

**DECAY AND STAIN FUNGI
OF NORTH AMERICAN CONIFERS
WITH SPECIAL REFERENCE
TO THE PRAIRIE PROVINCES**

1995

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ABSTRACT

This report describes a comprehensive literature review of major decay (white rot, brown rot, heart rot, butt rot, and root rot) and stain of conifer trees caused by various species of wood decay and stain fungi in North America with special reference to the prairie provinces of Canada. The description of each type of decay and identification of decay and stain causing fungi are also outlined. Attempts were made to isolate and identify decay fungi from conifers. Three species of decay fungi comprising seventeen isolates were made. These included ten isolates of *Armillaria ostoyae*, three isolates of *Fomitopsis pinicola*, and four isolates of *Phellinus pini*. All isolates were deposited in the fungal culture collection at the Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta. A list of fungal cultures at the Northern Forestry Centre that are associated with conifer decay and stain was also made.

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INTRODUCTION

Conifer trees are subjected to various types of decay. Decay of conifer trees is caused by living agents such as bacteria, fungi, insects, and other biotic agents that attack trees to obtain food materials essential to their growth. The development of decay and discoloration in the wood of a tree is a complex and continuous process which merges and overlaps in time and place. Several columns of decay and discoloration may be present in various stages of development at the same time and place. The process of decay and discoloration includes injury to the tree and exposure of injured cells to the air. When the cells are exposed, many different types of microorganisms begin to grow on the wound surface. These microorganisms become active and start digesting the cell walls as the decay process continues. Many species of microorganisms may interact until the wood is completely decomposed. The process of decay may take several years to complete. The severity of loss depends on the relative susceptibility of the tree, the virulence and life history of the causal agents, the environmental and other circumstances that influence the resistance of the host, and growth and reproductive ability of the causal agents. As a result, a particular type of decay may vary in importance between tree species in one region or in the same tree species adjacent region. Young conifer trees are usually not so prone to decay (except for *Armillaria* root rot) as compared to mature and over-mature trees. As trees grow older, several decay fungi attack conifer trees and the damage increases with the age of the trees. The incidence of heart rot in Engelmann spruce in Alberta is observed to be 0% at 60-100 years, 17% at 101-140 years, 30% at 141-180 years, 60% at 221-260 years, and 100% at 301-340 years (Hiratsuka 1987).

The decay fungi belonging to the class Basidiomycetes attack the heartwood, sapwood, root, butt or trunk of the tree (Boyce 1961, CMI 1964, Hepting 1971). The common decay of conifer include white and brown rot, heart rot, pocket rot, stringy rot, butt rot, and cubical rot (Buckland *et al.* 1949, Foster and Foster 1951, Boyce 1961, Baxter 1967, Shigo and Larson 1969, Hepting 1971, Etheridge 1973, Hobbs and Patridge 1979, Wilson and Ogawa 1979, Phillips and Burdekin 1982, Barnard and Dixon 1983, Grand 1985, Sinclair *et al.* 1987). Furthermore, several other fungi cause stain on living trees as well as on felling trees. Hiratsuka (1987) reported the 15 most common decay fungi associated with conifers in the prairie provinces.

Conifer trees with butt rot or root decay have reduced physical strength and can be easily toppled or blown by high wind or the weight of the snow. Certain types of rot such as *Tomentosus* root and butt rot and *Armillaria* root rot kill young as well as older trees and create stand openings. The following are the major decay of conifer trees in the prairie provinces of Canada caused by several species of decay and stain fungi. The objective of this report is to describe and identify decay and stain causing fungal species on conifer trees and to conduct a comprehensive literature search of decay and stain caused by various species of fungi in North America with particular reference to the prairie provinces of Canada.

TYPES OF DECAY

WHITE ROT: White rot is caused by several species of fungi which decompose lignin and hemicellulose first and cellulose later or decompose all wood components at the same time. Thus fungi reduce the wood to a light-colored spongy mass or white rot. Since lignin is decomposed, the affected wood appear white in color. This type of rot contains white pockets or steaks separated by thin areas of firm wood. These fungi attack trees normally resistant to brown-rot fungi. In the prairie provinces, white rot is caused by the following fungi:

i) *Phellinus pini* (Brot.: Fr.) A. Ames. (= *Fomes pini* (Thore:Fr.) Lloyd) or Red Ring Rot. This is the most important decay fungus in the prairie provinces of Canada (Hiratsuka 1987). It attacks a wide range of conifer hosts including Jack pine, lodgepole pine, Sitka and white spruce, Douglas fir, balsam and true fir, western hemlock, and tamarack in North America (Hiley 1919, Percival 1933, Haddow 1938a,b, Foster and Foster 1951, Boyce 1961, Foster and Wallis 1969, Hepting 1971, De Groot 1966, Aho *et al.* 1974, Ryvardeen 1976, 1978, Larsen *et al.* 1978, Blenchette 1980, 1982a,b, Gilbertson 1981, 1986, Gilbertson and Ryvardeen 1986, 1987, Hiratsuka 1987, Myren *et al.* 1994). The fungus causes white pocket trunk rot which results in loss of volume and a decrease in the quality of fibre. The fungus not only decay heartwood, but also attack sapwood and cause tree mortality.

In the early stage of decay, the affected wood becomes reddish to purplish in color. A cross section of the affected wood shows a well-defined ring (hence the name "red ring rot"). In advanced stages of decay, small, spindle-shaped white pockets are formed. According to Basham (1975) and Myren *et al.* (1994), the fungus can also cause considerable volume loss to the middle and upper parts of the butt log and can also move much higher.

The fungus forms perennial fruiting bodies or sporophores on living trees. The shape of the fruiting bodies range from hoof-shaped to flat. The upper surface of the fruiting body is light to dark brown or grayish in color and often has concentric bands running parallel to the outside edge. The margin of a fruiting body is velvety and yellowish brown. The lower surface is light brown and poroid; the pores are irregular in shape. Fruiting bodies sometimes develop next to branch stubs. In the case of heavy infection, sporophores are formed more or less along the length of the bole (Boyce 1961, Baxter 1967, Hepting 1971, Sinclair *et al.* 1987).

ii) *Trichaptum abietinum* (Dickson:Fr.) Ryvardeen [*Hirschioporus abietinus* (Dicks.: Fr.) Donk = *Polyporus abietinus* Dicks.: Fr.] or Purple Conk fungus.

This fungus attacks a wide range of conifer trees and causes white pocket rot or pitted sap rot (Boyce 1961, Baxter 1967, Foster and Wallis 1969, Hepting 1971, Hiratsuka 1987, Sinclair *et al.* 1987). In addition, this fungus also causes heart rot in living trees and also attacks unseasoned wood in the millyard.

In the incipient stage of decay, wood becomes soft and yellow in color. In the advanced stage, small pits develop which may be filled with a white fibrous material at first and become empty later on.

Numerous fruiting bodies or sporophores are formed on dead trees but rarely form on living trees. The fruiting bodies are small, annual, thin, and shelving to resupinate conks. The upper surface

is light gray in color, somewhat hairy and zoned. The lower surface is purple when fresh (hence the name "purple conk") and light brown in color when old.

iii) *Pholiota alnicola* (Fr.) Sing. (= *Flammula alnicola* (Fr.) Quel.

This fungus attacks a wide range of living and dead conifer trees. The fungus degrades lignin, leaving decayed wood whitish in color (Boyce 1961, Baxter 1967, Hepting 1971, Phillips and Burdekin 1982, Hiratsuka 1987).

The sporophores are relatively large mushrooms, often occurring together on living trees as well as on slash. The fresh mushroom is light brown in color and covered with scales. The gills are white, drying to dark brown. The stem is white to light brown and covered with white scales.

iv) *Ganoderma applanatum* (Pers. ex Fr.) Pouzar.

This fungus attacks a wide range of conifer trees in North America (White 1919, Overholts 1923, 1953, Englerth 1942, Childs 1953, Boyce 1961, CMI 1964, Stayaert 1971, 1975, Brown and Merrill 1973, Ryvardeen 1976, 1978, Corner 1983, Mereer and Kirk 1984, Gilbertson and Ryvardeen 1986, 1987, Myren *et al.* 1994). However, the occurrence of this fungus in the prairie provinces is not common. The genus *Ganoderma* causes white rot type of decay, but several species can cause decay in roots, butts, and trunks of living trees. *G. applanatum* causes decay of the butt and the base of the trunk of the tree which often results in breakage.

In the early stage of decay, the wood becomes bleached and is encircled by a dark brown color. In the advanced stage of decay, the wood becomes white, mottled, and spongy (Foster and Wallis 1969).

The fruiting bodies or sporophores are perennial, leathery to woody, and plate-like or flat in structure. The upper surface of the fruiting body is light brown to gray in color and deeply zoned. The context is light brown but may possess a light gray zone. The lower surface is white, brown when bruised.

BROWN ROT: Brown rot is caused by several species of fungi which attack softwoods and can decompose the cell wall polysaccharides (cellulose and hemicellulose), leaving the lignin more or less unaffected. As a result, the rotten wood appears brown in color (Gilbertson 1981). In advanced stages of brown rot, a cubical pattern of cracking and crumbly texture develops. In the prairie provinces, brown rot is caused by the following fungi:

i) *Anisomyces odoratus* (Wulf.:Fr.) Pat. (= *Trametes odoratus* (Wulf.:Fr.) Fr.

This fungus attacks a wide range of conifer trees in North America and also in the prairie provinces of Canada (Fergus 1960, Boyce 1961, Hepting 1971, Gilbertson 1981, Hiratsuka 1987). It reduces loss volume and quality of fibre.

In the early stage of decay, a light brown discoloration in the heartwood can be seen. In the advanced stage of decay, the affected wood becomes brown, fibrous, and stringy mass.

The fungus produces fruiting bodies or small annual shelving conks. The upper surface of the conk is reddish brown to gray in color. The lower surface has tubes.

ii) *Coniophora puteana* (Schum.:Fr.) Karst.

This fungus attacks a number of conifer trees causing brown cubical rot in North America and the prairie provinces in Canada (Furgus 1960, Boyce 1961, Hepting 1971, Blanchard and Tattar 1981, Phillips and Burdekin 1982, Hiratsuka 1987, Myren *et al.* 1994).

In the early stage of decay, the fungus attacks heartwood and causes light brown discoloration on the wood. As decay progress, the affected wood become brown, fibrous, and cubical mass.

The fungus produces fruiting bodies on the wood which are resupinate and effused; fleshy or more or less leathery or membranous. Powdery basidiospores are found on the hymenium.

iii) *Echinodontium tinctorium* (Ell. & Ev.) Ell. & Ev. (= *Fomes tinctorium* Ell. & Ev.) or Indian Paint fungus.

This fungus is one of the most destructive wood-rotting fungus in North America and also in the prairie provinces of Canada (Hiratsuka 1987). The fungus reduces the value of the affected conifer trees (Thomas 1958, Gross 1964, Maloy 1967, Etheridge and Craig 1976, Aho and Filip 1982, Hiratsuka 1987).

In the early stage of decay, the fungus causes light brown or water-soaked stain and rust colored flecks develop in the heartwood. The advanced stage of decay is a brown, fibrous, stringy mass of decayed wood.

The fungus produces perennial fruiting bodies or sporophores on living trees, usually in association with branch stubs. The fungus causes substantial volumes of decay and almost all the heartwood of the tree is rotted. The upper surface of the fruiting body is hoof-shaped, woody, and black in color. The lower surface is gray to light brown in color and has downward-directed spines. The context of the fruiting body is brick-red (hence the name "Indian paint fungus").

iv) *Fomitopsis officinalis* (Vill.:Fr.) Bond & Sing (= *Fomes officinalis* (Vill.:Fr.) Newman or Quinine Conk fungus.

This fungus attacks a wide range of conifer trees in North America as well as in the prairie provinces of Canada (Boyce 1961, Baxter 1967, Hepting 1971, Weaver 1974, Gilbertson 1981, Hiratsuka 1987). In the early stage of decay, the fungus causes light yellow to red-brown or purple stain which may extend a considerable distance beyond the decay. In the advanced stage of decay, the wood breaks into brown cubes.

The fungus forms large (up to 60 cm wide) perennial, hoof-shaped fruiting bodies or sporophores on the wood. The upper surface is distinctly zoned. The young sporophores are white to dark gray and light brown in color when old. The lower surface is poroid and white when young and light brown when dried. The context is white or gray, soft in texture and bitter in taste (hence the name "Quinine conk fungus").

v) Red belt fungus or *Fomitopsis pinicola* (Sw.: Fr.) Karst.(= *Fomes pinicola* Sw.:Fr.).

This fungus is one of the most common decay fungus, attacking a wide range of coniferous tree species (Mounce 1929, Hirt and Eliason 1938, Basham 1957, Gilbertson 1981, Harrington *et al.* 1981, Jurgensen *et al.* 1984, Hiratsuka 1987, Myren *et al.* 1994). The fungus occurs on dead trees

and plays an important role in the forest ecosystem since it reduces wood to forest litter. In certain cases, the fungus attacks heartwood of living trees.

In the early stage of decay, the fungus causes light brown stain on the wood. In the advanced stage of decay, the fungus breaks wood into small cubes and causes crumbly brown cubical rot.

Perennial fruiting bodies or sporophores are usually formed on dead trees but often develop on living trees. Sporophores are usually leathery to woody, hoof-shaped or shelved. The upper surface is usually zoned and dark brown to black in color. The margin is rounded and often red-brown and lighter than other portions of the upper surface (hence the name "red belt fungus"). The lower surface of the sporophore is white to cream color and poroid. The pores are small and regular in outline.

vi) *Gloephyllum saepiarium* (Wulf.:Fr.) Karst.(=*Lenzites saepiarium* (Wulf.: Fr.) Fr. or Slash Conk fungus.

The fungus attacks many coniferous trees and is associated with degradation of fire-killed trees and of slash (hence the name "slash conk fungus").

The early stage of decay appears as a yellow to yellow-brown discoloration in the sapwood or outer heartwood. In the advanced stage of decay, the fungus causes typical brown cubical rot (Boyce 1961, Foster and Wallis 1969, Hepting 1971, Hiratsuka 1987).

The fruiting bodies or sporophores are small, annual, leathery, shelf-like conks. The upper surface is rough, light to dark cinnamon brown in color and zoned. The lower surface is light brown and contains radiating thin gills.

vii) *Phaeolus schweinitzii* (Fr.) Pat. (= *Polyporus schweinitzii* Fr.) or Velvet Top fungus.

The fungus attacks a wide variety of conifer trees in North America and also in the prairie provinces of Canada (York *et al.* 1936, Wean 1937, Barrett 1985, Barrett and Greig 1985, Barrett and Uscuplic 1971, Dewey *et al.* 1984). The fungus develops within the heartwood of the roots and butt causing brown cubical rot or red brown butt rot. The decay can be extended upwards as high as 3 meters. The conifer trees infected by this fungus results in a considerable loss in volume and trees are prone to wind-throw (Boyce 1961, Baxter 1967, Hepting 1971, Blakeslee and Oak 1980, Myren *et al.* 1994).

The fungus produces annual shelf- or funnel-like fruiting bodies or sporophores. The fruiting bodies are formed with or without central stalk. The upper surface of the fruiting body is velvety and dark reddish-brown in color. The lower surface is yellowish green, darkens when bruised and is poroid. As fungus causes advance decay, the color of the wood become dark reddish-brown and break into cubical blocks.

viii) *Serpula himantioides* (Fr.) Bond. (= *Merulius himantioides* Fr.).

The fungus attacks a wide range of conifer trees (Boyce 1961, Foster and Wallis 1969, Hepting 1971, Gilbertson 1981, Hiratsuka 1987). It develops within the heartwood causing brown cubical rot. Infected trees suffer a considerable loss in volume.

Fruiting bodies or basidiocarps develop on bark or wood in resupinate patches and are shell-like, membranous, floccose, or fleshy. The hymenial surface is irregularly folded, brown to raw umber and the margin is cream in color.

ix) *Laetiporus sulphureus* (Bull.:Fr.) Murr. (= *Polyporus sulphureus* Bull. ex Fr.) or Sulphur Fungus.

This fungus causes brown cubical trunk rot and attacks a wide range of coniferous trees (Boyce 1961, Baxter 1967, Foster and Wallis 1969, Hepting 1971, Gilbertson 1981). In the prairie provinces of Canada, the fungus is not common.

In the early stage of decay, the fungus causes light brown stain on the wood. Later on, wood breaks into small brown cubes. Thick, white fungal mycelial felts can be seen on the decayed wood.

The fruiting bodies or sporophores are annual, large, spongy, or leathery. The upper surface is orange-yellow, the context is white and the lower surface is sulphur-yellow in color (hence the name "sulphur fungus") and has regular pores.

x) *Columnocystis abietina* (Pers. ex Fr.) Pouzar (= *Stereum abietinum* [Pers. ex Fr.] Fr.).

This fungus infects certain conifer trees such as western hemlock and the true firs (Boyce 1961, Baxter 1967, Foster and Wallis 1969, Hepting 1971, Gilbertson 1981). In the prairie provinces of Canada, the occurrence of this fungus is rare.

The fungus causes trunk rot and it also causes decay in unseasoned timber. This fungus is responsible for causing brown cubical pocket rot on the wood.

In the early stage of decay, the fungus causes dark brown or black color in the wood that occurs in streaks or patches. In the advanced stage of decay, small pockets develop which coalesce, forming a continuous column of decay. The decay is soft and friable and is usually associated with dark color, thin cobweb-like structures that contain mass of fungal mycelia.

The fruiting bodies or sporophores are small and shelf-like in structure. The lower surface is rough, and gray to brown in color. The upper surface is dark brown to black and the context is brown in color.

ROOT ROT: Root rot fungi attack underground parts of the plant or root collar and kill major roots. The infection can also move upwards (about a meter) and fungi kill the cambium and outer layers of wood and cause decay of the softwood and hardwood of the infected root and root collar. The aboveground parts of affected trees show symptoms of reduced or stunted growth, yellowish leaves, dieback of twigs and branches, and gradual or sudden death of the tree.

i) *Armillaria root rot:*

This disease is one of the most important diseases of young trees in natural regeneration and plantations of conifers (Thomas 1934, Bliss 1946, Rhoads 1950, 1956, Raabe 1962, 1965, 1972, 1979a,b, Leaphart 1963, Gibson and Corbett 1964, Boyce Jr. 1967, Barrett 1970, Ross 1970, Hepting 1971, Wargo and Houston 1974, Wargo 1977, 1981, Rishbeth 1978a,b, 1979, Patton 1978, Anderson *et al.* 1980, Lung-Escarmant and Dunez 1980, Blanchard and Tattar 1981,

Munnecke *et al.* 1981, Shigo and Tippett 1981, Morrison 1981, 1982, Walting *et al.* 1982, Morrison *et al.* 1985, Roll-Hansen 1985, Hiratsuka 1987, and Myren *et al.* 1994). *Armillaria* root rot is caused by many distinct species of *Armillaria* (Shaw and Roth 1976, Shaw and Kile 1991). The most important species causing high mortality of conifers in the prairie provinces is *A. ostoyae* (Romag.) Herink. (= *A. obscura* (Pers.) Herink).

Armillaria root rot is common in the prairie provinces of Canada and the fungus attacks both hardwood and coniferous trees (Hiratsuka 1987, Mallett 1985, 1990, 1991, 1992, Mallett and Hiratsuka 1985, 1988, Mallett and Volney 1990). The important hosts of *A. ostoyae* are lodgepole pine, Jack pine, red pine, white spruce, black spruce, and Engelmann spruce. Infected trees may occur singly or in groups. In plantations, infected trees are frequently found in close proximity to the older or decaying stumps. The fungus causes gradual or sudden reduction in growth. Bright reddish-brown or yellowish discoloration of foliage over the entire tree and resinosis around the root collar can be seen. Between the bark and wood around the base of infected trees, white, radiating mycelial fans are formed. On decayed wood or in the soil surrounding the diseased roots, dark brown or black fungal strands called rhizomorphs or shoestrings are also formed. In larger trees, the disease causes spongy root and butt rot with many fine, black zone lines. Trees under stress are highly susceptible although healthy and vigorous trees are also affected.

In the late summer or fall, the fruiting bodies or mushrooms are formed which usually develop in clusters at the base of an infected tree. The mushrooms have a honey-colored cap with dark scales and white gills, a yellow-brown or rusty-tinged stem and an inconspicuous ring surrounding the upper portion of the stem.

ii) *Heterobasidion annosum* (Fr. : Fr.) Bref. or *Fomes* root rot.

The fungus is common throughout North America (Hiley 1919, Rishbeth 1951, 1979, Sinclair 1964, Shain 1967, Hodges 1969, Hodges *et al.* 1970, 1971, Ross 1973, Kuhlman 1974, Kuhlman *et al.* 1976, Alexander *et al.* 1975, Hunt 1976, Ryvarden 1976, 1978, Froelich *et al.* 1977, Shigo 1979, Worrall *et al.* 1983, Gilbertson and Ryvarden 1986, 1987, Myren *et al.* 1994). In the prairie provinces, the incidence of this fungus is not common.

The fungus gains entry to trees on the exposed surface of freshly cut stumps and on wounds. The fungus causes butt rot of mature conifer trees and seriously affects the growth and survival of plantations of young forests. It also causes mortality of larger and young conifer seedlings. Infected trees are prone to wind-throw. The fungus attacks the lower stem and causes significant volume loss.

The early stage of decay appears as a yellow-brown to red-brown stain on the wood. The wood is reduced to a white stringy or spongy mass containing numerous small black flecks. In the advanced stage of decay, the wood is completely decayed, leaving a hollow butt.

The fungus forms woody to leathery perennial fruiting bodies or sporophores which vary from effused-reflexed to bracket-like structures. The lower surface is cream to white in color and is poroid. The pores are small and regular in outline. The context is cream to white in color. Usually the fruiting bodies are not seen in the living trees. They are formed on dead roots, old stumps, slash or upturned roots.

iii) *Inonotus tomentosus* (Fr.) Gilbertson (= *Polyporus tomentosus* Fr.) or Tomentosus root and butt rot.

This fungus attacks a wide variety of living and dead conifer trees (Haddow 1941, Huntly *et al.* 1961, Whitney 1962, 1966, 1977, Myren and Patton 1971, Bohaychuk and Whitney 1973, Gilbertson 1976, Ryvardeen 1976, 1978, Whitney and Bohaychuk 1976, Hiratsuka 1987, Myren *et al.* 1994) It causes a white pocket rot in the roots and lower stem of the host. The decay can extend upwards as much as 2 meters causing considerable volume loss in the butt log (Whitney 1962, 1977). Since this fungus attacks the root, it results in reduced growth, mortality, and is eventually blown away by the wind.

The fungus causes decay as red stain and later on small pockets develop which are lined with white fibre. From the infected roots, flow of resin can be seen.

The fungus forms numerous fruiting bodies or sporophores on the trunk of the host. Sporophores are usually tan to yellow-brown in color and velvety on the upper surface. The lower surface is tan to brown in color and is poroid.

iv) *Phellinus weirii* Murr. (= *Poria weirii* Murr.) or Laminated root rot.

The fungus is very common in western Canada and Pacific Northwest (Boyce 1961, Baxter 1967, Foster and Wallis 1969, Hepting 1971, Gilbertson 1981). The fungus causes root rot in both young and older trees. In the prairie provinces of Canada, the fungus is not common.

Usually, diseased trees occur in groups which enlarge from a focal point. The fungus causes reduced growth, thinning, and yellowing of the needles. White colored mycelia can be seen on the bark at the root collar and on roots. The infected trees are susceptible to wind-throw.

The fungus causes red-brown stain in the outer heartwood. Infection may also continue up to 1-2 meters up the bole of the living trees. As decay progress, the stain wood becomes soft, pit-like in appearance, and annual rings separate to form a typical laminate decay (hence the name "laminated root rot"). A brown mass of fungal mycelia can be seen between the sheets of decayed wood (Buckland *et al.* 1949, 1954, Wallis and Reynolds 1965, Childs 1970, Wallis 1976, Bloomberg and Wallis 1979, Filip and Schmitt 1979, Hobbs and Patridge 1979, Goheen and Filip 1980, McCauley and Cook 1980, Nelson *et al.* 1981, Wallis and Bloomberg 1981, Bloomberg and Reynolds 1982, Thies 1983, Oren *et al.* 1985).

The fungus forms brown, crust-like fruiting bodies or sporophores on the undersides of decayed logs or roots. When fresh, the fruiting bodies are light buff with a white margin. Older fruiting bodies are brown in color. The lower surface of the fruiting bodies is poroid which are regular in outline.

v) *Hericiium abietis* (Weir. ex Hubert) K. Harrison.

The fungus is common throughout North America (Boyce 1961, Foster and Wallis 1969, Hepting 1971, Gilbertson 1981). It causes butt and trunk rot of certain conifer trees such as western hemlock, true firs, and Sitka spruce.

In the early stage of decay, the fungus causes yellow to brown heartwood stain. Later on, elongated pits are formed that contain fungal mycelia. The rot is similar to red ring rot (caused by *Phellinus pini*) but with *H. abietis*, the pits are usually longer and have blunt ends and decay is irregular.

The fruiting bodies or sporophores are annual, soft, fleshy, short-lived, and white in color. The fruiting bodies are characterized by a large number of downward-directed spines, produced on a much branched fleshy stalk. The fruiting bodies are usually found on the ends of cut logs, but they may also form on wounds on living trees.

HEART ROT: This type of decay is caused by the fungi that infects only the heartwood of the tree leaving softwood more or less intact (Kimmey and Bynum 1961, Kimmey 1964, 1965). Only one fungus is found to be responsible for causing heart rot on conifer trees in the prairie provinces of Canada (Hiratsuka 1987).

***Haematostereum sanguinolentum* (Alb. & Schw.:Fr.) Pouzar (= *Stereum sanguinolentum* Alb. & Schw.: Fr.) or Bleeding fungus or Bleeding Stereum.**

This fungus causes red heart rot in many conifer trees in North America and in the prairie provinces of Canada (Boyce 1961, Foster and Wallis 1969, Hepting 1971, Hiratsuka 1987). In certain conifer trees, the fungus is responsible for heartwood stain and terminal dieback while in other hosts, it is a slash-destroyer.

The early stage of decay is firm and heartwood becomes red-brown in color. In the advanced stage, the wood turns soft and friable in texture and light brown to red-brown in color.

Annual, leathery, and resupinate fruiting bodies or sporophores are formed on the lower surface of fallen dead branches, or log ends. The upper surface is gray to light brown in color and zoned; the lower surface is gray to light brown, turning blood-red when bruised (hence the name "bleeding fungus").

STAIN: Stain in conifer trees is caused by various biotic (bacteria and fungi) and abiotic agents (Boyce 1961, Shigo and Larson 1969, Hepting 1971). There is only one fungus reported to cause stain on both standing as well as felling conifer trees in the prairie provinces of Canada (Hiratsuka 1987).

***Peniophora pseudo-pini* Weres. & Gibson.**

This fungus attacks a wide range of conifer trees. The fungus does not cause advance decay but causes discoloration of the wood. The affected heartwood and rays become pink to red in color (Hiratsuka 1987).

The fruiting bodies of the fungus is basidiocarps that occurs on bark or decorticated wood and is resupinate, effused, leathery to dry and brittle. The hymenial surface is even, granular or cracked and is variously colored.

CONCLUSION

A number of fungi cause decay and stain of conifers in Alberta. These fungi can cause significant reduction of conifer utilization in Alberta. More research is necessary in order to understand the biology, pathology, interactions of decay and stain fungi, and to develop effective control measures.

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APPENDIX 1

ISOLATION AND IDENTIFICATION OF DECAY FUNGI FROM CONIFER WOODS

Decay fungi were isolated on acidified malt extract agar containing 20 g malt extract, 15 g agar, 1 L distilled water, and 10 mL lactic acid. The lactic acid was added after autoclaving. The infected tissue was removed from the wood and plated on nutrient medium. The fungi were identified based on their morphological, cultural, and microscopical characters. The fungi were deposited in the fungal culture collection at the Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta (NOF) and maintained at 5°C in McCartney bottles. The following isolates were deposited: ten isolates of *Armillaria ostoyae*, three isolates of *Fomitopsis pinicola* and four isolates of *Phellinus pini*.

APPENDIX 2

LIST OF FUNGAL CULTURES DEPOSITED AT THE NORTHERN FORESTRY CENTRE, EDMONTON, ALBERTA

The culture collection of Northern Forestry Centre, Canadian Forestry Service has the following isolates of decay and stain fungi of conifer trees:

Amylocystis lapponica (Rom.) Singer [= *Polyporus lapponicus* (Rom.) Sing.]

NOF-89 *Picea engelmannii*

Antrodia heteromorpha (Fr.:Fr.) Donk [= *Trametes heteromorpha* (Fr.:Fr.) Bres.]

NOF-71 *Picea glauca*

Antrodia serialis (Fr.:Fr.) Donk [= *Trametes serialis* (Fr.:Fr.) Fr.]

NOF-19 *Picea sitchensis*

NOF-20 *Tsuga* sp.

NOF-128 *Picea glauca*

NOF-192 *Pseudotsuga taxifolia*

Antrodia sinuosa (Fr.:Fr.) P. Karst [= *Poria sinuosa* (Fr.:Fr.) Cooke]:

NOF-598 *Pinus glauca*

Antrodia xantha (Fr.:Fr.) Ryvarden [= *Poria xantha* (Fr.:Fr.) Cooke]:

NOF-77 *Pinus contorta* var. *latifolia*

NOF-219 *Pseudotsuga taxifolia*

***Armillaria* (Vahl ex Fr.) Kummer:**

NOF-109	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-612	<i>Pinus monticola</i>
NOF-613	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-615	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-616	<i>Tsuga heterophylla</i>
NOF-617	<i>Pseudotsuga menziesii</i>
NOF-618	<i>Pinus radiata</i>
NOF-620	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-621	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-622	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-623	<i>Larix occidentalis</i>
NOF-624	<i>Pinus ponderosa</i>
NOF-625	<i>Pinus muricata</i>
NOF-626	<i>Pinus monticola</i>
NOF-627	<i>Pinus sylvestris</i>
NOF-628	<i>Pinus resinosa</i>
NOF-631	<i>Picea glauca</i>
NOF-632	<i>Abies amabilis</i>
NOF-633	<i>Abies lasiocarpa</i>
NOF-734	<i>Pseudotsuga menziesii</i>
NOF-738	<i>Pinus sylvestris</i>
NOF-739	<i>Pinus sylvestris</i>
NOF-746	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-748	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-750	<i>Pinus banksiana</i>
NOF-752	<i>Pinus resinosa</i>
NOF-753	<i>Abies balsamea</i>
NOF-754	<i>Pinus banksiana</i>
NOF-755	<i>Abies balsamea</i>
NOF-756	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-757	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-759	<i>Pinus resinosa</i>
NOF-760	<i>Abies balsamea</i>
NOF-761	<i>Picea sitchensis</i>
NOF-762	<i>Picea glauca</i>
NOF-763	<i>Picea glauca</i>
NOF-764	<i>Picea glauca</i>
NOF-765	<i>Picea sitchensis</i>
NOF-766	<i>Picea sitchensis</i>
NOF-767	<i>Picea sitchensis</i>
NOF-768	<i>Picea abies</i>
NOF-769	<i>Picea rubra</i>
NOF-771	<i>Picea mariana</i>
NOF-807	<i>Tsuga heterophylla</i>

NOF-809	<i>Pinus resinosa</i>
NOF-824	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-825	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-826	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-827	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-828	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-829	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-830	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-831	<i>Pinus banksiana</i>
NOF-832	<i>Pinus banksiana</i>
NOF-833	<i>Pinus resinosa</i>
NOF-834	<i>Pinus resinosa</i>
NOF-835	<i>Pinus resinosa</i>
NOF-836	<i>Pinus resinosa</i>
NOF-859	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-876	<i>Pseudotsuga menziesii</i>
NOF-877	<i>Cupressus funchris</i>
NOF-898	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-899	<i>Picea mariana</i>
NOF-900	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-902	<i>Abies balsamea</i>
NOF-903	<i>Abies balsamea</i>
NOF-904	<i>Pinus banksiana</i>
NOF-906	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-908	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-909	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-910	<i>Abies balsamea</i>
NOF-911	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-913	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-915	<i>Abies balsamea</i>
NOF-919	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-920	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-921	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-922	<i>Abies</i> sp.
NOF-923	<i>Pinus banksiana</i>
NOF-926	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-928	<i>Picea glauca</i>
NOF-929	<i>Abies</i> sp.
NOF-931	<i>Picea glauca</i>
NOF-932	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-934	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-939	<i>Abies balsamea</i>
NOF-987	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-988	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-989	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-990	<i>Pinus contorta</i> var. <i>latifolia</i>

NOF-991	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-992	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-993	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-994	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-995	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-996	<i>Pinus resinosa</i>
NOF-997	<i>Pinus resinosa</i>
NOF-998	<i>Pinus resinosa</i>
NOF-999	<i>Pinus resinosa</i>
NOF-1003	<i>Picea glauca</i>
NOF-1004	<i>Picea glauca</i>
NOF-1005	<i>Picea glauca</i>
NOF-1007	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1008	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1009	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1010	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1011	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1012	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1013	<i>Pinus resinosa</i>
NOF-1014	<i>Pinus banksiana</i>
NOF-1015	<i>Pinus banksiana</i>
NOF-1016	<i>Pinus resinosa</i>
NOF-1017	<i>Pinus resinosa</i>
NOF-1018	<i>Pinus resinosa</i>
NOF-1019	<i>Pinus resinosa</i>
NOF-1020	<i>Pinus resinosa</i>
NOF-1021	<i>Pinus resinosa</i>
NOF-1022	<i>Pinus resinosa</i>
NOF-1023	<i>Abies balsamea</i>
NOF-1024	<i>Picea glauca</i>
NOF-1025	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1026	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1027	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1028	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1029	<i>Picea glauca</i>
NOF-1030	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1031	<i>Abies lasiocarpa</i>
NOF-1031	<i>Abies lasiocarpa</i>
NOF-1032	<i>Abies lasiocarpa</i>
NOF-1033	<i>Abies lasiocarpa</i>
NOF-1034	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1035	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1036	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1037	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1038	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1039	<i>Pinus contorta</i> var. <i>latifolia</i>

NOF-1040	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1041	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1042	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1044	<i>Pinus banksiana</i>
NOF-1045	<i>Pinus banksiana</i>
NOF-1046	<i>Abies lasiocarpa</i>
NOF-1047	<i>Abies lasiocarpa</i>
NOF-1048	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1049	<i>Abies lasiocarpa</i>
NOF-1050	<i>Pinus banksiana</i>
NOF-1051	<i>Pinus contorta</i>
NOF-1052	<i>Pinus sylvestris</i>
NOF-1062	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1064	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1066	<i>Pinus banksiana</i>
NOF-1067	<i>Pinus banksiana</i>
NOF-1068	<i>Pinus banksiana</i>
NOF-1069	<i>Pinus banksiana</i>
NOF-1070	<i>Pinus banksiana</i>
NOF-1071	<i>Pinus banksiana</i>
NOF-1072	<i>Pinus banksiana</i>
NOF-1073	<i>Pinus banksiana</i>
NOF-1074	<i>Pinus banksiana</i>
NOF-1076	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1077	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1081	<i>Picea glauca</i>
NOF-1082	<i>Abies lasiocarpa</i>
NOF-1083	<i>Abies lasiocarpa</i>
NOF-1084	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1085	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1086	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1087	<i>Abies lasiocarpa</i>
NOF-1088	<i>Abies lasiocarpa</i>
NOF-1090	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1091	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1091	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1092	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1093	<i>Abies lasiocarpa</i>
NOF-1094	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1097	<i>Pinus banksiana</i>
NOF-1098	<i>Pinus banksiana</i>
NOF-1099	<i>Pinus banksiana</i>
NOF-1100	<i>Pinus banksiana</i>
NOF-1101	<i>Pinus banksiana</i>
NOF-1102	<i>Pinus resinosa</i>
NOF-1103	<i>Abies balsamea</i>

NOF-1104	<i>Abies balsamea</i>
NOF-1105	<i>Picea glauca</i>
NOF-1106	<i>Pinus banksiana</i>
NOF-1107	<i>Picea glauca</i>
NOF-1108	<i>Pinus banksiana</i>
NOF-1109	<i>Picea glauca</i>
NOF-1110	<i>Pinus banksiana</i>
NOF-1111	<i>Pinus banksiana</i>
NOF-1112	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1113	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1136	<i>Abies lasiocarpa</i> stump
NOF-1137	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1138	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1139	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1140	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1141	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1144	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1145	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1146	<i>Pinus contorta</i> var. <i>latifolia</i> stump
NOF-1147	Dead wood of <i>Abies balsamea</i>
NOF-1148	Dead wood of <i>Abies balsamea</i>
NOF-1151	<i>Pinus banksiana</i> stump
NOF-1152	<i>Pinus banksiana</i> stump
NOF-1153	<i>Pinus banksiana</i> stump
NOF-1154	<i>Pinus banksiana</i> stump
NOF-1155	<i>Pinus banksiana</i> stump
NOF-1156	<i>Pinus banksiana</i> stump
NOF-1157	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1158	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1159	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1162	<i>Picea glauca</i>
NOF-1164	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1165	<i>Abies balsamea</i>
NOF-1167	<i>Picea glauca</i>
NOF-1168	<i>Abies balsamea</i>
NOF-1169	<i>Picea glauca</i>
NOF-1170	<i>Picea glauca</i>
NOF-1173	<i>Abies balsamea</i>
NOF-1175	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1176	<i>Abies balsamea</i>
NOF-1177	<i>Picea glauca</i>
NOF-1178	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1179	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1180	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1181	<i>Picea glauca</i>
NOF-1182	<i>Picea glauca</i>

NOF-1183	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1184	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1186	<i>Pinus banksiana</i>
NOF-1187	<i>Abies balsamea</i>
NOF-1188	<i>Abies lasiocarpa</i>
NOF-1239	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1240	<i>Pinus banksiana</i>
NOF-1241	<i>Pinus banksiana</i>
NOF-1242	<i>Pinus banksiana</i>
NOF-1243	<i>Pinus banksiana</i>
NOF-1246	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1248	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1249	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1250	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1252	<i>Picea glauca</i>
NOF-1255	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1257	<i>Abies balsamea</i>
NOF-1258	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1259	<i>Abies balsamea</i>
NOF-1260	<i>Picea glauca</i>
NOF-1261	<i>Picea glauca</i>
NOF-1262	<i>Pinus banksiana</i>
NOF-1263	<i>Pinus banksiana</i>
NOF-1264	<i>Abies balsamea</i>
NOF-1265	<i>Pinus banksiana</i>
NOF-1266	<i>Pinus banksiana</i>
NOF-1267	<i>Pinus banksiana</i>
NOF-1268	<i>Pinus banksiana</i>
NOF-1270	<i>Picea glauca</i>
NOF-1271	<i>Abies balsamea</i>
NOF-1272	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1273	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1274	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1275	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1276	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1277	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1278	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1279	<i>Pinus banksiana</i>
NOF-1463	<i>Abies balsamea</i>

Armillaria obscura (Sercr.) Rom.:

NOF-872	<i>Pinus sylvestris</i>
NOF-874	<i>Pinus sylvestris</i>
NOF-875	<i>Pinus sylvestris</i>

***Armillaria ostoyae* (Romagn.) Herink:**

NOF-1488	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1489	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1961	<i>Pinus banksiana</i>
NOF-1962	<i>Pinus resinosa</i>
NOF-1963	<i>Pinus resinosa</i>
NOF-1964	<i>Pinus resinosa</i>
NOF-1965	<i>Pinus resinosa</i>
NOF-1966	<i>Pinus resinosa</i>
NOF-1967	<i>Pinus resinosa</i>
NOF-1968	<i>Pinus resinosa</i>
NOF-1969	<i>Pinus resinosa</i>
NOF-1970	<i>Pinus resinosa</i>
NOF-1971	<i>Pinus resinosa</i>
NOF-1972	<i>Pinus resinosa</i>
NOF-1973	<i>Pinus resinosa</i>
NOF-1974	<i>Pinus resinosa</i>
NOF-1975	<i>Pinus resinosa</i>
NOF-1976	<i>Pinus resinosa</i>
NOF-1977	<i>Pinus resinosa</i>
NOF-1978	<i>Pinus resinosa</i>
NOF-1979	<i>Pinus resinosa</i>
NOF-1980	<i>Pinus resinosa</i>
NOF-1981	<i>Pinus resinosa</i>
NOF-1982	<i>Pinus resinosa</i>
NOF-1983	<i>Pinus resinosa</i>
NOF-1984	<i>Pinus resinosa</i>
NOF-1985	<i>Pinus resinosa</i>
NOF-2218	<i>Picea glauca</i>
NOF-2219	<i>Picea glauca</i>
NOF-2220	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2221	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2222	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2223	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2224	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2225	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2226	<i>Pinus contorta</i> var. <i>latifolia</i>

***Armillaria* sp.:**

NOF-1490	<i>Abies balsamea</i>
NOF-1493	<i>Abies balsamea</i>
NOF-2005	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-2006	<i>Larix siberica</i>
NOF-2010	<i>Abies balsamea</i>

***Ceratocystiopsis minuta-bicolor* (Davids.) Upadhyay and Kendrick:**

NOF-1200	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1201	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1202	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1203	<i>Pinus contorta</i> var. <i>latifolia</i>

***Ceratocystis piceaperdas* (Rumbold) Moreau (= *Ceratocystis europhioides* Wright & Cain):**

NOF-555	<i>Picea mariana</i>
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***Ceratocystis* sp.:**

NOF-1218	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1406	<i>Pinus contorta</i> var. <i>latifolia</i>

***Condrostereum purpureum* (Pers. ex Fr.):**

NOF-166	<i>Pseudotsuga taxifolia</i>
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***Coniophora puteana* (Schum. ex Fr.) Karst:**

NOF-4	<i>Picea mariana</i>
NOF-94	<i>Picea glauca</i>
NOF-95	<i>Picea glauca</i>
NOF-221	<i>Picea glauca</i>

***Cryptoporus volvatus* (Peck) Shear (= *Polyporus volvatus* Peck):**

NOF-549	<i>Pinus contorta</i> var. <i>latifolia</i>
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***Dichomitus squalens* (P. Karst.) D. Reig. [= *Polyporus anceps* Peck.]:**

NOF-50	<i>Pseudotsuga taxifolia</i>
NOF-60	Conifer log
NOF-99	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-269	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-287	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-406	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-604	<i>Pinus ponderosa</i>

***Echinodontium tinctorium* (Ell. and Ev.) Ell. & Ev.:**

NOF-25	<i>Abies lasiocarpa</i>
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***Fomitopsis cajanderi* (P. Karst.) Kotlaba & Pouzar (=Fomes cajanderi Weir):**

NOF-40	<i>Picea glauca</i>
NOF-47	<i>Picea</i> sp.
NOF-75	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-79	<i>Picea glauca</i>

***Fomitopsis officinalis* (Vill.:Fr.) Bond. & Sing:**

NOF-216	<i>Pseudotsuga taxifolia</i>
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***Fomitopsis pinicola* (Sw.:Fr.) P. Karst:**

NOF-10	<i>Picea sitchensis</i>
NOF-11	<i>Tsuga heterophylla</i>
NOF-37	Unknown coniferous log
NOF-183	<i>Picea glauca</i>
NOF-607	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1453	<i>Abies lasiocarpa</i>
NOF-1472	<i>Picea glauca</i>
NOF-2227	<i>Picea glauca</i>
NOF-2228	<i>Picea glauca</i>
NOF-2229	<i>Picea glauca</i>

***Fomitopsis rosea* (Alb. & Sch.:Fr.) P. Karst:**

NOF-39	<i>Picea glauca</i>
NOF-46	Unknown

***Gloeophyllum saepiarium* (Wulf. ex Fr.) Fr.:**

NOF-23	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-42	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-235	<i>Pinus contorta</i> var. <i>latifolia</i>

***Heterobasidion annosum* (Fr.:Fr.) Bref. [=Fomes annosus (Fr.) Cke.:**

NOF-297	<i>Pinus sylvestris</i>
NOF-298	<i>Pseudotsuga taxifolia</i>
NOF-596	<i>Thuja plicata</i>
NOF-601	<i>Abies amabilis</i>
NOF-602	<i>Pseudotsuga menziesii</i>

***Hyphoderma setigerum* (Fr.) Donk [=Peniophora setigera (Fr.) Hoehn & Lit.]:**

NOF-233 *Pinus contorta* var. *latifolia*
NOF-290 *Pinus contorta* var. *latifolia*

***Inonotus tomentosus* (Fr.) Gilb.:**

NOF-14 *Picea glauca*
NOF-15 *Picea glauca*
NOF-16 *Picea rubra*
NOF-41 *Picea engelmannii*
NOF-299 *Larix lyalli*
NOF-311 *Picea engelmannii*
NOF-312 *Picea glauca*
NOF-313 *Picea glauca*
NOF-532 Unknown
NOF-533 *Picea mariana*
NOF-534 Unknown
NOF-535 *Picea glauca*
NOF-536 *Pinus strobus*
NOF-539 *Picea mariana*
NOF-540 *Picea glauca*
NOF-541 *Picea glauca*
NOF-542 *Picea glauca*
NOF-543 *Picea glauca*
NOF-545 *Picea sitchensis*
NOF-545 *Picea glauca*

***Junghuhnia collabens* (Fr.) Ryvar den [=Poria rixosa (P. Karst) P. Karst.]:**

NOF-176 *Pinus banksiana*
NOF-178 Conifer log

***Laurilla sulcata* (Burt.) Pouzar [=Echinodontium sulcatum (Burt.) H. Gross]:**

NOF-63 *Picea glauca*
NOF-64 *Abies* sp.
NOF-182 *Picea engelmannii*

***Meruliopsis ambiguus* (Berk.) Ginns. (=Merulius ambiguus Berk.):**

NOF-108 *Pinus contorta* var. *latifolia*
NOF-338 *Pinus contorta* var. *latifolia*

***Ophiostoma clavigerum* (Robinson-Jeffrey & R.W. Davidson) T.C. Harrington [= *Ceratocystis clavigera* (R.Jeff. & Davis) Upadhyay:**

NOF-837	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-838	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-841	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-842	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-843	Unknown
NOF-1215	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1216	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1217	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1280	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1281	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1282	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1283	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1398	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1418	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1419	<i>Pinus contorta</i> var. <i>latifolia</i>

***Ophiostoma huntii* (Robinson-Jeffrey) De Hoog & R.J. Scheffer (= *Ceratocystis huntii* Robinson):**

NOF-451	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-840	<i>Pinus contorta</i> var. <i>latifolia</i>

***Ophiostoma ips* (Rumb.) Nannf. [= *Ceratocystis ips* (Rumb.) Moreau = *Ceratocystis montia* Rumb.]:**

NOF-450	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-554	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-684	Unknown
NOF-685	Unknown
NOF-852	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1204	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1205	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1206	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1207	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1208	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1209	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1284	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-1420	<i>Pinus contorta</i> var. <i>latifolia</i>

***Ophiostoma minus* (Hedge.) Syd. & P. Syd. [= *Ceratocystis minor* (Hedge.) Hunt.]:**

NOF-248	<i>Pinus contorta</i> var. <i>latifolia</i>
NOF-262	<i>Pinus contorta</i> var. <i>latifolia</i>

NOF-342 *Pinus contorta* var. *latifolia*
NOF-839 *Pinus contorta* var. *latifolia*
NOF-844 *Pinus contorta* var. *latifolia*
NOF-845 *Pinus flexilis*

***Ophiostoma stenoceras* (Robak) Melin & Nannf. [=*Ceratocystis stenoceras* (Robak) C. Moreau:**

NOF-1210 *Pinus contorta* var. *latifolia*
NOF-1211 *Pinus contorta* var. *latifolia*
NOF-1212 *Pinus contorta* var. *latifolia*
NOF-1214 *Pinus contorta* var. *latifolia*

***Ostenia obducta* (Berk.) Donk (= *Polyporus osseus* Kal.):**

NOF-17 *Pseudotsuga taxifolia*

***Peniophora pseudo-pini* Weres. & Gibson:**

NOF-114 *Pinus contorta* var. *latifolia*
NOF-125 *Pinus contorta* var. *latifolia*
NOF-126 *Pinus contorta* var. *latifolia*
NOF-186 *Pinus sylvestris*
NOF-191 *Pinus contorta* var. *latifolia*
NOF-237 *Pinus contorta* var. *latifolia*
NOF-264 *Pinus contorta* var. *latifolia*
NOF-267 *Pinus contorta* var. *latifolia*
NOF-272 *Pinus contorta* var. *latifolia*
NOF-282 *Pinus contorta* var. *latifolia*
NOF-283 *Pinus contorta* var. *latifolia*
NOF-452 *Pinus contorta* var. *latifolia*
NOF-453 *Pinus contorta* var. *latifolia*
NOF-455 *Pinus contorta* var. *latifolia*

***Peniophora septentrionalis* Laurila:**

NOF-69 *Picea glauca*
NOF-70 *Picea glauca*
NOF-116 *Picea glauca*
NOF-117 *Picea engelmannii*
NOF-238 *Pinus contorta* var. *latifolia*
NOF-244 *Picea glauca*
NOF-302 *Picea glauca*
NOF-332 *Picea mariana*
NOF-405 *Picea glauca*

***Phaeolus schweinitzii* (Fr.) Pat.:**

NOF-44 *Pinus strobus*

***Phanerochaete affinis* (Burt.) Parm.(=*Peniophora affinis* Burt.):**

NOF-172 *Abies balsamea*
NOF-174 *Abies balsamea*
NOF-231 *Pinus contorta* var. *latifolia*
NOF-353 *Pinus contorta* var. *latifolia*

***Phellinus nigrolimitatus* (Romell) Bourd. & Galzin [= *Fomes nigrolimitatus* (Rom.) Egel.:**

NOF-97 *Picea* sp.
NOF-98 *Tsuga heterophylla*

***Phellinus pini* (Tho. ex Fr.) Pil.:**

NOF-8 *Pinus resinosa*
NOF-9 *Picea glauca*
NOF-53 *Picea engelmannii*
NOF-72 *Picea engelmannii*
NOF-90 *Pinus contorta* var. *latifolia*
NOF-184 *Picea glauca*
NOF-220 *Pinus contorta* var. *latifolia*
NOF-288 *Picea glauca*
NOF-308 *Picea glauca*
NOF-309 *Abies lasiocarpa*
NOF-310 *Picea glauca*
NOF-373 *Abies lasiocarpa*
NOF-374 *Picea engelmannii*
NOF-379 *Larix lyallii*
NOF-411 *Picea engelmannii*
NOF-501 *Pinus contorta* var. *latifolia*
NOF-529 Coniferous stump
NOF-530 *Tsuga canadensis*
NOF-531 *Picea* sp.
NOF-546 *Picea glauca*
NOF-547 *Picea mariana*
NOF-548 *Pseudotsuga menziesii*
NOF-2230 *Picea glauca*
NOF-2231 *Picea glauca*
NOF-2232 *Picea glauca*
NOF-2233 *Pinus contorta* var. *latifolia*

***Phellinus pini* var. *abietes* (Thor.:Fr.) A. Ames (=Fomes pini var. abietes Karst:**

NOF-528 *Picea mariana*

***Phellinus punctatus* (Fr.) Pilat [=Poria tsugina robustus var. tsugina (Murr.) Ov.].**

NOF-474 *Tsuga heterophylla*

***Phellinus weirii* (Murr.) R.L. Gilb**

NOF-48 *Thuja plicata*
NOF-610 *Pseudotsuga taxifolia*
NOF-810 *Pseudotsuga menziesii*
NOF-811 *Pseudotsuga menziesii*
NOF-812 *Pseudotsuga menziesii*
NOF-813 *Pseudotsuga menziesii*

***Phlebia radiata* Fr.:**

NOF-190 *Pinus contorta* var. *latifolia*
NOF-271 *Pinus contorta* var. *latifolia*
NOF-276 *Pinus contorta* var. *latifolia*
NOF-291 *Pinus contorta* var. *latifolia*

***Phlebia subserialis* (Bourd. & Galzin) Donk: (=Peniophora phlebioides Jacks & Dear:**

NOF-294 *Pinus contorta* var. *latifolia*
NOF-524 Hybrid pine

***Phlebiopsis gigantea* (Fr.:FR.) Jülich [=Peniophora gigantea (Fr.) Mass.:**

NOF-131 *Pinus contorta* var. *latifolia*
NOF-199 *Pinus contorta* var. *latifolia*
NOF-200 *Pinus contorta* var. *latifolia*
NOF-201 *Pinus contorta* var. *latifolia*
NOF-202 *Pinus contorta* var. *latifolia*
NOF-203 *Pinus contorta* var. *latifolia*
NOF-204 *Pinus contorta* var. *latifolia*
NOF-279 *Pinus contorta* var. *latifolia*
NOF-284 *Pinus contorta* var. *latifolia*
NOF-289 *Pinus contorta* var. *latifolia*

***Poria punctata* (Fr.) Karst.:**

NOF-286 *Tsuga heterophylla*
NOF-459 *Tsuga canadensis*

***Postia placenta* (Fr.) M. Larsen & Lomb. [= *Poria placenta* (Fr.) Cooke]:**

NOF-639 Timber
NOF-640 Timber

***Postia sericeomollis* (Rom.) Jülich (= *Polyporus sericeomollis* Rom.):**

NOF-525 *Pinus* sp.

***Pycnoporellus alboteus* (Ell.&Ev) Kotlaba & Pouzar [= *Polyporus alboluteus* (Ell. & Ev.) Ell. & Ev.:**

NOF-106 *Picea glauca*
NOF-133 *Picea* sp.
NOF-523 *Picea glauca*

***Stereum sanguinolentum* (Alb. & Sch.:Fr.) Fr. [= *Haematostereum sanguinolentum* (Alb.& Sch.:Fr.) Pouzar:**

NOF-34 *Pinus contorta* var. *latifolia*
NOF-78 *Picea engelmannii*
NOF-118 *Picea engelmannii*
NOF-179 *Picea glauca*
NOF-185 *Picea glauca*
NOF-206 *Pinus contorta* var. *latifolia*
NOF-210 *Pinus contorta* var. *latifolia*
NOF-234 *Pinus contorta* var. *latifolia*
NOF-292 *Pinus contorta* var. *latifolia*
NOF-315 *Picea glauca*
NOF-316 *Picea mariana*
NOF-317 *Picea glauca*

***Trametes pubescens* (Schumach.:Fr.) Pilat [= *Coriolus pubescens* (Schumach. Fr.) Quel:**

NOF-273 *Pinus contorta* var. *latifolia*

***Trametes versicolor* (L. ex Fr.) Quel. [=*Coriolus versicolor* (L. ex Fr.) Quel.:**

NOF-45 Unknown

***Trichaptum abietinum* (Dickson:Fr.) Ryvar den [*Hirchiosporus abietinus* (Dicks.:Fr.) Donk:**

NOF-194 *Pseudotsuga taxifolia*
NOF-208 *Pinus contorta* var. *latifolia*