-green area about 1/2 inch in diameter on the upper leaf surface.

Season:)
) As for R. acerinum.
Importance:)

Fig. 19. Rhytisma punctatum, A. Speckled tar spot on mountain maple. B. Close-up, showing the individual perithecia.

Common name: Willow tar spot.

Scientific name: Rhytisma salicinum (Pers.) Fr.

Hosts: Willows.

Symptoms:)
)
Season:) As for R. acerinum.
)
Importance:)

Fig. 20. Rhytisma salicinum, large irregular tar spots on willow leaves.

21A

21B

21C

(d) Leaf Blotches

Common name: Anthracnose of hardwoods.

Scientific name: A number of species of fungi cause this condition on different hosts as outlined below.

Kabatiella apocrypta (Ell. & Ev.) Arx
maples - red, sugar, mountain, striped, silver, Manitoba, and Norway maple.

Discula quercina (West.) Arx (ash - white and black ash.
(beech.
(basswood.
(oak - red and bur oak.

Discula spp. (birch - yellow and white
(birch.
(horse-chestnut.

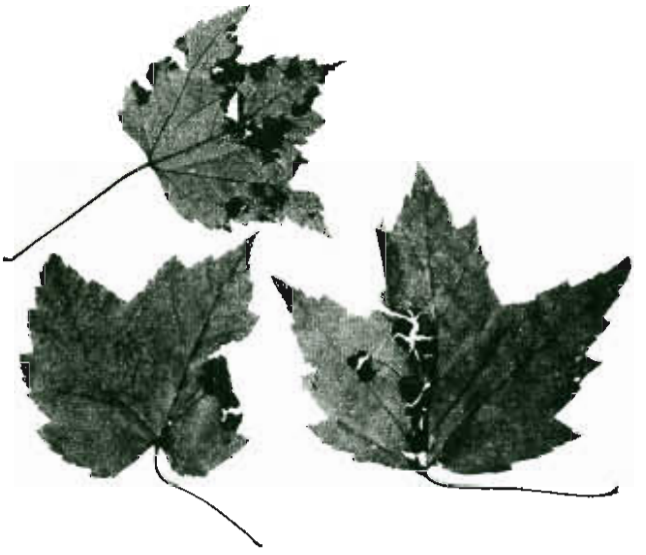
Symptoms: On many leaves, large irregular patches are killed and turn reddish-brown. From a distance trees may appear scorched. Premature defoliation with twig dieback may result from early and heavy attacks. This is usually followed by a second crop of leaves during the summer. Very small pale pink masses of spores may be visible with a handlens.

Season: Early spring - late summer; disease can be identified from the spores produced by the fungus.

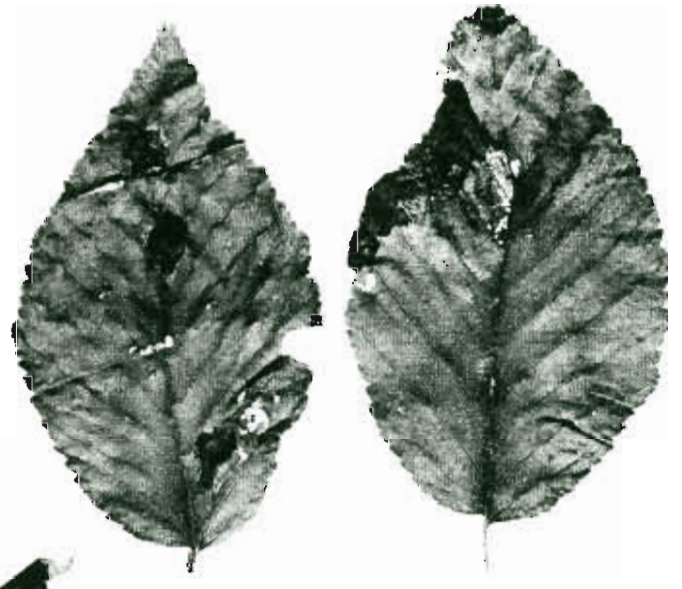
Importance: Premature defoliation with some dieback, particularly in wet seasons. Trees attacked for a single year generally recover, but if attacks continue for a number of years trees may die.

Fig. 21. Kabatiella spp. and Discula spp., large irregular brown patches caused by anthracnose on leaves of many hardwoods. A. D. quercina on white ash, and B, on beech, C. K. apocrypta on sugar maple.

22



23A



23B

23C

23D

Common name: Horse-chestnut leaf blotch.

Scientific name: Guignardia aesculi (Peck) V.B. Stew.

Hosts: Horse-chestnut.

Symptoms: Large, reddish-brown leaf blotches usually with yellowish margins. Curling of infected leaves is common, and occasionally petioles are attacked. Summer spores (conidia) develop in small black specks on the dead leaf tissue. The fungus overwinters on ground leaf litter.

Season: Midsummer until autumn leaf fall.

Importance: Unsightly browning followed by defoliation which, if repeated for several successive years, may cause growth loss and death.

Fig. 22. Guignardia aesculi, a single leaflet of horse-chestnut showing the irregular brown blotches with yellowish margins typical of leaf blotch.

Common name: Leaf blisters.

Scientific name: Taphrina spp.

Hosts: Red maple (T. dearnessii Jenkins).
White birch and yellow birch (T. carnea Johans.).
Red oak (T. caerulescens (Desm.) Tul.).
Pin cherry (T. wiesnerii (Rathay) Mix).

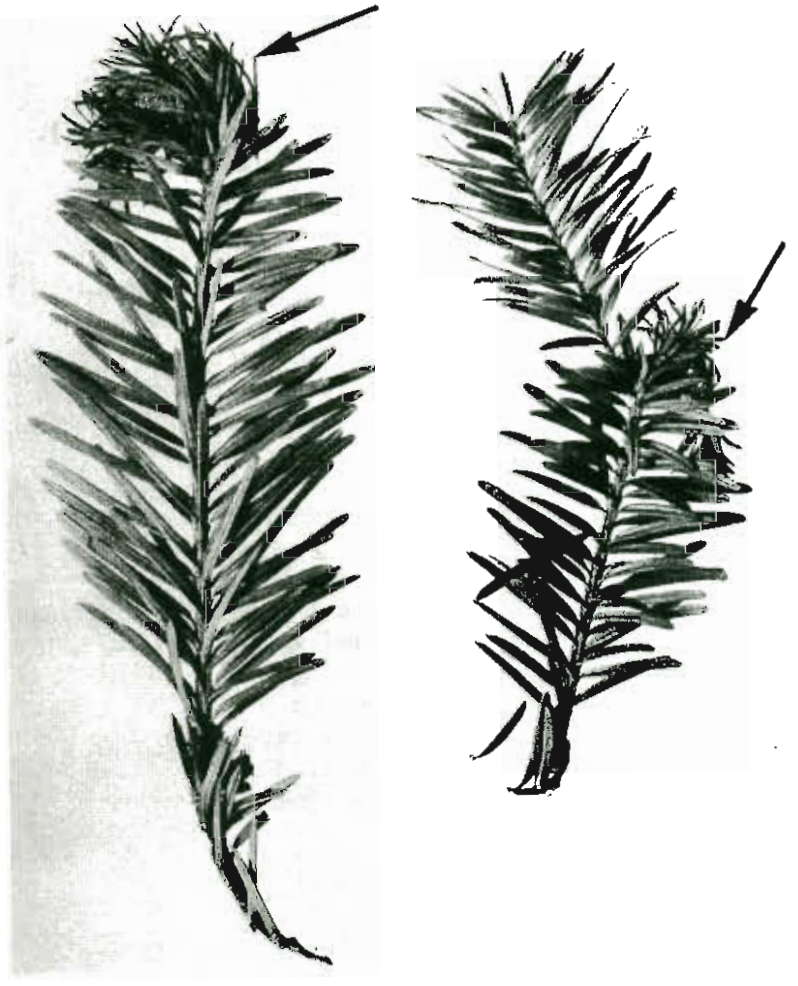
Symptoms: Blistering and curling of hardwood foliage. Affected maple leaves have numerous, irregular, blackened, patches about 1/4 - 1 inch in diameter. Birch leaves have one or more large brown to black blisters. Blisters on oak leaves are generally light yellow-green. Pin cherry leaves become brown and curled and a small witches' broom is formed.

Season: Late spring and summer. Particularly during cool wet springs.

Importance: Most serious during a cool wet spring when it may cause early defoliation and growth loss.

Fig. 23. Taphrina spp., A-C. Leaf blisters. A. T. dearnessii on red maple. B. T. carnea on yellow birch. C. T. caerulescens on red oak. D. T. wiesnerii causing a witches' broom and some leaf browning on pin cherry.

24



25

(e) Other Foliage Diseases

Common name: Cedar leaf blight.

Scientific name: *Didymascella thujina* (Durand) Maire.

Hosts: Eastern white cedar.

Symptoms: Lower foliage may appear scorched. A black, "pinhead sized" or larger fruiting body (apothecium) appears on top of each infected scale. This matures and falls out leaving a hole in the reddish-brown scale.

Season: Late summer-autumn; apothecia are mature and release spores.

Importance: May damage or kill seedlings or saplings. Often serious in nurseries and regions of high atmospheric humidity.

Fig. 24. *Didymascella thujina*, cedar leaf blight. Note the black apothecia in some leaf scales.

Common name: Balsam fir tip blight.

Scientific name: *Delphinella balsameae* (Waterm.) E. Muell.

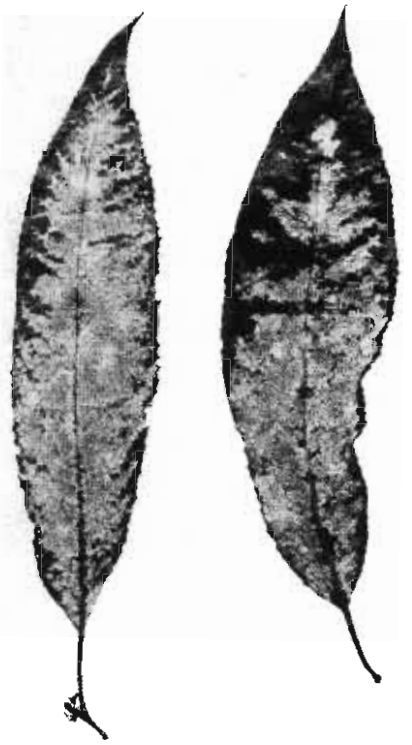
Hosts: Balsam fir.

Symptoms: Several to all of the current year's branch tips may be browned, shrivelled, and drooping. Needles of these branch tips are generally not fully developed when they turn color.

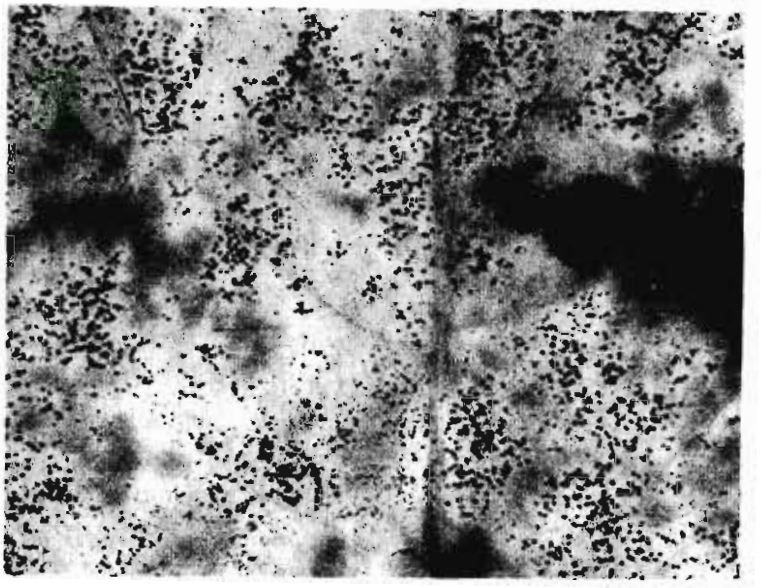
Season: In early spring and summer positive identification of the causal fungus is possible. Later, brown tips are still evident on the trees, but identification then can only be tentative.

Importance: Degrades Christmas trees and is unsightly on ornamentals. Loss of many new needles may seriously affect photosynthesis and growth.

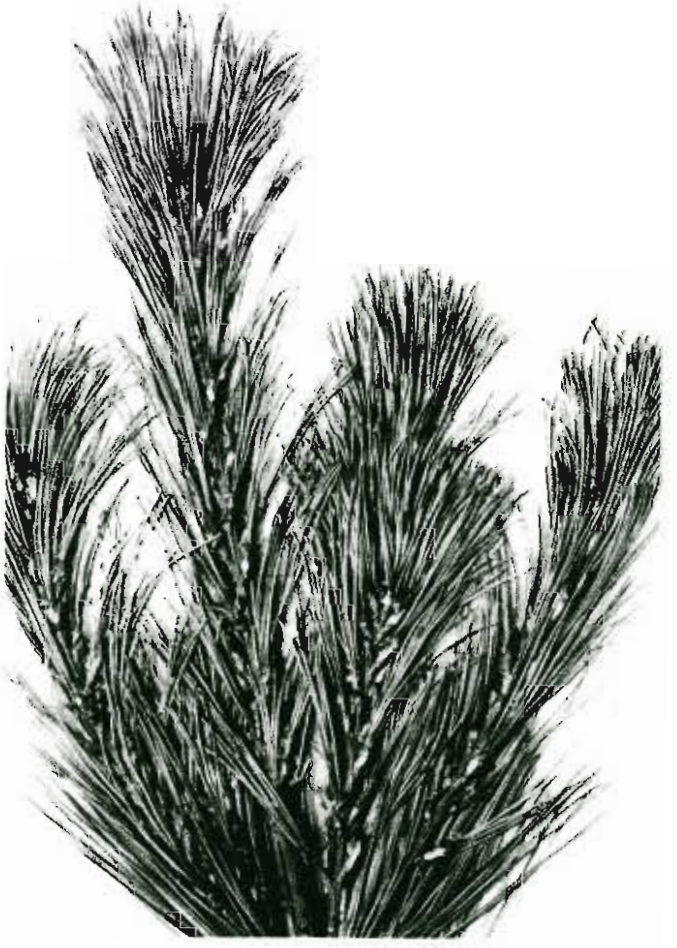
Fig. 25. *Delphinella balsameae*. Brown, shrivelled, and drooping branch tips typical of balsam fir tip blight.



26A



26B



27

Common name: Powdery mildew.

Scientific name: Mildew is caused by any one of several closely related fungi. A few common ones are: Uncinula spp., Erysiphe spp., Microsphaera spp., and Phyllactinia spp.

Hosts: Most common on leaves of aspen, balsam poplar, and willow but may occur on other hardwoods and on alder catkins.

Symptoms: External white mycelium forms a thick, diffused or patchy mat, generally on the upper leaf surface. A powdery effect is caused by the formation of conidia. Small dark dots (cleistothecia) may be evident in the hyphal mat.

Season: Late spring-early autumn; commonly in shaded areas or in belts of high air humidity.

Importance: Seldom serious, may result in premature defoliation.

Fig. 26. Uncinula salicis, A. A. common powdery mildew, in this sample on a willow leaf. B. Close-up showing the white mycelium and the dark cleistothecia.

Common name: White pine needle blight.

Scientific name: Probably physiological.

Hosts: White pine.

Symptoms: From a distance, portions of the tree crown may appear discolored. Diseased and healthy trees frequently are found side by side. White pine of all ages may be affected. Late in June, orange-red bands occur mid-way along the current year's immature needles. Within a few days the entire tip of the needle turns reddish-brown.

Season: Needles may become affected from mid July to late August. These, and needles of past "infections", may remain on the tree for 3 or 4 years.

Importance: Little is known about this condition.

Fig. 27. White pine needle blight. New needle tips are brown, but base remains green.

28A

28B

29A

29B

Common name: Climatic damage.
Many hosts affected by weather extremes are considered here:

Winter drying of conifers
Frost damage
Ice, snow, hail damage
Wind damage
Heat damage (leaf scorch, sunscald)

Symptoms: These extremes may cause widespread or localized damage. Signs of fungus or insect attack may be absent, or secondary following climatic disturbances.

Season: Conditions generally noticeable shortly after disturbance, and usually remain evident for most of the field season.

Importance: Severe damage may cause a significant growth loss, infection by decay organisms, or an early death.

Fig. 28. Climatic damage. A. Balsam fir branch with several wounds caused by hail stones. B. Winter drying of red pine, the entire branch tips may be reddish brown while older sheltered needles usually remain green.

Common name: Fume or smoke damage.

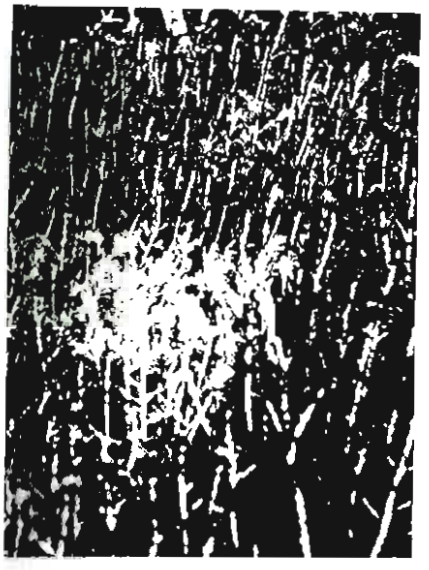
Hosts: Most conifers and hardwoods are susceptible, even if concentration of incombustibles (mainly sulfur dioxide and fluorine) is as low as 1 ppm.

Symptoms: In broadleaf trees, yellow-brown to dark brown patches appear between veins of leaves while tissue adjacent to the veins remains green. Sometimes only margins or tips of leaves are affected. All or parts of conifer needles of all ages may turn red-brown.

Season: May occur at any time throughout growing season. Conifers may also be affected during mild periods in winter.

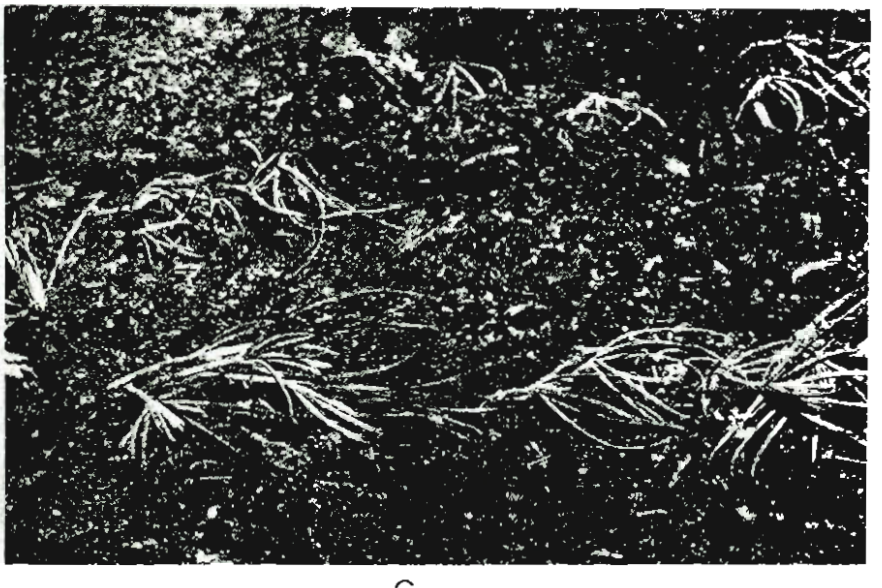
Importance: Acute injury causes foliage discoloration, defoliation, and in extreme cases death. More information is needed regarding chronic injuries which cause growth losses and reduce plant vigor. Stands adjacent to thermal plants and concentrated industry should be checked carefully.

Fig. 29. Fume damage causes yellowing of leaf tissue between larger veins. A. On silver maple. B. On white birch.



A

B



C

Common name: Snow blight of conifers.

Scientific name: Phacidium spp.

Hosts: White spruce, red spruce, balsam fir and, occasionally, species of pine.

Symptoms: Brown needles still attached are evident as snow melts. In seedbeds, occurs in more or less circular patches up to two feet in diameter. On young trees, only needles near the stem which were laden by snow are affected. Webs of white mycelium may be seen on the brown foliage and later in the season, black specks (apothecia) appear on the underside of the needles.

Season: Autumn; apothecia release spores which are air-borne to infect new foliage. Late winter - early spring; under a protective snow cover, mycelium develops and spreads, intensifying the infection.

Importance: Serious losses caused in nursery seedbeds, seldom kills larger trees.

Fig. Snow blight. A. Dead patch, one foot in diameter, in one-year-old red spruce seedbed; note the sharp line between the dead and healthy seedlings. B. Dead seedling from patch shown in A.

Common name: Damping-off of seedlings.

Scientific name: The disease is caused by a number of common soil fungi: Rhizoctonia spp., Pythium spp., Cylindrocarpon spp., Fusarium spp.

Hosts: All commercial conifers (excluding cedar) and some small-seeded hardwood.

Symptoms: Seedlings wilted, bent sharply at ground line, the stem constricted. Mortality often occurs in patches and within 1-2 weeks of seedling emergence (post-emergent) or even before seedlings appear above ground (pre-emergent damping-off).

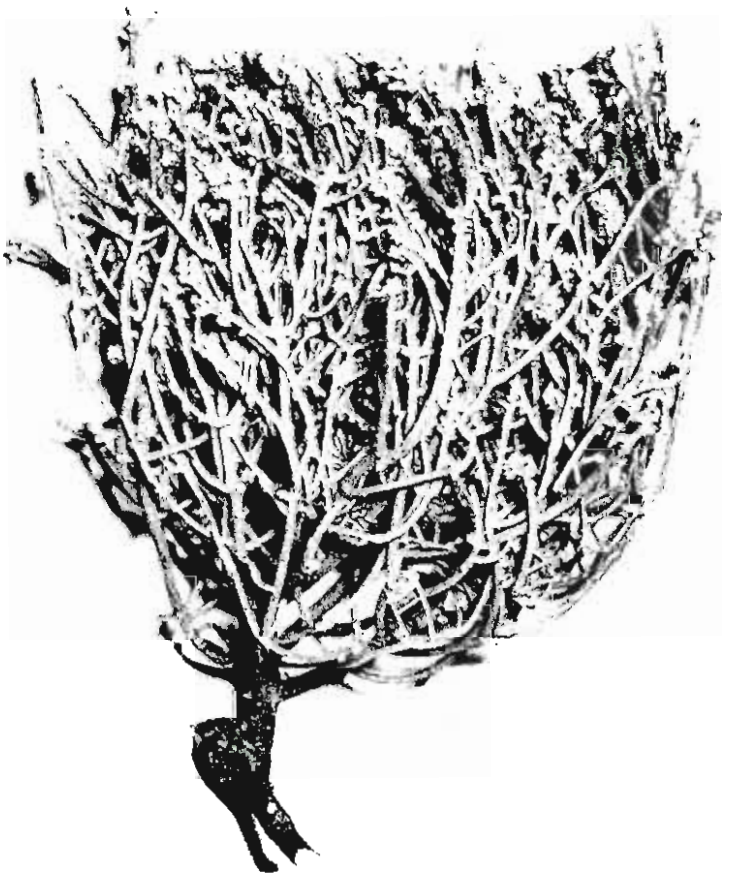
Season: Early spring and summer until the stems become woody.

Importance: Serious losses caused in nursery seedbeds. Not too important in the forest and where seedlings are less crowded.

Fig. Damping-off. C. Wilted pine seedlings, bent sharply at ground line, are typical symptoms.

30A

30B



31

(iii) Twig and Branch Diseases

Common name: Eastern dwarf mistletoe.

Scientific name: Arceuthobium pusillum Peck.

This is not a fungus, but a parasitic flowering plant that depends upon its host for water, shelter, support, and most nutrients.

Hosts: White spruce, black spruce, occasionally red spruce, and rarely tamarack.

Symptoms: One or more witches' brooms may occur on infected trees. The "roots" (haustoria and sinkers) feed within the host's wood and cambium. Inconspicuous aerial shoots extending 1/2 - 3/4 inch from infected branches bear male and female flowers. Following pollination, small olive-green berries form, and in early autumn the sticky seeds are "shot" away. They adhere to the first object or needle they contact, and if conditions are favorable, infect the needles and subsequently the twig and branch.

Season: Witches' brooms remain throughout the year. Mistletoe plants appear from June to September and the females bear fruit in September and October.

Importance: Sometimes abundant and severe on spruce in poor sites. Trees of any age may be deformed, and seedlings and saplings killed. Mistletoe causes growth loss and lower tree vigor. Affected wood is often abnormally grained, knotty, and spongy.

Fig. 30. Arceuthobium pusillum, eastern dwarf mistletoe. A. Black spruce tree with witches' brooms. B. Section of branch from broom with many mistletoe plants bearing mature berries.

Common name: Yellow witches' broom on balsam fir.

Scientific name: Melampsorella caryophyllacearum Schroet.

Hosts: Balsam fir is the coniferous host and chickweeds (Stellaria spp. and Cerastium spp.) are alternate hosts.

Symptoms: Infection stimulates abnormal lateral shoots to form a conspicuous witches' broom. Aecia develop during the summer as two rows of orange-yellow blisters on the yellow, dwarfed needles of each broom. The infected needles drop each year, but the mycelium is perennial in the stem and once established continues to invade new shoots as they develop. Spindle-shaped swellings may develop on the branches and trunk of infected trees.

Season: Summer; aecia on needles of each broom. Late summer - autumn; uredia, then telia on chickweeds.

Importance: Not serious unless particularly heavy on individual trees or in a small patch. May be an infection court for decay fungi.

Fig. 31. Melampsorella caryophyllacearum, a compact yellow witches' broom on balsam fir.

Common name: Yellow witches' broom on spruce.

Scientific name: Chrysomyxa arctostaphyli Diet.

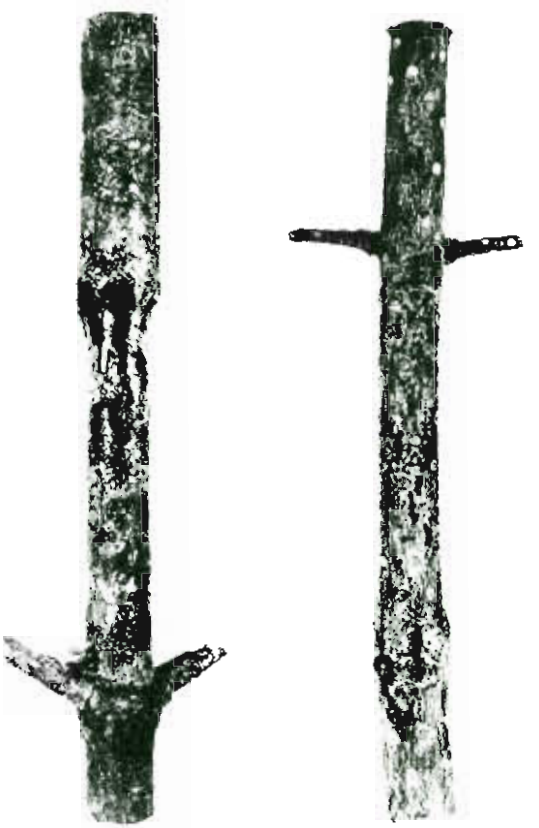
Hosts: White spruce, black spruce or red spruce are the coniferous hosts and bearberry (Kinnikinnick, Arctostaphylos uva-ursi) is the broad-leaved host.

Symptoms: As for Melampsorella caryophyllacearum but no swellings occur on branches or stems.

Season: Similar, but somewhat later than M. caryophyllacearum.

Importance: As for M. caryophyllacearum.

32A



32B

33A

33B

Common name: Balsam fir red flag.

Scientific name: Fusicoccum abietinum (Hartig) Prill. and Delacr.

Hosts: Balsam fir.

Symptoms: Branch tips become red-brown. Slight constriction or canker often evident on small twigs and branches. Easily distinguished from Monochamus beetle damage by lack of bark chewing.

Season: Late spring and summer; spores may be found in the canker to give positive identification.

Importance: Unimportant unless repeatedly severe, but may lower grade of Christmas trees.

Fig. 32. Fusicoccum abietinum, balsam fir red flag. A. All branches beyond arrow are red white those toward stem are normal. B. Close-up of slight branch constriction at base of flag.

Common name: Black knot of cherry.

Scientific name: Apiosporina morbosa (Schw. ex Fr.) Arx.

Hosts: Pin cherry, choke cherry, and black cherry.

Symptoms: Black, rough, cylindrical or spindle-shaped twig swellings up to several inches long. Twigs and branches often dead beyond enlargement. A fungal parasite of black knot (Phaestoma sphaerophila (Peck) Barr.) makes knots appear "hairy". Old knots may be riddled with insects.

Season: Old infections remain on twigs for several years. Current infections are yellow-green from spring until late summer when they become hard and black.

Importance: Unimportant because of low value of hosts but may be unsightly on pin cherry regeneration along roadsides or at campgrounds.

Fig. 33. Apiosporina morbosa. A. Rough, spindle-shaped, black knot on a pin cherry branch. B. Long perithecial necks of the parasite, Phaeostoma sphaerophila, make some knots appear "hairy".

34

35

Common name: Globose gall rust.

Scientific name: Peridermium harknessii J. P. Moore.

Hosts: Scots pine, jack pine, and lodgepole pine.

Symptoms: Branches have few to many, different-sized, globose galls with bright orange-yellow blisters (aecia) on their surface.

Season: Galls perennial and evident throughout the year. Aecia appear about midsummer to re-infect the pine.

Importance: Generally unimportant, but may become severe on individual trees in plantations.

Fig. 34. Peridermium harknessii, a slobose gall on jack pine.

Common name: Cherry blight.

Scientific name: Unknown.

Hosts: Pin cherry.

Symptoms: Clumps of leaves wilt, turn brown, and curl but commonly remain attached to the twig for most of season. Lesions or cankers produce a gummy exudate.

Season: Late spring and early summer, although affected portions may be visible most of the season.

Importance: Unimportant in the forest but collections required to learn more about this condition.

Fig. 35. Cherry blight causes leaf wilt and browning, branch or twig lesions, and resinosis.

36

37

Common name: Poplar leaf and twig blight.

Scientific name:) Venturia macularis (Fr.) E. Muell. and Arx
) on trembling aspen, largetooth aspen, and
Hosts:) silver poplar.
) Venturia populina (Vuill.) Fabric. on balsam
) poplar.

Symptoms: Kills and blackens new shoots and leaves of young trees resulting in brittle, shrivelled, "shepherd's crooks". The fungus fruits on the leaves and petioles, forming green velvety layers of conidia.

Season: Early spring to midsummer.

Importance: Not important in forest stands; may be unsightly in shelterbelts and on shade trees.

Fig. 36. Venturia macularis, leaf and twig blight; (note typical "shepherd's crook).

Common name: Willow blight.

Scientific name: Venturia saliciperda Nuesch and Physalospora miyabeana Fukushi.

Hosts: Willows.

Symptoms: Dead patches on leaves sometimes result in considerable browning and defoliation. Small twigs may die and form "shepherd's crooks". Repeated attacks may result in "dieback" and eventual death.

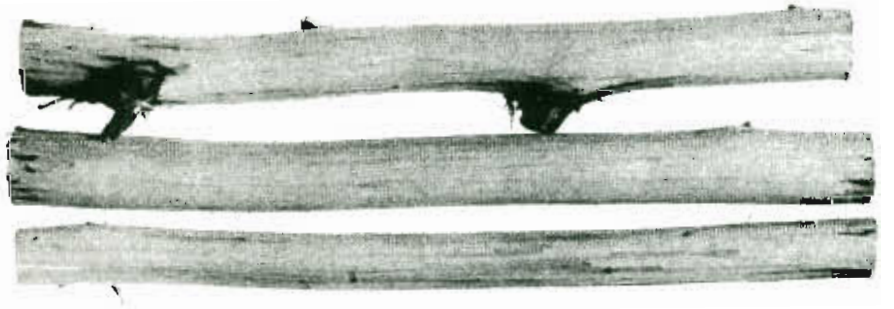
Season: Early spring and summer is best for identification purposes although some infected leaves may remain on the tree longer.

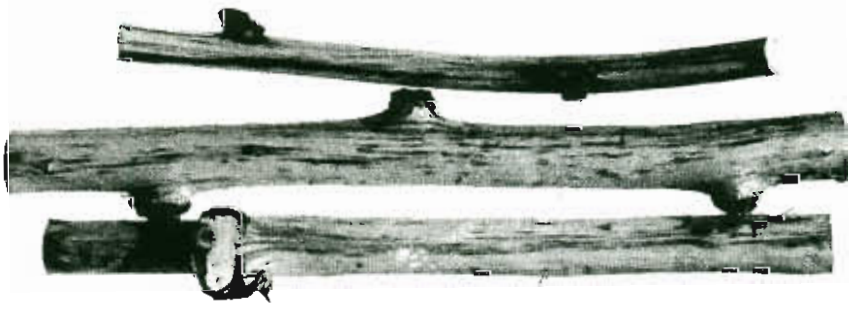
Importance: Not important in forest stands, but sometimes significant on ornamental trees or in shelterbelts.

Fig. 37. Willow blight. Small twigs double into "shepherd's crooks" and leaves wither and blacken.

38A

38C





38B

Common name: Dutch elm disease.

Scientific name: Ceratocystis ulmi (Buism.) C. Moreau.

Hosts: White elm, and occasionally English and Chinese elms.

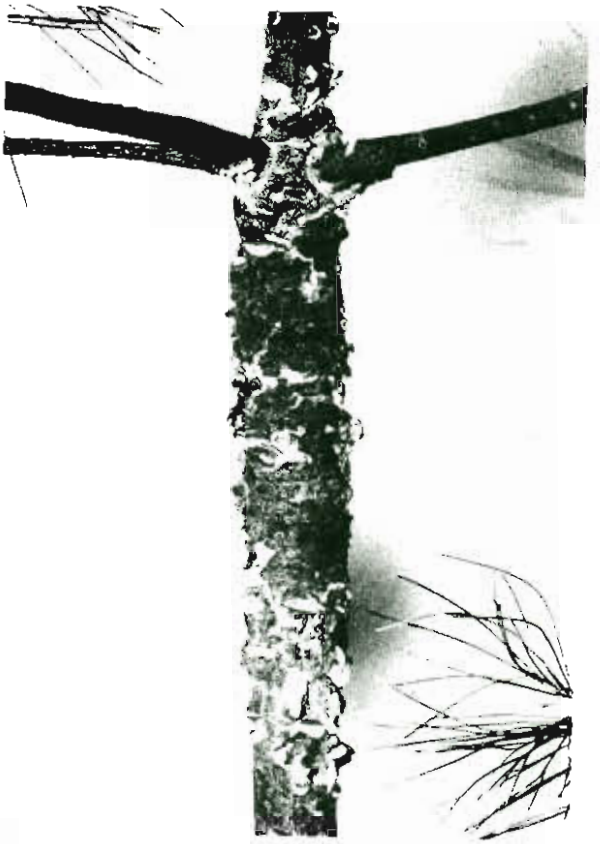
Symptoms: This fungus causes sudden wilting and yellowing of leaves. Defoliation is followed by death of affected branches. Some trees die within a few weeks whereas others may die over a period of one or more years. When cut across or peeled, diseased branches or stems show a more or less continuous brown ring in the outer sapwood. This is due to the clogging of vessels (water-conducting tubes) by tyloses and brown gumlike substances. Since these symptoms are not entirely distinct from those caused by Cephalosporium and Verticillium wilts, a laboratory culture test is necessary for exact diagnosis.

Season: Careful and widespread surveys should be made in July to determine incidence and distribution. Prior to this, individual infections may be evident, but others in the same area may be by-passed. After this, diseased trees may still be identified, but many normal, healthy trees begin to bear yellowish foliage which may be confused with the initial disease symptoms.

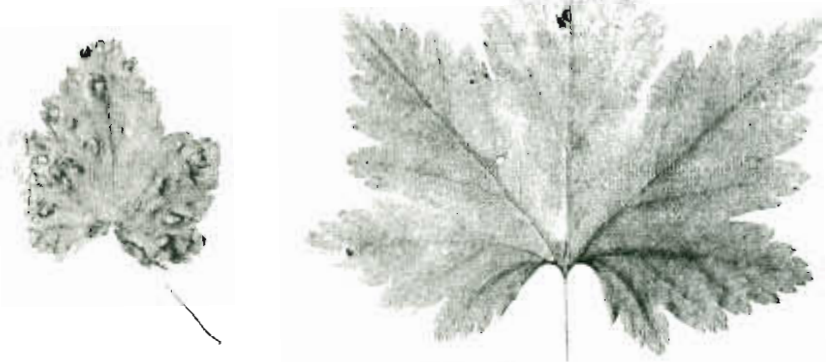
Importance: Since elms are generally shade or ornamental trees with very high aesthetic values considerable attention has been directed towards this disease which can kill elms within 1 to 3 years. There is no known control for this fatal disease, but it has been shown that a sanitation and control program aimed at improving the vigor of trees and controlling the insect carriers of the disease is less costly than continuous removal of dead trees. Adult elm bark beetles (mainly Hylurgopinus rufipes) breed only on weakened or dying wood. When adults emerge in May, they feed on healthy wood and carry the disease fungus with them.

Fig. 38. Ceratocystis ulmi, Dutch elm disease. A. White elm tree two months after first symptoms of disease were reported. Note patchy defoliation and curled, dwarfed appearance of remaining leaves. B. Peeled elm branches, (top group) healthy, (lower group) with brown streaking of the sapwood common in diseased trees. C. Beetle and larval galleries between the bark and wood of a dead elm tree.

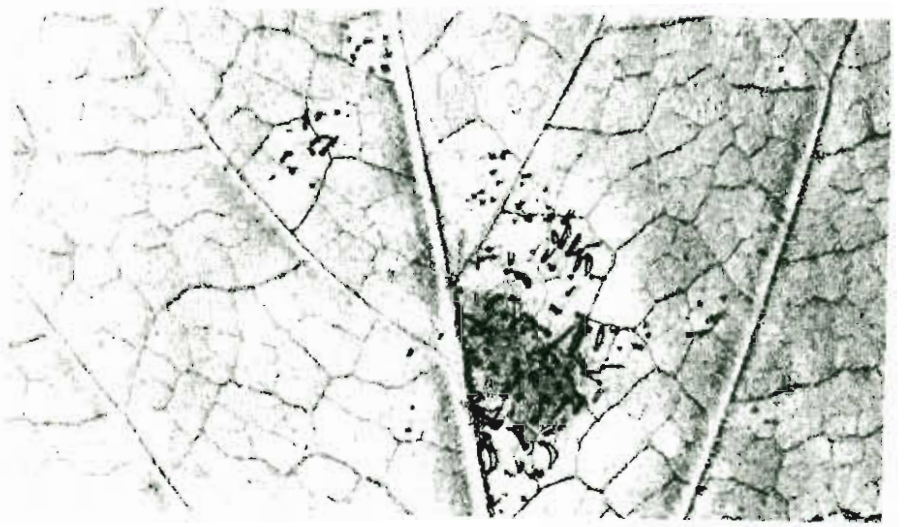
39A



39B



39C



39D

(B.) Stem Diseases

(i) Cankers

Common name: White pine blister rust.

Scientific name: *Cronartium ribicola* J. C. Fischer.

Hosts: Eastern white pine is the coniferous host in the Maritimes. Currants and gooseberries (*Ribes* spp.) are alternate hosts for this introduced disease.

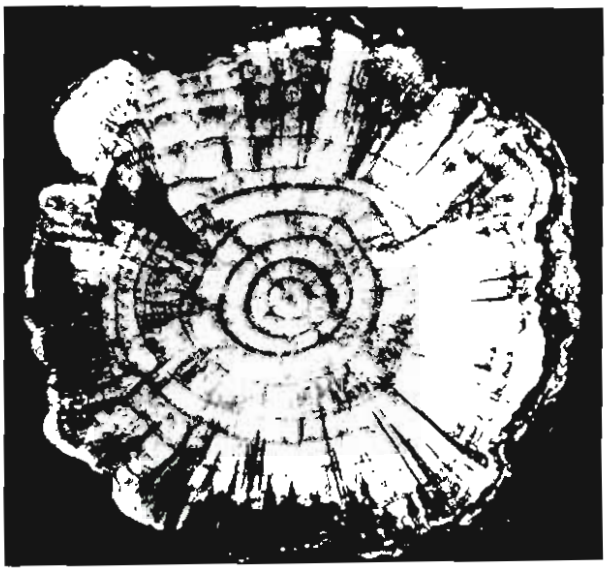
Symptoms: Pines are infected through the needles, and during a three-year incubation period, a spindle-shaped branch or stem canker develops. At the centre of the canker, the dead bark is dark and cracked. Surrounding this, a narrow band of bark ruptures, during May or June, to expose the orange or white blisters (aecia) and the spores which carry far to infect the leaves of *Ribes*. Beyond the ruptured zone the smooth bark is yellowish-green and exudes a clear sticky liquid (pycnia). This marks the outer limits of the canker, but each year it continues to enlarge until the tree or branch is girdled and dies.
Spores from the infected pine form small yellow blisters (uredia) on the under sides of currant and gooseberry leaves. These urediospores re-infect other *Ribes* for great distances. Then, about midsummer, brown hair-like or horn-like projections develop (telia) and produce spores (basidia) which may re-infect the needles of near-by pine.

Season: Cankers on pine have spores present from about mid-May to the end of June. This is when positive identification can be made of the fungus on pine. Identification of the fungus on *Ribes* is possible from mid-June to the end of September.

Importance: Blister rust is fatal to white pines. Older trees attain merchantable maturity, but the future of regeneration is questionable without the considerable expense of *Ribes* eradication programs.

Fig. 39. *Cronartium ribicola*, white pine blister rust. A. Stag-topped white pine caused by girdling of the stem by blister rust. B. Young sapling with orange-yellow aecia rupturing the bark. C. Gooseberry, (*Ribes* sp.) required as an alternate host for the complete life cycle of the blister rust. D. Telial horns with some shorter uredial pustules on the lower surface of *Ribes* leaves.

A



B

C

D

Common name: Sweetfern blister rust.

Scientific name: *Cronartium comptoniae* Arth.

Hosts: Jack pine and lodgepole pine (yet to be collected on Scots pine in the Maritimes) are the coniferous hosts. Sweetfern (*Comptonia peregrina*) and sweet gale (*Myrica gale*) are alternate hosts.

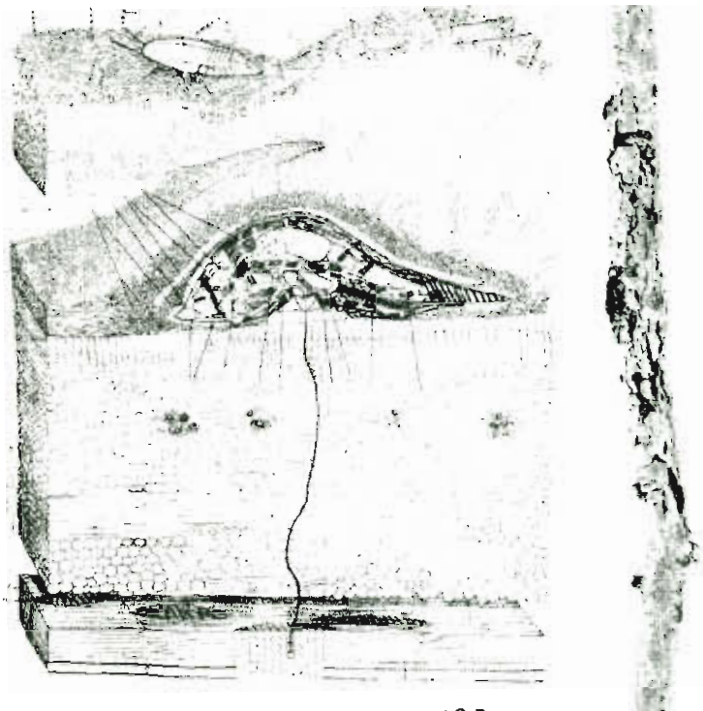
Symptoms: Similar to white pine blister rust. Pines are infected through the needles and a spindle-shaped, usually basal, stem canker develops. Narrow bands of bark rupture, during May or June, to expose orange blisters (aecia) and spores which carry short distances to infect the leaves of sweetfern or sweet gale. The rust matures on the alternate host, spreading the infection to other similar plants (uredia) and produces horn-like projections (telia) on which spores (basidia) form which may infect near-by pine.

Season: Cankers on pine have spores present from about mid-May to the end of June. On sweetfern or sweet gale rust pustules may be seen form mid-May to the end of September.

Importance: Sweetfern blister rust is fatal to young hard pines. In older trees it causes abnormal wood formation which often becomes infested by bark beetles and woodborers, eventually killing the host. Care should be taken when planting or introducing hard pines in the Maritimes where sweetfern is so common.

Fig. *Cronartium comptoniae*, sweetfern blister rust. A. Fatal stem canker on 4-year-old pine seedling. B. Stem section showing abnormal annual growth. C. Clumps of sweetfern, the most common alternate host. D. Telial horns with some shorter uredial pustules on the lower surface of sweetfern leaves.

40A



40B

41A

41B

41C

41D

Common name: Brown felt fungus.

Scientific name: Septobasidium pinicola Snell.

Hosts: Matsucoccus macrocicatrices. On white pine trees in association with a scale insect.

Symptoms: Flat, crusty or spongy circular patches (up to 2 inches in diameter) occur near base of white pine limbs. Dark brown at centre with lighter buff margins.

Season: From late spring to late autumn.

Importance: Damage to the host tree is negligible in this symbiotic (mutual) relationship. the fungus obtains its food from the insect whose sucking tube extends to the cambium of the tree.

Fig. 40. Septobasidium pinicola. A. The brown felt fungus on white pine stems. B. Cross-section of the felt shows fungus covering the scale insect which is drawing food from cambium of the tree. (J.N. Couch, 1938. The genus Septobasidium. Chapel Hill, North Carolina, 480 pp.).

Common name: Hypoxylon canker of poplar.

Scientific name: Hypoxylon mammatum (Wahl.) Miller.

Hosts: Trembling aspen, largetooth aspen, and balsam poplar.

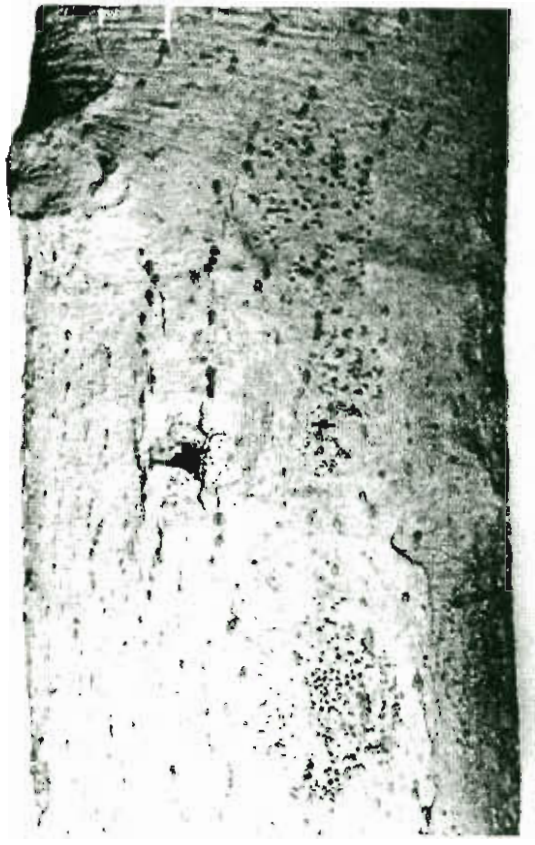
Symptoms: Stem cankers, 2-8 feet long, appear on individual trees, particularly in 15 to 40-year-old stands. The canker margin is yellow to reddish-brown, often with brownish sap flowing from it. Summer spores (conidia) are produced on hyphal pegs which rupture the thin surface layer of the bark. In older zones of the perennial canker, the tree is a mottled grey to black color, and ascospores are produced in a hard fruiting body (perithecia).

Season: The cankers may be evident throughout the entire year.

Importance: Hypoxylon canker can girdle and kill a pole-sized tree in 3-4 years. During wind storms stems are frequently broken in the region of cankers.

Fig. 41: Hypoxylon canker on trembling aspen. A. A 4-foot long canker which almost girdles this stem. B. Canker with yellow margin and dead centre. C. Hyphal pegs which bear conidia and rupture the thin papery layer of the bark. D. Hard grey-black perithecia which release ascospores.

42A



42B

42C

43

Common name: Beech bark disease.

Scientific name: Cryptococcus fagi (Baer.) - insect - followed by Nectria coccinea var. faginata Lohm., Wats., and Ayers - fungus.

Hosts: Beech.

Symptoms: The beech scale inserts its stylet into the living bark causing death and shrinkage of small patches of cells. The fungus enters through these minute cracks killing bark, cambium, and sapwood, resulting in formation of a large distorted canker. Circular clusters of tiny red fruiting bodies (perithecia) occur near margins of these cankers, or occasionally may cover large areas of the trunk.

Season. The fungus is evident from early March to late October but is most easily seen during or following moist periods.

Importance: This is the most prevalent and serious canker disease of beech. It greatly reduces merchantable volume and may kill the host.

Fig. 42. A. Canker with beech scale around margins. (The dotted white circular object in the upper corner is not part of the complex but a common lichen on beech). B. Nectria coccinea var. faginata is most commonly seen as circular patches of tiny red perithecia. C. Occasionally, much of the stem is covered with the red fruiting bodies.

(ii) Decays

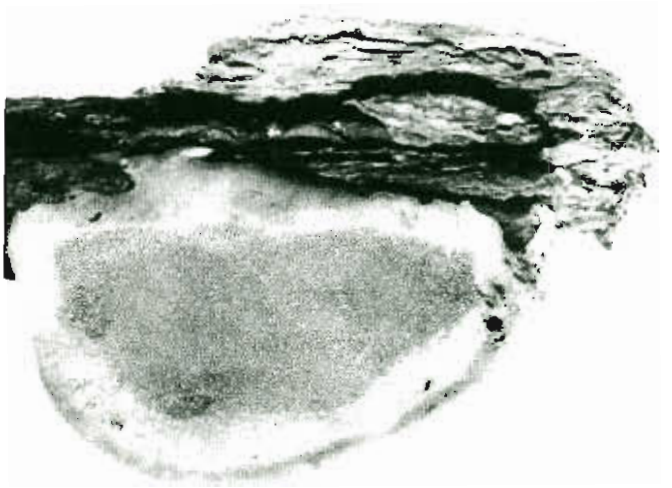
Common name: Wood decay fungi.

Scientific name: Decay in wood is caused mostly by fungi of the following, closely related, groups (genera):

Polyporus spp.
Fomes spp.
Lenzites spp.
Daedalea spp.
Trametes spp.
Poria spp.
Stereum spp.

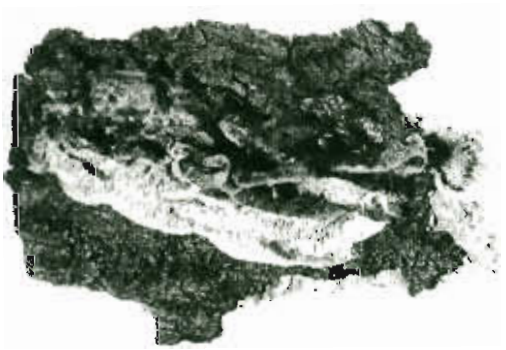
Hosts: Some fungi have both hardwood and softwood hosts while others are restricted to one group or the other. Other fungi are common on dead wood (includes the inactive heartwood of living trees) or slash, and a few attack wood which is in service.

44A



44B

45



47

46

Symptoms: Initially decay is hard to detect and may show only as a slight stain or discoloration. With advanced decay, the wood is visibly changed in structure and appearance. It may become soft and spongy with reddish-brown cubical texture, or it may contain pockets of white mycelium and cellulose. Usually at this time, the first external sign of the decay appears. It is these spore-producing bodies (fruiting bodies) or conks which are described below.

1. Polyporus spp. Annual fruiting bodies look like mushrooms or zonately marked conks. The under surface has many small tubular pores or openings.

Fig. 43. Polyporus hirsutus. Note conk form and circular pores.

2. Fomes spp. Perennial, woody fruiting bodies continue to grow and produce spores for many years. The upper surface is brown to black and ridged. The lower surface is light tan or buff and has numerous small tubular pores.

Fig. 44. A-B. Fomes pinicola. Note the perennial, zoned conk with circular pores and the sterile margin with no pores.

3. Lenzites spp. Annual fruiting bodies are usually long, narrow, and shelf-like. Upper surface is reddish-brown to greyish-black. Under surface has thick gills with occasional cross connections.

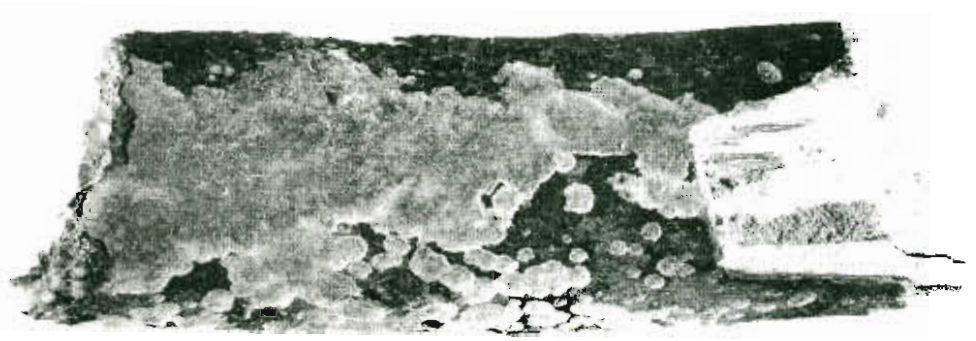
Fig. 45. Lenzites saepiaria. Annual fruiting body with thick branching gills.

4. Daedalea spp. Annual woody fruiting bodies yield spores for several seasons. Conks have hairy upper surface and generally occur in clusters. Lower surface is a labyrinth (maze) of elongated pores.

Fig. 46. Daedalea unicolor. Cluster of fruiting bodies and one conk showing the maze of elongated pores.

5. Trametes spp. Fruiting bodies are shelf-like, similar to those of Lenzites, except that lower surface is comprised of tubular pores and not thick gills.

Fig. 47. Trametes trogii. Annual fruiting body with tubular pores.



48

49

50A

50B

6. Poria spp. Perennial fruiting bodies are brown, flattened crusts (resupinate). When young they are soft and pliable but later become tough and leathery. The exposed surface bears numerous small tubular pores.

Fig. 48. Poria ferruginosa. A crust-like conk with tubular pores.

7. Stereum spp. Annual fruiting bodies are small, seldom more than 2 inches wide. These thin leathery conks with no pores or gills have a smooth, buff-colored upper surface and an upturned margin.

Fig. 49. Stereum sanguinolentum. Thin leathery fruiting body.

Season: Fruiting bodies of the decay fungi are seen throughout the entire year.

Importance: Problems caused by wood decay fungi vary with host and stand conditions. In mature and over-mature stands decay may cause significant losses and degrade in wood volume. Less frequently are individual trees killed. Some decay fungi are beneficial in decomposing debris and slash, thus adding valuable organic matter to the soil.

(i) Decays

Common name: Shoestring root rot.

Scientific name: Armillaria mellea (Vahl ex Fr.) Kummer.

Hosts: This fungus may attack almost all species of trees and shrubs.

Symptoms: From a distance affected hardwoods seem to have lighter, smaller foliage, while the needles of softwoods may be light yellow, eventually turning red-brown. Excessive resin flow may occur at the base and root collar of infected conifers particularly pines. Removal of bark at ground level reveals extensive white mycelial mats. Frequently, dark brown to black "shoestrings" (rhizomorph) are also evident. Light tan colored mushrooms often grow singly or in clusters, either at the base of dead or dying trees or at some distance from the tree. These fruiting bodies have distinct gills and a ring (annulus) circling the stalk slightly below the gills.

Season: The mycelial fans and "shoestrings" may be found between the bark and wood throughout the year. Mushrooms are common in early autumn and occasional during wet summer periods.

Importance: Can kill much reproduction or cause moderate losses through decay. Often thought to attack low vigor trees weakened by insect attack, storm damage, etc.

Fig. 50. Armillaria mellea. A. Tan mushrooms of shoestring root rot. (Note the annulus). B. Stump with bark removed to show the white mycelium.

51A

51B

Common name: Annosus butt and root rot.

Scientific name: Fomes annosus (Fr.) Cke.

Hosts: All commercial conifers particularly pine plantations, and some hardwoods. This fungus is common in many parts of North America and Europe.

Symptoms: Foliage yellows and the tree dies. Individual trees whose roots have been infected may blow down even before the foliage yellows. The perennial fruiting bodies occur on the lower side of partly upturned roots or low on the butt, often hidden in the loose duff and litter. Conks are greyish-brown and zoned on upper surface with white or tan lower surface which is covered with tiny round pores.

Season: Early spring to late autumn.

Importance: Currently of minor significance in the Maritimes but could become important in plantations, and after thinning programs.

Fig. 51. Fomes annosus. A. Zoned, greyish-brown upper surface of the perennial fruit body. B. White to cream lower (pore) surface.

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GLOSSARY

Adventitious shoots: shoots in unusual positions, often developing after defoliation or injury of overwintering buds.

Aecial stage: second spore stage in the life cycle of rust fungi producing conspicuous orange-yellow aeciospores. Often appear like blisters.

Aeciospore: rust spore formed in an aecium; carried by wind currents to the alternate host where the life cycle continues.

Aecium, pl. Aecia: cup-like structure in which chains of aeciospores are produced.

Alternate host: either of the host plants necessary for completion of the life cycle of most rust fungi. The commercially valuable host is usually considered the primary host and a shrubby or herbaceous host as the alternate.

Annual: completing growth in one year or season.

Annulus: ring-like structure around the stalk of some mushrooms, just below the gills.

Apothecium, pl. Apothecia; open cup-shaped fruiting body bearing asci on its upper concave surface. Occurs in some species of Ascomycetes.

Applanate: flattened out or horizontally expanded.

Ascomycetes: a major group of fungi in which the spores are produced within little sack-like structures, called asci.

Ascospore: type of spore produced in an ascus.

Ascus, pl. Asci: a microscopic, sack-like structure containing a definite number of ascospores, usually eight. Characteristic of the class Ascomycetes.

Asexual: vegetative reproduction, not involving union of two nuclei.

Bacterium, pl. Bacteria: microscopic, one-celled organisms with no chlorophyll and therefore dependent upon other living things or decayed organic matter for food supply. They reproduce by splitting into two cells.

Basidial stage: the fifth and last stage in the life cycle of rust fungi; produces small, short-lived basidiospores which may infect the primary host.

Basidiomycetes: a major group of fungi in which the spores are produced on club-shaped structures called basidia.

Basidiospore: type of spore produced on basidia.

Basidium, pl. Basidia: a club-shaped structure, in Basidiomycetes, which usually bears four basidiospores.

Blight: a common name for the condition characterized by sudden leaf damage and often followed by withering of the affected parts of the plant.

Blister: a swelling or rupture of the surface layer.

Callus: tissue that develops at the margins of wounds, tending to grow over them.

Cambium: the dividing layer of cells which forms new layers of bark and wood each year.

Canker: an area of diseased tissue, often discolored and cracked, on a living host stem or branch. May be annual (callus growth covers the wound quickly) or perennial (continued disease development prevents callus from completely covering the wound).

Cleistothecium, pl. Cleistothecia: a completely closed fruiting body in which asci are produced.

Conidium, pl. Conidia: asexual spore, usually produced in great numbers by certain fungi during the summer. These spores carry short distances and intensify the disease in a given area.

Damping-off: disease of seedlings which causes them to rot at the soil level and fall over.

Decay: the process by which sound tissue is destroyed through decomposition by fungi.

Defoliation: reduction in the normal amount of foliage.

Disease: any abnormality which interferes with the normal functions of the tree except those caused by fire or insects.

Facultative parasite: an organism capable of infecting and living on either living or dead organic matter.

Flag: a dying or recently dead twig or branch still supporting discolored leaves or needles.

Fruiting body: (conk; mushroom; etc.): an organized fungal unit for the protection, production and dissemination of spores.

Fungus, pl. Fungi: a multicellular organism lacking chlorophyll and therefore dependent upon other organic materials for food. Fungi generally lack the power of movement and reproduce by spores. They do not have true stems, leaves, or a vascular system.

Fusiform: spindle-shaped, tapering at both end

Gall: a permanent swelling in plants, frequently on the stem, branch, or twig.

Gills: plate-like folds on the under surface of many mushrooms, which bear the hymenium or fruiting layer.

Haustoria: special branch of mycelium which penetrates plant cells and serves as a point of attachment and absorption for the fungus.

Host: name given to any organism, on or within which another organism feeds.

Hymenium: the spore-producing layer on the surface of gills, tubes, teeth, etc. of a fungus fruiting body.

Hypertrophy: excessive enlargement of cells.

Hypha, pl. Hyphae: small filaments or thread-like strands which make up the mycelium and the fruiting bodies of fungi.

Infectious disease: one that has the ability to multiply and spread.

Lesion: an area of damaged or diseased tissue.

Lichen: a symbiotic combination of an alga (algae-simple green plants) and a fungus which appears as one organism growing on rocks, bark, branches or other objects.

Micron: microscopic unit of measure; 1/1000 or a millimeter; approximately 1/25,000 inch.

Mildew: (mold): fungi with conspicuous mats of mycelium growing on the surface of many materials.

Mycelium, pl. Mycelia: a group or mass of fungal hyphae, typically embedded in soil, wood, dung, etc.

Mycology: the science which deals with fungi. (identification, classification, etc.).

Non-infectious disease: one that is caused by non-living agents, e.g. frost, smoke, storm damage, mechanical damage, etc.

Obligate parasite: an organism able to live only on a living host. It dies when the host dies.

Parasite: any organism which lives at the expense of another, usually invading it and causing death.

Pathology, forest: study of forest tree diseases, their nature, causes, effects, and treatment.

Perennial: those plants, fruiting bodies, etc. which continue to grow from year to year.

Perithecium, pl. Perithecia: flask-shaped fruiting structure which releases ascospores.

Petiole: stem of a leaf.

Pore: the small opening of the tubes characteristic of some fruiting bodies. They bear basidia on their surfaces.

Pycnial stage: first stage in the life cycle of rusts, appears as a resinous flow at margin of cankers.

Resinosis: an abnormal flow of resin or pitch from conifers.

Resupinate: description of a fruiting body which lies flat on the substrate.

Rhizomorph: a long, branching, root-like cord of fungal mycelium with dark or black covering, often between the bark and wood of dead or dying trees.

Rot: plant tissue in a state of decay.

Rust: a group of obligate-parasitic fungi (the Uredinales) commonly causing blister-like growths on leaves, needles, branches or stems of higher plants. As many as five kinds of spores are produced by some rusts.

Sclerotium, pl. Sclerotia: a hard, blackish, fungal resting stage which germinates when favourable conditions return.

Shot hole: a leaf spot disease characterized by holes formed when dead parts drop out.

Spore: a small, fungal reproductive unit that functions like a seed, but a spore does not contain a preformed embryo.

Spot, leaf: any one of several leaf diseases characterized by numerous isolated circular or angular lesions.

Stain fungi: those that cause wood discoloration but little or no decay.

Stipe: stalk of a mushroom.

Stoma, pl. Stomata: a small opening on the surface of a leaf permitting gaseous exchange.

Stroma, pl. Stromata: a cushion-like mass of fungal hyphae containing or bearing fruiting structures.

Substrate: the material on which an organism lives and from which it often obtains nourishment.

Sunscald: localized injury to bark and cambium caused by exposure to intense sunlight and high temperatures.

Symbiosis: an association of two or more kinds of organisms in which both are benefited.

Telial stage: a spore stage in the life cycle of rusts during which teliospores are produced. Material in this stage is required for absolute identification of most rusts.

Teliospore: a thick-walled rust spore which eventually gives rise to the basidial stage.

Telium, pl. Telia: a fruiting stage in rusts during which teliospores are produced.

Tubes: small circular gallery in some fruiting bodies, the opening of which is the pore. Basidia are produced on the walls of the tubes.

Tyloses: results from the growth of one cell into the cavity of another, often causing a blockage of vessels or tracheids.

Uredial stage: a stage in the life cycle of rusts during which uredospores are produced.

Uredium, pl. Uredia: the rust fruiting body which produces uredospores.

Uredospores: a rust spore capable of rapid reproduction which intensifies an infection.

Virus: extremely small protein particles capable of causing disease.

Wilt: a withered and drooping condition common in leaves with a water deficiency.

Witches' broom: a compact clumping of branches caused by excessive branching as the result of disease.

Zonate: having zones, marked with concentric bands of color.

COMMON NAMES, SCIENTIFIC NAMES, AND ABBREVIATIONS FOR MAJOR HOST TREES

The Softwoods (Conifers)

Common name	Scientific name	Abbreviation
Cedar,	Thuja sp.	C
Eastern white cedar	T. occidentalis	eC
Fir,	Abies sp.	F
balsam fir	A. balsamea	bF
Hemlock,	Tsuga sp.	H
Eastern hemlock	T. canadensis	eH
Juniper,	Juniperus sp.	J
red juniper (Eastern red cedar)	J. virginiana	rJ
Larch,	Larix sp.	L
tamarack (Eastern larch)	L. laricina	tL
Pine,	Pinus sp.	P
jack pine	P. banksiana	jP
red pine	P. resinosa	rP
Scots pine	P. sylvestris	scP
white pine (eastern)	P. strobus	wP
Spruce,	Picea sp.	S
black spruce	P. mariana	bS
blue spruce	P. pungens	-
red spruce	P. rubens	rS
white spruce	P. glauca	wS

The Hardwoods (Broad-leaved)

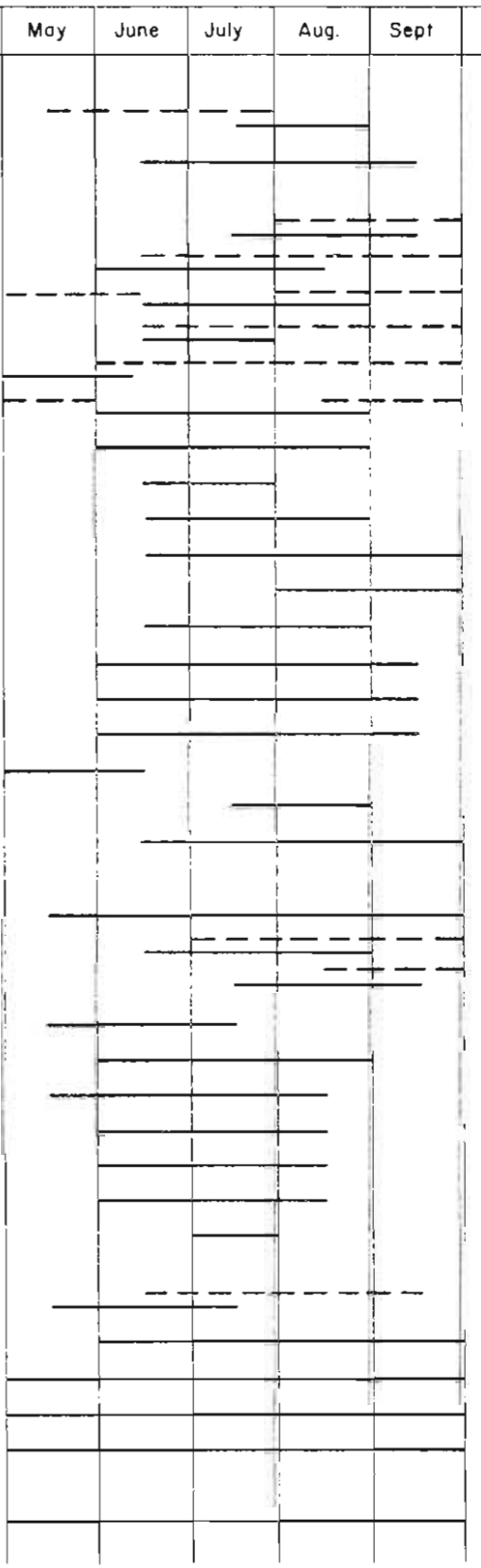
Alder,	Alnus sp.	Al
speckled alder	A. rugosa var. americana	spAl
Ash,	Fraxinus sp.	As
black ash	F. nigra	bAs
white ash	F. americana	wAs
Aspen,	Populus sp.	A
largetooth aspen	P. grandidentata	lA
trembling aspen	P. tremuloides	tA
Basswood	Tilia americana	Ba
Beech	Fagus grandifolia	Be

Common name	Scientific name	Abbreviation
Birch,	Betula sp.	B
white birch	B. papyrifera	wB
wire birch	B. populifolia	wiB
yellow birch	B. alleghaniensis	yB
Butternut	Juglans cinerea	Bu
Cherry,	Prunus sp.	Ch
black cherry	P. serotina	bCh
choke cherry	P. virginiana	cCh
pin cherry	P. pensylvanica	pCh
Elm,	Ulmus sp.	E
Chinese elm	U. parvifolia	-
English elm	U. campestris	-
white elm	U. americana	wE
Hazel	Corylus cornuta	-
Horse-chestnut	Aesculus hippocastanum	hChe
Maple,	Acer sp.	M
Manitoba maple	A. negundo	mM
mountain maple	A. spicatum	moM
Norway maple	A. platanioides	-
red maple	A. rubrum	rM
silver maple	A saccharinum	siM
striped maple	A. pensylvanicum	stM
sugar maple	A. saccharum	sM
Mountain ash,	Sorbus sp.	Mo
American mountain-ash	S. americana	aMo
Oak,	Quercus sp.	O
bur (white) oak	Q. macrocarpa	bO
red oak	Q borealis	rO
Poplar,	Populus sp.	Po
balsam	P. balsamifera	bPo
lombardy	P. nigra var. italica	lPo
silver	P. alba	sPo
Serviceberry (Saskatoon, shadbush)	Amelanchier sp.	Se
Willow	Salix sp.	W

Fig 3

Approximate Seasonal Distribution of Common Diseases in the Moritimes Region

On forest trees ———— On "alternate host" if applicable — — — —



Common name of Disease	Remarks
Fruit Diseases	
Spruce cone rust	Alternate on wintergreen
Alder catkin hypertrophy	Present earlier on previous years catkins
Foliage Diseases	
Spruce needle rust	Alternate on Labrodor tea
Pine needle rust	" " asters and goldenrod
Balsam fir needle rust	" " fireweed or blueberry
Willow leaf rust	" " tamarack
Cedar & Juniper leaf rusts	" " mountain-ash or Amelonchier
Ash rust	" " cord grass - overwinters
Needle casts	
Aspen ink spot	
Cherry shot-hole	
Leaf spots	On maple , elm , hazelnut, aspen, etc
Tar spots	Also October depending on leaf-fall
Anthracnose of hardwoods	On maple , ash, oak, birch, basswood, etc
Leaf blotch of horse-chestnut	
Leaf blisters	On oak, birch, maple , cherry, etc
Cedar leaf blight	
Balsam fir tip blight	Late March & April best for identification
White pine needle blight	Needles of previous infections remain for several years
Powdery mildews	
Branch Diseases	
Eastern dwarf mistletoe	Releases seed in Sept & Oct
Yellow witches' broom of balsam fir	Alternate on chickweeds
" " " " spruce	" " bearberry
Globose gall rust	
Balsam fir red flag	
Black knot of cherry	Infections remain visible for several years
Poplar leaf and twig blight	
Willow blight	
Cherry blight	
Dutch elm disease	Yellowing may occur later but then is not as diagnostically meaningful
Stem Diseases	
White pine blister rust	Alternate on Ribes
Brown felt fungus	In association with scale insects
Hypoxylon canker of poplar	
Beech bark disease	Nectria most evident after periods of moisture
Wood decay fungi	Fruiting bodies evident all season
Root diseases	
Shoestring root rot	Mushrooms evident late summer & fall, white mycelium under bark all season

INDEX