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Why Is My
EVERGREEN BROWN?

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Why Is My Evergreen Brown?

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Coniferous evergreens display illness by discoloration of their needles. This is true although the illness or injury may be in roots, trunk, or branches. The crown then looks slightly or distinctly yellow, straw-colored, brown, grey-brown, deep red-brown, or purple depending on the severity of damage and its cause. Such color change is prominent, sometimes spectacular, and means that something is seriously wrong. The change often occurs long after injury so that recovery is doubtful, but some affected trees can be helped. The cause determines whether recovery is possible or not.

Although color change is a good clue, it must be used with other symptoms to diagnose cause and control. The following is a key to common diseases and injuries associated with foliar discoloration in Idaho conifers. Use it carefully and compare your results with closely related conditions as indicated in the description. It is possible to follow several pathways and arrive at the same cause depending on the symptoms your specimen displays. Descriptions of each condition follow the key.

Key to Causes of Conifer Discoloration

The number at the end of a line refers to the next step in The Key. A number in parenthesis refers to the description which succeeds The Key.

1. Only old needles (previous year's) affected or old needles affected first 2
 - 1a. Any age needles affected 3
2. Old needles:
 - A. Brown and drop during late summer or fall (1) AUTUMN SHED
 - B. On Douglas fir, needles spotted or banded (2) DOUGLAS FIR NEEDLE CAST
 - C. Grey-green with fine mottling and very fine webs between them. Mites may be present (3) MITE DAMAGE
3. Any age needles
 - A. No fungus or insect present 4
 - B. Fungus or insects present 8

4. No fungus or insect
 - A. A distinct pattern or progression of injury discernible or swellings present 5
 - B. No pattern discernible, no swellings
 - a. Discoloration of foliage occurs slowly 6a-6c
 - b. Discoloration of foliage is rapid 7
5. Pattern or progression:
 - A. Only terminals or tips of branches affected
 - a. Tips (new growth) droop and brown during spring (4)
FROST DAMAGE
 - b. Terminals wilt and gradually brown. Small holes through bark of affected terminals, and inner bark bored by an insect (5)
TIP WEEVIL DAMAGE
 - B. Tips of needles affected first, then condition spreads inward 6a
 - C. Discoloration begins at the top and/or outside of the crown and works down and in 6b
 - D. Swellings (galls, burls, or simple swellings) on branches or stems which have discolored foliage, or a clumping of branches which becomes discolored.
 - a. Swelling or lip-like extension of bark surrounding a dead area (canker) (6) DASYSCYPHA CANKER
 - b. Distinct round galls on branches or stem of ponderosa or lodgepole pine (7) WESTERN GALL RUST
 - c. Small branches with elongate swollen areas; or some branches in the crown clumped together (witches broomed) and bearing partly juvenile leaves; only on arborvitae, cedar, or juniper (8) GYMNOSPORANGIUM RUSTS
 - d. Loose or tight clumping of branches:
 - I. With small green plants or small cups on the affected limbs (9) DWARF MISTLETOE DAMAGE
 - II. No plants or cups present. Ponderosa or lodgepole pine (31) ELYTRODERMA NEEDLE CAST
- 6a. Discoloration of foliage occurs slowly
 - A. Tips of needles often affected first or entire needles may be symptomatic, but ordinarily color change is not rapid.
 - a. Needle tips turn purple, then this discoloration proceeds inward with eventual browning (10) PHOSPHORUS DEFICIENCY
 - b. Needle tips die then death proceeds downward, or when severe, needles brown or redden rapidly. When chronic, needles are stunted and burned at tips (11) FUME AND GAS DAMAGE

- c. Tree has one or all of the following:
 - I. Needles curled, twisted or distorted.
 - II. New stems clumped together.
 - III. New stems stunted and twisted.
 - IV. Needles conspicuously very light yellow to white then brown and are shed.
 - V. Green new growth shows during spring at branch tips and tree often recovers (12) HERBICIDE DAMAGE

- 6b. Discoloration often begins at top and outside of the crown, but may be general throughout the crown or throughout a specific branch. Color change ordinarily is not rapid.
 - A. Entire crown or a large part of it distinctly yellow. Planted trees only (29) IRON DEFICIENCY

 - B. Entire crown gradually browns, usually from the top down and outside in, until the tree is dead:
 - a. Roots and/or lower stem decayed at least partly. Foliage often dwarfed and thinned out (13) ROOT ROT
 - b. Roots and stem not decayed:
 - I. Small, regular holes in bark (of stem) where beetles emerge. Engraving beneath bark (14) BARK BEETLE DAMAGE
 - II. Obvious, large holes in bark of the stem. Large tunnels and/or holes in wood beneath the bark (35) WOOD BORER DAMAGE
 - III. Medium-sized holes in the bark of the lower stem only. Tunnels under bark gradually increase in size and end in pupal cell (36) ROOT-COLLAR WEEVIL DAMAGE
 - IV. Affected trees shallow rooted, on ground with a high water table, and/or insufficiently irrigated (15) DROUGHT DAMAGE
 - V. Needles eaten at least partly. Cocoons or caterpillars usually present (16) TUSsock Moth DAMAGE

 - C. Discoloration usually confined to one or a few branches of a large tree or the terminal and a few whorls of small trees.
 - a. Stems or branches have obvious round galls (7) WESTERN GALL RUST
 - b. No galls. A distinct margin between live and dead bark can be found on the stem or branch bearing discolored foliage.
 - I. In pines only. Wood beneath dead bark is blue to blue-black streaked (17) ATROPELLIS CANKER
 - II. In white pines only (5-needled). Pitch associated with a dying area of bark (18) WHITE PINE BLISTER RUST

- III. In Douglas fir, true firs, or pines. Wood beneath dead bark usually pitch soaked (6) DASYSYPHA CANKER
 - IV. Common in Douglas fir and true firs, with little or no pitch on bark or in wood (19) CYTOSPORA OR PHOMOPSIS CANKER

- 6c. Individual needles discolored, at least at first. Later discoloration may become general.
 - A. Individual needles with distinct spots or bands.
 - a. Needles hollowed partly by insect. Douglas fir, true fir, or pine (33) NEEDLE MINERS
 - b. Douglas fir only. Needles not hollowed (2) DOUGLAS FIR NEEDLE CAST
 - B. Individual needles on part or all of some branches conspicuously yellow and then brown during the growing season. Common on spruces and true firs, occasional on pines (34) NEEDLE RUSTS

- 7. The crown or a large part of it discolors, often rapidly.
 - A. Occurs suddenly at the advent of warm weather in the spring (20) COLD OR WINTER INJURY
 - B. With evidence of gnawing (teeth marks on debarked areas) on the stem (21) RÖDENT DAMAGE
 - C. With bark of the stem and or surrounding vegetation partly blackened by fire (22) FIRE DAMAGE
 - D. In arborvitae or cedar. Small branches brown and may drop leaving bare grey stems and holes in the crown. Spreads gradually in the crown after initial discoloration (23) BLIGHTS
 - E. In larch only:
 - a. Needles yellow in spring, curl and brown in summer (24) LARCH NEEDLE CAST
 - b. Needles yellow in spring but do not curl and are hollowed by insect feeding (25) LARCH CASEBEARER DAMAGE
 - F. Trees, particularly spruce, true fir, or Douglas fir, appear scorched at branch tips where new foliage is destroyed by insect feeding. When severe, tree may be stripped (26) SPRUCE BUDWORM or (27) CATERPILLAR-LIKE DEFOLIATORS
 - G. Lower branches of large trees or crowns of small trees near houses, but away from walls, yellow and brown suddenly (esp. cedars, junipers) (28) DOG DAMAGE
 - H. Distinct yellowing of entire crown or a large part of it. Planted trees only (29) IRON DEFICIENCY
 - I. In ponderosa pine. Individual fascicles die, then branches (30) PRESCOTT SCALE INJURY
 - J. Ponderosa or lodgepole pine. Individual branches brown a few each year; often associated with loose brooms in the crown (31) ELYTRODERMA NEEDLE CAST

K. Old needles gradually turn brown or bleached. Often associated with dust, smoke, or repeated use of insecticides. (esp. pines, sometimes Douglas fir, cedar, spruce) (32) PINE NEEDLE SCALE DAMAGE

8. Fungus or insect present on

A. Leaves as:

a. A white, yellow or orange powdery material on leaves only (34) NEEDLE RUST

b. Tiny black pustules on browned needles. Cedars or junipers (23) BLIGHTS

c. Elongate black bodies on browned needles. Ponderosa or lodgepole pines (31) ELYTRODERMA NEEDLE CAST

d. Tiny black bodies on browned needles. Larch only (24) LARCH NEEDLE CAST

e. Small black or white scales on partly discolored or yet green needles (32) PINE NEEDLE SCALE DAMAGE

f. Tiny crawling red mites (3) MITE DAMAGE

g. Fine webbing or silk

I. Loose webbing of almost invisible threads between needles or a silvery coating on needles (3) MITE DAMAGE

II. Binding needles together at their tips (26) SPRUCE BUDWORM DAMAGE

III. Defoliated part of tree covered with a light, inconspicuous webbing. Caterpillars usually present (16) TUSSOCK MOTH DAMAGE

h. Grub-like insects within a slightly swollen portion of the needle. Common in Douglas fir (33) NEEDLE MINERS

i. Caterpillars:

I. In the needles of larch (25) LARCH CASEBEARER DAMAGE

II. On or in the needles. Caterpillars brown up to one inch long (26) SPRUCE BUDWORM DAMAGE or (27) CATERPILLAR-LIKE DEFOLIATOR DAMAGE

III. On needles or stems. Caterpillars distinctly tufted with bright spots (16) TUSSOCK MOTH DAMAGE

B. Stems as:

a. White, yellow, or orange powdery material on:

I. Galls. Ponderosa or lodgepole pine (7) WESTERN GALL RUST

II. Stems (without galls). White pines only (18) WHITE PINE BLISTER RUST

b. Bright (white, yellow, orange, etc.) jelly-like masses or columns on branches or stems during or just after moist periods (8) GYMNOSPORANGIUM RUSTS

c. Small, upright, green, usually leafless plants growing from branches or stems (9) DWARF MISTLETOE DAMAGE

- d. On ponderosa pine, inconspicuous tiny, dark brown to black shiny scale attached to the bark between the discolored needle fascicle (base of the bundle) and bark. This can be difficult to find and often requires considerable searching (30) PRES-COTT SCALE DAMAGE
- e. Caterpillars
 - I. Distinctly tufted with bright spots (16) TUSSOCK MOTH DAMAGE
 - II. Brown up to one-inch long (26) SPRUCE BUD-WORM DAMAGE or (27) CATERPILLAR-LIKE DEFOLIATOR DAMAGE
 - III. Very small, enclosed in a light brown, cigar-shaped case on larch (25) LARCH CASEBEARER DAMAGE
- f. Grub-like insects
 - I. Small white grubs between bark and wood (14) BARK BEETLE DAMAGE
 - II. Medium-sized, C-shaped grubs between bark and wood
 - 1.) In terminals (5) TIP WEEVIL DAMAGE
 - 2.) At or near root collar (36) ROOT-COLLAR WEEVIL DAMAGE
 - III. Large white grubs boring between bark and wood or into the wood. Holes in bark do not have pitch exudate around them (35) WOOD BORER DAMAGE
- g. Beetles
 - I Beneath and within the bark and/or wood (14) BARK BEETLE DAMAGE
 - II. Represented by tiny, regular holes in the bark usually with boring dust associated on the bark. Pitch tubes often present around the holes (14) BARK BEETLE DAMAGE
- h. Small black or white fungal bodies (may be very tiny)
 - I. Tiny (pinhead size), embedded, round bodies barely visible as pimples on recently killed bark of branches; usually these are visible only when the bark is very lightly sliced (19) CYTOSPORA OR PHOMOPSIS CANKERS
 - II. Small black, cup-shaped bodies on dead bark with blue-streaked wood beneath. On pines only (17) AT-ROPELLIS CANKER
 - III. Small white, cup-shaped bodies on dead bark or wood (6) DASYSYPHA CANKER
- i. Mats of fungus (white, yellow, or brown) under or in the bark at the tree base or roots (13) ROOT ROTS

DESCRIPTIONS

(1) **Autumn needle shed**

Old foliage of many conifers browns and sheds during autumn. These are two-year and three-year-old needles depending on the species. The new growth and the previous year's needles remain normal. This is a natural process often confused with injury or disease. Most often noticed in pines.

(2) **Douglas fir needle cast**

Cause: The fungus *Rhabdocline pseudotsugae*. Distinct bands or spots of yellow soon become red brown on each needle during the spring. Only one year old needles are affected. Growth of the current season will not be spotted. The crown soon looks thin and brown as though scorched. Needles begin to fall during the summer. On Douglas fir only. Compare with (33).

(3) **Mite damage**

Cause: "Red spiders" or mites *Paratetranychus* and *Tetranychus*. Foliage becomes grey-green with a very tiny yellow spotting or mottling of each needle. Gradually the crown becomes grey-brown. The older needles are affected first. Usually a fine webbing occurs on and between the needles. Tiny red mites often can be found on junipers, cedars, and spruces. Compare with (32).

(4) **Frost injury**

In spring, new growing tips suddenly droop and get a blanched appearance then turn brown leaving only the branch tips dead. The condition then progresses no further and the dead tips soon are shed usually causing little harm to any but very small trees. Compare with (5).

(5) **Tip weevil damage**

Cause: The insect *Pissodes* sp. Terminals (leaders) wilt, then yellow, and finally brown. The inner bark and sapwood of affected terminals is bored by the insect and small grubs may be present therein. Compare with (4).

(6) **Dasyscypha canker**

Cause: The fungus *Dasyscypha* sp. Branches or part of the top turns yellow then brown and the dieback progresses slowly down the affected stem. A distinct margin can be found between live and dead tissues by repeatedly cutting into the bark below the discolored foliage. In Douglas fir, affected bark may be swollen around a cankered (open) area to form a lip-like margin. Small, but visible, white (or light colored), cup-shaped fungus bodies appear on and in the canker during spring. Common on pines, true fir, Douglas fir. Compare with (7), (17), (18), (19).

(7) **Western gall rust**

Cause: The fungus *Peridermium harknessii*. Yellowing or browning of the foliage on individual branches or stems can be traced back to a distinct, round gall on the supporting stem or branch. Orange to yellow powdery fungal fruiting occurs on the galls during spring. On ponderosa or lodgepole pines only.

(8) **Gymnosporangium rusts**

Cause: The fungus *Gymnosporangium* sp. Needles on individual limbs or occasionally much of the crown yellow and gradually brown and die. Two types of symptoms may be associated:

Type I. Needles often juvenile (do not develop normally), and a loose or compact massing or clumping (witches brooming) of the branches occurs within the crown.

Type II. Swellings or galls can be found on limbs with discolored foliage. A bright-colored, gelatinous, mass exudes from these swellings when they are moistened by wet weather or continuous irrigation.

On arborvitae, cedar, or juniper only.

(9) **Dwarf mistletoe damage**

Cause: The green plant *Arceuthobium* sp. Individual parts of the crown become yellow slowly, then brown and die. Witches brooming is common in affected crowns and some swelling of discolored limbs is common. Tiny, upright, green, usually needleless plants grow from the affected stems (particularly in or near brooms and swellings). When the plants have been broken off tiny greenish cups remain attached to the bark. Compare with (31).

(10) **Phosphorus deficiency**

Needle tips become purplish slowly and remain so during the summer with a tendency to extend inward with time. When severe, the purpling turns to browning and needle fall begins. Particularly common on planted spruces. Compare with (11), (12).

(11) **Fume and gas damage**

Cause: Ethane, propane, flourine, sulfur dioxide, smoke and other gaseous airborne materials. When fume concentration is high, needles rapidly discolor brown or red brown. Typically, this begins at needle tips, but when severe may simply cause total discoloration and/or defoliation. When less severe, needles are stunted with correspondingly less discoloration and defoliation. Fume or gas injury is progressively less intense from the center or source of contamination outward, and tends to follow air drainages. When you suspect such injury look for principal airflow systems and decreasing injury away from a suspected source (e.g. smelter, smoke stack, pipeline). Compare with (10), (12).

(12) **Herbicide damage** (including herbicides, grass killers, soil sterilants)

Herbicides, etc. tend to kill some but usually not all conifers in an area. Often, affected trees are browned completely during winter and then produce new growth at the tips when the growing season resumes. The advent of green tips following severe crown discoloration is a common symptom of herbicide damage. Other symptoms indicate more specific groups of herbicides:

(a.) 2,4-D and similar chemicals cause a curl, twist or distortion of new needles and often stunting and distortion of new stems. Affected needles often are clumped together. Later needles become brown, but tend not to be shed immediately.

(b.) Atrazine and similar chemicals cause needles on the entire crown or whole branches to become very light yellow or white with some tip browning. Affected needles shed soon after symptoms appear. Compare with (10), (11).

(13) **Root rot**

Cause: Several fungi particularly *Armillaria mellea*, *Fomes annosus*, *Poria weirii*, *Poria subacida*. The first noticeable symptom is a decline of a few branches on which the foliage thins out and gradually falls. This soon involves the entire crown. The foliage frequently is dwarfed and the crown becomes off-color to yellow. Symptom progression is slow becoming more pronounced during several months to one or two years. Typically, only one tree is affected then surrounding trees become involved. Abnormal resin flow from the lower trunk and/or fungal fans or mats (white, yellow, or brown) beneath or in the bark of the roots and/or lower stem are good diagnostic indicators. Rotted roots also indicate the disease.

Root rots frequently are associated with bark beetle infestations and vice versa. Compare with (14), (15).

(14) **Bark beetle damage**

Cause: The beetles *Dendroctonus* spp., *Ips* spp., *Scolytus* spp. The crown or top of the crown yellows or browns during the growing season. The bark has small, regular holes where beetles emerged. The inner bark and sapwood surface is engraved by the beetles (usually as diverging tunnels). Boring dust accumulates in bark crevices as it falls from the emergence holes and sometimes tubes of pitch project from the holes. Compare with (13), (15).

(15) **Drought damage**

Trees gradually turn yellowish-green, then light brown from the top down and outside in until the tree dies. No insect or fungus will be found associated with these symptoms and ordinarily only individuals will be affected. Shallow rooted species (e.g. cedars) particularly in irrigated areas or on sites with normally high water tables will be affected first. The absence of symptoms or indicators other than a gradually downward decline implies drought damage. Compare with (13), (14).

(16) **Tussock moth damage**

Cause: The insect *Hemerocampa pseudotsugata*. Defoliation during the growing season begins at the top and periphery then works down and in. Needles are eaten by caterpillars which are present during the spring and early summer. Older caterpillars have distinct tufts of brightly colored hairs. Grey cocoons of silk and hairs are present during the late summer and winter. Damage is obvious in late July and August. Douglas firs and true firs are attacked preferentially, but during severe infestations other species are attacked. Compare with (26).

(17) **Atropellis canker**

Cause: The fungus *Atropellis* spp. Part of the top or more usually individual branches yellow then brown. The ensuing dieback progresses slowly down affected stems. A distinct margin can be found between live and dead tissues by repeatedly cutting into bark below the discolored foliage. Wood beneath the dead bark (under cankers) is blue-grey streaked. Small, cup-shaped, black fungus bodies appear on the dead bark over cankered wood. On pines only. Compare with (6), (18), (19).

(18) **White pine blister rust**

Cause: The fungus *Cronartium ribicola*. Part of the top or more usually individual branches yellow then brown. The dieback then does not progress down the affected stems noticeably. At the cankered area on affected stems the bark is discolored yellow to yellow-green (except on older, thick barked limbs) and may appear slightly swollen on small stems. During the spring and early summer powdery, yellow or orange fungal fruiting occurs in the cankered area. Later, a regular pock-marking is visible where this fruiting took place. On 5-needled pines only (white pines, limber pine, sugar pine, whitebark pine and others). Compare with (6), (17), (19).

(19) **Cytospora or Phomopsis cankers**

Causes: The fungi *Cytospora* spp. (*Valsa* spp.) or *Phomopsis* spp. A gradual dieback of the tip progressing down the main stem or more often small branches is expressed by yellow or light-brown foliage. A distinct margin of live wood can be found on affected stems by repeatedly cutting into the bark. Resin flow is common from cankers particularly on large stems. Just beneath the outer bark are embedded tiny black fungal bodies. These are often difficult to see, but are exposed to view by very lightly shaving off the outer bark. Then they appear as black circles in the bark. Compare with (6), (17), (18).

(20) **Cold or winter injury**

At the advent of warm weather in the spring a sudden deep red-brown discoloration of branches or entire trees implies cold injury. The color fades to light brown during the summer. Most winter injury is caused by evaporation of moisture from crowns during sudden warm or windy periods in winter rather than by extreme cold. Particularly common in junipers, ornamental cedars, true firs, or any off-site ornamental. Compare with (11), (12), (13), (15), (21).

(21) **Rodent damage**

Causes: Mice, gophers (*Thomomys* spp.), porcupine (*Erethizon* spp.). Foliage suddenly browns at any time of the year although usually during the spring following winter feeding by rodents. Evidence of rodent gnawing and girdling is usually conspicuous on the affected tree or stem. Compare with (13), (20).

(22) **Fire damage**

Foliage, particularly of thin-barked trees, suddenly browns. This is also associated with bark scorching. The latter may occur inconspicuously at the ground line following a light ground fire. Compare with (13), (20), (21).

(23) **Blights**

Cause: Various fungi esp. *Coryneum* sp., *Phomopsis* sp. Small branches (of arborvitae or junipers) become reddish brown and later fade to grey at which time tiny black pustules can be found on individual leaves of affected stems. Then many small branches drop leaving bare grey stems and holes in the crown. The disease usually begins with one or two limbs being affected and then gradually spreads throughout the crown. Compare with (28).

(24) **Larch needle cast**

Cause: *Hypodermella laricis* or *Meria laricis*. Needles yellow conspicuously during the spring and early summer and later tend to curl and turn light brown. Affected needles often are not cast, but overwinter on the tree. Browened needles have very tiny black fungal bodies scattered on them. On larch only. Compare with (25).

(25) **Larch casebearer damage**

Cause: The insect *Coleophora laricella*. Needles discolor conspicuously during the spring and early summer. Affected needles are hollowed by insect activity and appear bleached. Small caterpillars may be present or may be indicated by small cigar-shaped cases on the twigs during fall and winter weather. On larch only. Compare with (24).

(26) **Spruce budworm**

Cause: The insect *Cacoecia fumiferana*. As new buds open in the spring, tiny caterpillars enter them and hollow them out. As new needles develop they also are fed on. The affected tree appears blighted or scorched at its limb tips where new foliage is destroyed. Later, larvae loosely bind needles together at their tips using silk. These needles are then cut off at their bases to form a shelter of dead needles, bud scales, and frass. In July the insects also form cocoons of silk and dead needles. When severe, the insects may strip entire trees of their foliage. Larvae if present are up to one-inch long and deep brown with yellowish or pale-green warts along the sides. Commonly affects spruces, Douglas fir, true firs. Also see (27).

(27) **Caterpillar-like defoliators**

There are many caterpillar-like insects which may cause partial or complete defoliation of conifers. Only a few important ones like the tussock moth, larch casebearer, and spruce budworm have been described herein.

(28) **Dog damage**

The foliage of outer, lower branches of ornamental small trees and shrubs (esp. junipers) may become progressively yellow and then brown when neighborhood dogs use them as urinals. Compare with (20), (21), (22), (23).

(29) **Iron deficiency**

Foliage on a branch, part of the crown or more often the entire crown becomes distinctly yellow during several years. No insects or fungi are present. When severe, dieback will occur. This is common in irrigated areas of southern Idaho and/or in alkaline soils where iron is unavailable. Common in spruce, juniper, cedar. Compare with (8), (24).

(30) **Prescott scale injury**

Cause: The insect *Matsucoccus vexillorum*. Individual fascicles (bundles) of needles turn light brown in an irregular pattern throughout a limb or crown. When severe, branches or small trees may be killed. At the base of each affected fascicle, between the fascicle and the bark at the acute angle so formed, a tiny dark brown, shiny, scale-like insect will be found on the bark. The insect appears varnished but is difficult to see both because it is hidden by the needle fascicle and because its color is similar to bark. On ponderosa pine only. Compare with (31), (32).

(31) **Elytroderma needle cast**

Cause: The fungus *Elytroderma deformans*. Single branches of ponderosa or lodgepole pine become red-brown in contrast with the remaining crown's normal green. After midsummer the color fades to grey brown or grey so that affected limbs are difficult to see. Trees that die do so by losing a few branches a year. In many trees, a loose clumping of twigs occurs to form loose "witches brooms." In late summer or early fall the foliage thins out on affected limbs and long, black fungal fruiting bodies appear on many of the browned needles. Compare with (30).

(32) **Pine needle scale damage**

Cause: The insect *Chionaspis* sp. and others. Needles of previous growing seasons gradually mottle to a yellowish brown and then turn completely brown. This occurs on scattered individual needles or entire branches, particularly in trees exposed to dust, smoke, or sprays in the atmosphere. Many small white or black scales will be found adhering to affected needles. Common on pines particularly muhgo pine, sometimes on Douglas fir, spruce, or cedar. Compare with (3).

(33) **Needle miner damage**

Cause: The insect *Recurvaria* spp. and others. Individual needles have distinct spots or bands which are first yellow then brown. In each band a tiny grub-like insect may be found. Often the condition occurs only on the lower branches of large trees. Defoliation may occur in small heavily infested trees. Common in pines, Douglas fir, true fir. Compare with (2).

(34) **Needle rusts**

Cause: The fungi *Coleosporium* spp., *Chrysomyxa* spp., *Melampsora* spp., and others. Part or all of individual branches become conspicuously yellow in contrast to the remaining crown during the growing season. When severe the crown may look yellowed. Individual needles have yellow spots or bands within which white, yellow, or orange powdery fungal fruiting is visible. Common on spruces, pines. Occasional on true firs. Compare with (2), (33).

(35) **Wood borer damage**

Cause: Beetles in the Families Buprestidae and Cerambycidae. These insects generally invade dying or felled trees but may attack live trees occasionally. Part or all of the crown of an infested tree browns or yellows during the growing season. Obvious large bore holes usually are present in the bark and do not have mounds of pitch associated. Beneath the bark are large feeding tunnels and/or holes bored into the wood. These may be packed with borings or not. The insect if present is a large, white legless grub with an enlarged "head."

(36) **Root-collar weevil damage**

Cause: The insects *Pissodes* sp. The entire crown of an infested tree yellows and browns during the growing season. Holes appear in the bark of the lower stem. Beneath the bark will be winding or straight tunnels which gradually increase in size and end in a pupal cell. Tunnels are packed with borings and the pupal cells are enveloped by packed, coarse borings. The insect if present is a medium-sized, C-shaped, legless grub. Pines, spruces, and firs are affected only occasionally by these insects.

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Rodent damage	21	13
Root-collar weevil damage	36	15
Root rot	13	11
Spruce budworm	26	13
Tip weevil damage	5	9
Tussock moth damage	16	12
Western gall rust	7	10
White pine blister rust	18	12
Winter injury	20	12
Wood borer damage	35	15