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Leaflet

79

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**ARCHIVE**

# Decay Fungi in Conifers

B J W Greig



FRONT COVER: Fructification of *Sparassis crispa*

# DECAY FUNGI IN CONIFERS

by B. J. W. Greig

*Forestry Commission.*

## INTRODUCTION

This leaflet is a field guide to the identification of decays in conifers for both foresters and arboriculturists. Although the common types of decay and the fungi that cause them are described in various publications (a brief list is given on p.21), there is frequently confusion over the identification of decay in plantations and in trees in parks and gardens. This leaflet summarises information on the main decay organisms found on conifers in Britain and is a companion volume to Arboricultural Leaflet 5, *Common Decay Fungi in Broadleaved Trees*. A guide to the susceptibility of the commonly planted conifers to the six most frequently encountered decays is given in Table 1. The information is based mainly on observational evidence gathered by the staff of the Forestry Commission's Pathology Branch over the past 20 years.

Decays are described as root, butt or trunk-rots in this leaflet. A root-rot is confined chiefly to the roots, whereas a butt-rot, although entering through the roots, causes decay principally in the base or lower bole of a tree. Trunk-rots are decays that enter primarily through wounds on exposed parts of roots or in the stem. Decay in a standing tree is often not evident until the tree is felled or blown over, but some indirect evidence of decay may be present and these signs are discussed in Arboricultural Leaflet 1.

Decays are often described as white or brown rots; in white rot the fungus attacks both cellulose and lignin and leaves a whitish residue. In contrast, brown rots destroy mainly the cellulose leaving a brown, friable decay. The characteristic of decay caused by each fungus are described under the three sub-headings of stain, incipient decay and advanced decay. With stain the wood is discoloured but the structure is not altered. Incipient decay is an early stage of rot in which the wood is still firm. In advanced decay the wood is soft or may have totally collapsed.

Recognition of fruit bodies is of considerable value in diagnosing decay. Most decay fungi are either polypores or agarics (see Figure 1 of Arboricultural Leaflet 5). Typically the fruit bodies of polypores are bracket or hoof-shaped and the under surface of the fruit body is perforated with numerous small pores. Agarics are typical toadstools with a stalk and cap. Both types occur on stumps, stems or roots or around the base of the tree. A few decay fungi produce fruit bodies which are described as resupinate, that is they lie flat on the bark or wood. Fruit bodies are not often found on living conifers that are suffering from butt-rot, but are commonly found on wounds on trees with trunk-rot.

In recent years there has been considerable revision of nomenclature of fungi, but where names that may be unfamiliar are used a synonym is also given.

## ARMILLARIA MELLEA

### Honey Fungus

#### HOSTS

Most conifers are susceptible to *Armillaria mellea* decay, especially the spruces (*Picea*), Western hemlock (*Tsuga heterophylla*) and Western red cedar (*Thuja plicata*) and the fungus causes extensive decay in many broadleaved species. *A. mellea* may also kill trees and is one of the commonest causes of death of trees and shrubs in Britain and throughout the world.

#### FRUIT BODIES

The toadstools are brown or honey-coloured and appear in clusters in the autumn on stumps and on the ground over roots and at the base of dead trees. They first resemble tiny mushrooms but rapidly expand to measure 5–15cm across the cap and up to 15cm high. The caps often have dark scales on the upper surface and pale cream, usually slightly decurrent gills, on the lower surface. The stem may be up to 2cm thick and has a collar or ring just below the cap. The fruit bodies only survive for a few weeks, usually being killed by the autumn frosts, which reduce them to a brownish slimy pulp.

#### DECAY

**Stain.** Irregular patches of grey, pale brown, or inky blue stain, later darkening to deep brown or blue-black.

**Incipient decay.** Mid-brown to orange-brown or yellow in colour, dry and firm, often with thin, black zone lines at the junction between decayed and sound wood. Incipient decay is often surrounded by a zone of blue-grey stain, especially in Norway spruce. In longitudinal section white or cream-coloured flecks are noticeable.

**Advanced decay.** Contains areas of wet stringy, orange-brown decay in which whitish regions occur. Black skins of fungal tissue may also be present.

#### OCCURRENCE

*A. mellea* is common throughout Britain on woodland sites, both broadleaved and conifers, as well as in hedgerows, parks and gardens. Decay can occur in very young trees, but is usually not important until the trees are 30–40 years old. The butt-rot may be very extensive at ground level but rarely extends more than 50cm up the stem and in the forest losses in timber volume are negligible even in susceptible species. However, with solitary trees, decay of the roots or at the base of the trunk may lead to windthrow or snapping of the stem. Old trees in parks and gardens are particularly vulnerable to this. Decay by *A. mellea* in the roots may allow other organisms into the stem, causing more extensive decays.

#### INFECTION AND SPREAD

*A. mellea* lives saprophytically in decaying stumps and roots of trees and shrubs and these are the major sources of new infection. From them thin, round strands called rhizomorphs are produced. At first these are reddish brown but they darken to become black with age, when they are slightly elastic, tough, branched structures resembling bootlaces. Flattened rhizomorphs also occur under the bark of dead trees and on roots. Rhizomorphs can grow through the soil for many metres enabling the fungus to spread and infect nearby plants and stumps. Roots are invaded leading to root death and butt-rot

in the stem of the tree, frequently through decaying the tap roots. Under the bark at the base of diseased trees there are conspicuous and characteristic fans or sheets of creamy white fungal mycelium. This is an important diagnostic feature of *A. mellea*. Long distance spread of the fungus is probably by spores which on rare occasions may establish new infection centres.

Arboricultural Leaflet 2 describes the biology of *A. mellea* and gives a more detailed account of damage and recommends control methods. For convenience only *A. mellea* has been referred to in this leaflet as this is the name most familiar to foresters and arboriculturists. However, recent work has indicated that *Armillaria* probably comprises at least four separate species, which can be distinguished by differences in the fruit bodies, rhizomorphs and host preference.



*Armillaria mellea* fruit bodies

27169

## FOMES ANNOSUS (syn. *Heterobasidion annosum*)

### HOSTS

Most conifers are susceptible to root-rot caused by *Fomes annosus*, but butt-rot is only extensive in Norway spruce (*Picea abies*), Sitka spruce (*P. sitchensis*), larch (*Larix*), Western hemlock and Western red cedar. Douglas fir (*Pseudotsuga menziesii*) and Lawson cypress (*Chamaecyparis lawsoniana*) are less susceptible. Occasionally broad-leaved trees, such as beech (*Fagus sylvatica*) and birch (*Betula*) may also be rotted. In addition, *F. annosus* causes death of a wide range of conifer species and some broadleaved trees.

### FRUIT BODIES

The perennial, normally bracket-shaped fruit bodies of this polypore are found most commonly on conifer stumps and on the base of dead trees. They are tough and leathery, with a rich brown concentrically zoned upper surface and usually have a white outer rim which may be thick or thin according to the vigour of the fruit body. The lower surface is white or buff-coloured and is visibly perforated with numerous small pores. Old specimens become darker brown or slate-grey on the upper surface and may persist for well over a year. The fruit bodies vary from 2 to 30cm in diameter, often consisting of a series of brackets growing together. Pustules or immature fruit bodies often grow on the surface of stumps or roots, as small, round white bodies, usually less than 1cm in diameter and of a rubbery consistency.

### DECAY

**Stain.** Stain caused by *F. annosus* often appears eccentrically in the stem coinciding with lateral root infections. Its colour varies with the host species. In Western hemlock, Western red cedar and cypresses it is dark brown, whereas in larches it is at first brownish grey turning later to dark or reddish-brown. In Sitka spruce the stain may be brown but can also be pink or lilac, and in Norway spruce the stain is often bluish or grey.

**Incipient decay.** Pale-yellow or straw colour, usually paler than the adjacent wood and normally surrounded by a darker stained zone. In longitudinal sections occasional black flecks may be seen.

**Advanced decay.** The decay is dry, stringy and fibrous, light brown or straw coloured. In longitudinal sections conspicuous white pockets occur which are filled with fungal tissue. These pockets appear as small holes in cross-section and are a diagnostic feature of *F. annosus* decay.

### OCCURRENCE

*F. annosus* is the most important cause of butt-rot in conifers in British forests, where it causes 80–90 per cent of all decay. *F. annosus* occurs in second rotation crops or in first rotation crops which were thinned without stump protection. With fast-growing crops such as larch or Sitka spruce, decay may be present at the time of first thinning, even as early as 15–18 years of age. Decay can be very extensive radially and may extend 7m or more up the stem. Large individual trees of Norway spruce and Western hemlock are often severely decayed. The fungus usually invades the tree from the roots but can occasionally enter through stem and root wounds caused by mechanical damage. Root-rot may also be severe and many species in which butt-rot does not develop, e.g. pines

(*Pinus*) and Grand fir (*Abies grandis*) may be windthrown as a result. *Fomes annosus* is also responsible for killing attacks especially in young plantations on calcareous soils.

#### INFECTION AND SPREAD

Spores of the fungus, which are released from the fruit bodies throughout the year, colonise freshly cut stumps. The fungus grows down through the stump into the roots, and, via root contacts, across to neighbouring trees. Root-rot occurs and the decay eventually spreads into the main stem. Unlike *A. mellea*, *F. annosus* is confined to the woody tissues of the roots and stumps and does not spread independently through the soil. In parks and gardens many cases have been found where *F. annosus* has spread from a conifer or birch stump to infect a nearby tree. Details of the biology of *F. annosus* and recommended control measures are described in Forestry Commission Leaflet 5.



*Fomes annosus* fruit bodies

EK124

*Armillaria* decay



Transverse section

19200



Longitudinal section

19652



*Fomes* decay



Transverse section

19648



Longitudinal section

19643

## PHAEOLUS SCHWEINITZII

(syn. *Polyporus schweinitzii*)

### HOSTS

*Phaeolus schweinitzii* is common in Sitka spruce, Douglas fir and the larches, particularly in older trees. It has also been recorded on Scots (*Pinus sylvestris*), Corsican (*P. nigra* var. *maritima*), Lodgepole (*P. contorta*) and Monterey (*P. radiata*) pines, Serbian spruce (*P. omorika*) and cedars (*Cedrus*).

### FRUIT BODIES

The annual fruit bodies of this polypore appear in late summer. They are either flattish, plate-like structures with a short, central stalk, or brackets without stalks. They grow at the base of infected, standing trees and on stumps, roots, or on the ground. Very occasionally they grow as brackets from wounds on the trunk of trees. The fruit body is fleshy, easily broken and can measure up to 30cm across. The upper surface is deep rusty-brown, resembling coarse brown velvet, with a contrasting bright yellow rim which gradually disappears with age. The underside is yellow/green and easily bruised, and when fresh it exudes droplets of moisture. The pores are irregular and maze-like in appearance. The fruit bodies die by late autumn but persist *in situ* for up to a year as dried, dark brown specimens resembling old cow-pats.

### DECAY

**Stain.** Stain is not conspicuous but is yellow in Sitka spruce and pinkish-brown in Douglas fir. It is usually central and is seen as discolouration of the heartwood.

**Incipient decay.** This stage is not distinct, but is usually central, merging into sound wood; it is normally dry, light in colour and may be slightly soft.

**Advanced decay.** A brown cubical rot, which is at first dry and light yellow-brown in colour, later becoming much darker. The decayed wood can easily be dug out with a knife and readily crumbles when rubbed between the fingers. Radial cracks are present in advanced decay and tend to break the wood up into cubical blocks. These cracks are often filled with yellowish or creamy-white mycelium. The decay smells strongly of turpentine and in the later stages of decay the wood becomes very dry, brittle and dark brown. Advanced decay is frequently surrounded by dark bands of very resinous wood, especially in Sitka spruce.

### OCCURRENCE

*P. schweinitzii* has a widespread distribution but sporadic occurrence in Britain; only occasionally does it cause severe losses in plantations. The fungus occurs mainly on old woodland sites where the previous crops were either broadleaves or pine. Decay is usually very extensive radially with a large proportion of the cross-sectional area at the butt being decayed and often only a narrow rim of sound sapwood remaining. Decay can commonly extend 6–8m up a tree. Trees decayed by *P. schweinitzii* frequently shatter in gales, usually splitting at just above ground level. Large specimen trees of susceptible species in parks and gardens are particularly prone to this condition. In plantations, decay first appears in thinnings at about 30 years of age, but the main losses occur in crops 40–50 years of age. In certain Sitka spruce plantations over 30 per cent of trees may be infected.

### INFECTION AND SPREAD

The fungus enters trees through roots and then spreads up into the stem. There is evidence that *P. schweinitzii* does not attack healthy roots but invades roots weakened or killed in some other way, in particular by *Armillaria mellea*. Occasionally stem wounds are colonised, suggesting that spores may be able to infect exposed woody tissues. The only control measure recommended is to replant infested sites with a more resistant species.

*Phaeolus*



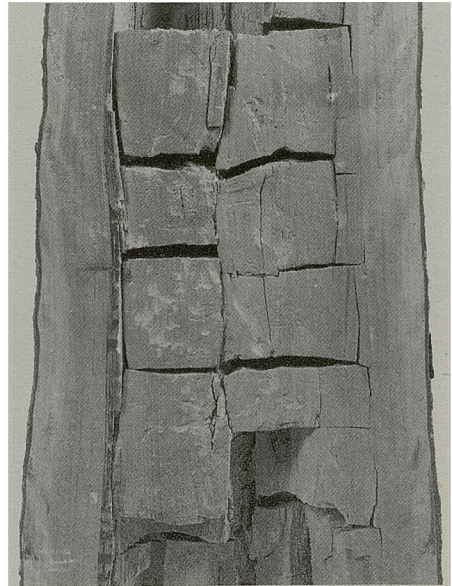
Fruit body

*B. Greig*



Transverse section

35484



Longitudinal section

*B9068*

## SPARASSIS CRISPA

### HOSTS

*Sparassis crispa* is frequently found on old pine, and also occurs in Sitka spruce, Douglas fir, larches and cedars.

### FRUIT BODIES

The large, fleshy fruit bodies are cream or white in colour, up to 30cm across, produced annually in the late summer at the base of living trees and on stumps. They resemble open cauliflowers or sponges, with many flattened branches or lobes, the edges of which turn brown with age.

### DECAY

The decay is a brown, cubical rot, and all stages are virtually indistinguishable in the field from that caused by *P. schweinitzii*. The only difference is that in advanced decay caused by *S. crispa*, the mycelium in the radial cracks is always white, whereas with *P. schweinitzii* the mycelium may be yellow. The advanced decay becomes very dark, almost black, especially in over-mature pine (see illustration of decay).

### OCCURRENCE

*S. crispa* is distributed throughout Britain, but in forests is less important than *P. schweinitzii*. Its decay is frequently confused with that caused by *P. schweinitzii* and both fungi often cause damage on the same site. *S. crispa* is a major cause of decay in conifers over 60 years old, especially Scots pine. Trees weakened by butt-rot frequently shatter in gales, usually at a point near ground level.

### INFECTION AND SPREAD

Entry is through the roots, probably central tap roots, and the fungus then spreads radially and vertically up the stem. In forests control measures are rarely necessary, although on sites where infection is prevalent it would be prudent to avoid planting Sitka spruce.

*Sparassis*



Fruit body

*B. Greig*



Decay

35481

**STEREUM SANGUINOLENTUM**  
(syn. *Haematostereum sanguinolentum*)

HOSTS

*Stereum sanguinolentum* occurs mainly on Norway and Sitka spruce and larch.

FRUIT BODIES

This fungus differs from the polypores in that the fruit body has a smooth undersurface (without pores). The fruit bodies are small, thin brackets, and occur throughout the year in groups or tiers on stumps, extraction wounds and on produce left in the woods for several months, it may also grow in a resupinate form. The upper surface of the brackets is grey to brown and the under-surface is light grey to buff in colour. When fresh the under-surface bleeds red within 15–20 seconds if damaged. Individual brackets are about 1–2cm in diameter but clusters may be up to 30 cm across.

DECAY

**Stain.** Yellow-brown, usually in sapwood and associated with a trunk or root wound.

**Incipient decay.** Firm brownish-yellow and difficult to distinguish from other similar decays.

**Advanced decay.** Dry, fibrous and orange-brown in colour; in longitudinal section decayed wood contains lemon-yellow streaks. At some distance up the stem, away from the wound, the decay column may become centralised.

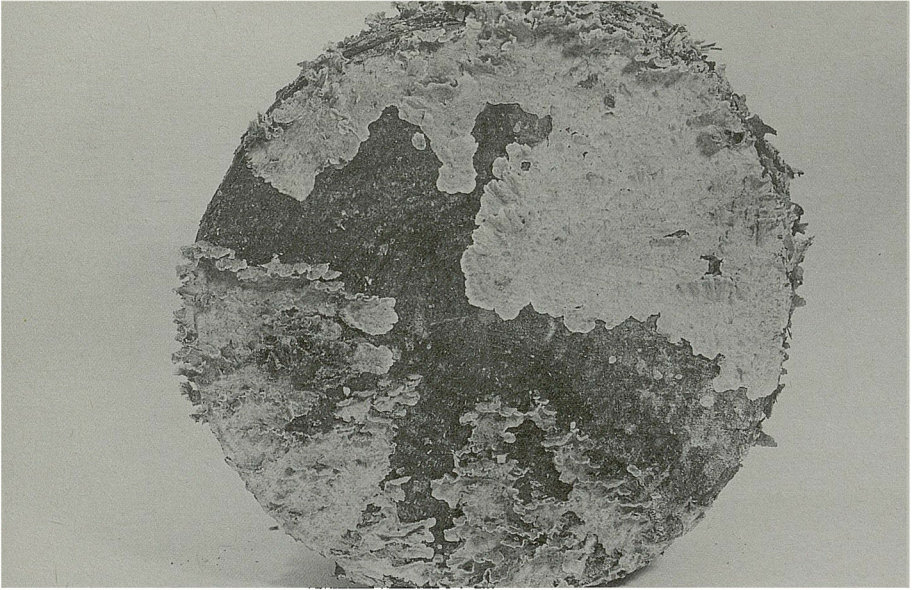
OCCURRENCE

*S. sanguinolentum* is probably the most important cause of decay following extraction damage wounds in Britain. *S. sanguinolentum* is most frequent in Norway and Sitka spruce. It has not been reported on Douglas fir, Grand fir, Western hemlock and Western red cedar in Britain, but records from North America suggest that these species are also susceptible. Pines are only slightly susceptible.

INFECTION AND SPREAD

Entry is through spores colonising wounds on the lower stem or roots. Extraction damage wounds are the most frequent infection sites, but rot can also develop following severe brashing and from slasher wounds used for marking trees for thinning. Decay develops in the wood formed prior to the time of damage (see illustration of decay) and commonly extends 2–3m above and below wounds. Avoidance of damage to trees during timber extraction will minimise losses caused by *S. sanguinolentum* and unlike the situation with *F. annosus*, infection does not carry over into the next rotation.

*Stereum*



Fruit body

C4564



Decay

34780

## TYROMYCES STIPTICUS

(syn. *Polyporus stipticus*)

### HOSTS

*Tyromyces stipticus* occurs on Norway and Sitka spruce and larch.

### FRUIT BODIES

The fruit bodies of this polypore form as small brackets (5–8cm diameter) on stem wounds, or on the cut ends of logs, or occasionally as irregular pads on the underside of logs. They are annual and are produced in autumn, although under favourable moist conditions they may be found from June to January. The brackets are white, fleshy and easily broken, and pores are clearly visible on the undersurface. Old specimens which are off-white to grey and firm, may be found at any time of the year.

### DECAY

**Stain.** Light yellow stain in the sapwood, usually associated with a root or stem wound.

**Incipient decay.** Light-brown, dry and becoming softish, but not clearly defined and merging into sound wood. Decay is usually located eccentrically in the stem.

**Advanced decay.** Dry, brown cubical rot, and in Sitka spruce is very similar to that caused by *P. schweinitzii*. In Norway spruce, advanced decay by *T. stipticus* is often very dark. The decay usually becomes central higher up the stem and merges with incipient decay. It is characterised by the presence of broad radial cracks which are often filled with white mycelium.

### OCCURRENCE

*T. stipticus* may be an important cause of trunk-rot following extraction damage. It occurs mainly in older plantations that have been thinned several times, where damage to stems or roots has been frequent. Although not a very common decay it may be locally important, especially in older crops of Norway spruce. The decay it causes is difficult to distinguish from decays caused by *P. schweinitzii* and *S. crispa*. However, *T. stipticus* is the only one of these fungi to cause a brown, cubical rot in Norway spruce and on other species its association with wounds should enable a diagnosis to be made. This is shown clearly in the illustration.

### INFECTION AND SPREAD

Stem and root wounds are colonised by fungal spores. The fungus then spreads up and down the stem, first in the sapwood and eventually extending into the heartwood. Decay often develops from wounds at the base of the stem and on buttress roots. Larger wounds are more frequently colonised than small ones.



*Tyromyces*



Fruit bodies

35769



Decay

35485

## LESS COMMON DECAY FUNGI

The vast majority of cases of decay found in conifers in Britain will have been caused by one of the six fungi already described. However, many other fungi occasionally cause decay in standing trees and the more common of these are described below:

### *CALOCERA VISCOSA*

A brown cubical decay caused by *C. viscosa* has been reported on European larch (*Larix decidua*) damaged by extraction of timber. The fruit bodies are bright yellow, erect, branched structures 1–8cm tall and slimy to touch. They are found on stumps of conifers in autumn and winter.

### *CONIOPHORA PUTEANA*

*Coniophora puteana* causes a dark brown cubical rot in over-mature European larch and Norway spruce, probably by colonising extraction wounds. The decay closely resembles that caused by *Tyromyces stipticus*. The fruit bodies are resupinate, with a light brown upper surface and a pale margin. They vary in size from 1–20cm across.

### *CORYNE SARCOIDES*

*Coryne sarcoides* has frequently been found in decayed spruce, usually on the periphery of decay columns caused by *Fomes annosus*, *Stereum sanguinolentum*, *T. stipticus* and *Odontia bicolor*. The exact role of *C. sarcoides* in the decay process is not clear. Typically the fruit bodies of this fungus are small, purple, gelatinous, columnar to almost cup-shaped structures, about 0.5cm in diameter.

### *HYPHOLOMA FASCICULARE*

Butt-rot caused by *H. fasciculare* has been recorded in larch, Norway and Sitka spruce and Western red cedar. It is a soft, fibrous yellow-brown rot, somewhat similar to that caused by *F. annosus*. It is possible that *H. fasciculare* enters stems after invading roots already killed by *F. annosus* or *Armillaria mellea*. The fungus has been observed fruiting on extraction scars and may be capable of invading such wounds. The fruit bodies are typical toadstools, known as 'sulphur-tufts' and may be seen growing in clusters on old conifer and broadleaved stumps at any time of the year. The caps are pale yellow, 2–5cm across, on slender stems up to 10cm tall; the gills are sulphur-yellow with a characteristic greenish tint when mature.

### *LAETIPORUS SULPHUREUS* (syn. *Polyporus sulphureus*)

*Laetiporus sulphureus* is the commonest cause of decay in the trunk and limbs of yew (*Taxus baccata*) and has occasionally been reported on pine and larch. The decay is a brown cubical rot and in advanced decay broad radial cracks develop which are often filled with thick sheets of yellow mycelium resembling chamois leather. *L. sulphureus* is also a most important cause of trunk and butt-rot in oak and Sweet chestnut. The fruit bodies of this polypore are annual and occur at the end of summer. They grow as soft fleshy brackets, often on pruning wounds or from broken branches and measure up to 30cm across. They are bright yellow when fresh but as they age and dry they fade and become pale brown.

### *LENTINUS LEPIDEUS*

*Lentinus lepideus* is mainly important in causing decay in felled timber such as telegraph poles and railway sleepers but also has been found causing a dark, brown cubical decay in old Scots pine, probably having entered through pruning or other wounds. This agaric has a cap up to 10cm in diameter which is pale yellow with reddish-brown scales and white or yellow gills. It is supported by a usually eccentric stem 2–7cm tall and up to 2.5cm thick. The fruit bodies are found on decaying timber or pine stumps.

### *ODONTIA BICOLOR* (syn. *Resinicium bicolor*)

Butt-rot caused by *O. bicolor* has been found in Grand fir, Noble fir (*Abies procera*) and Douglas fir and isolated from extraction wounds in Norway and Sitka spruce and Japanese larch (*Larix kaempferi*). The decay is dry and fibrous and is similar to that caused by *S. sanguinolentum*. The fruit bodies occur attached to the bark of stumps, roots and bark of conifers. They are inconspicuous usually only 2–5cm across, grey in colour and very thin, resembling dried sheepskin.

### *PELLINUS PINI* (syn. *Trametes pini*)

In Scotland, *P. pini* causes considerable decay in Scots pine in the Caledonian pine forests, especially on trees over 100 years old. It is a trunk-rot, entering through wounds and broken branches. Once in the trunk it grows up and down the stem causing severe rot. The decay is a red, ring rot, in which the decay occurs in bands along the annual rings. The rot is dry and fibrous and contains white pockets which are slightly larger than those found in *F. annosus* decay. The perennial fruit bodies of this polypore are hard, encrusted, bracket or hoof-shaped structures measuring 5–15cm across, which grow out from the side of the trunk from knots and branch-stubs and persisting for many years. The upper surface of the fruit body is dull grey or black with concentric furrows parallel to the margin, the under-surface is greyish or brown with irregularly shaped pores. *P. pini* is a very important cause of decay in North America and in other parts of the world where it has a wide host range of conifers.

### *SERPULA HIMANTOIDES* (syn. *Merulius himantoides*)

This fungus causes a dark brown cubical rot and has been recorded on European larch and Scots pine in Britain. It is not known how the fungus enters the tree, but from examination of decay columns it is probable that it gains entry through wounds. The fruit body is resupinate, pale in colour with a white border and may be up to 20cm in diameter.

TABLE 1. Susceptibility of major conifer species to the six most common decay fungi

HS = highly susceptible

SS = slightly susceptible

MS = moderately susceptible

R = resistant

Conifer host	Fungi	<i>Armillaria mellea</i>	<i>Fomes annosus</i>	<i>Phaeolus schweinitzii</i>	<i>Sparassis crispa</i>	<i>Stereum sanguinolentum</i>	<i>Tyromyces stipticus</i>
Scots pine <sup>1</sup> ( <i>Pinus sylvestris</i> )		R	R	MS	MS	SS	SS
Sitka spruce ( <i>Picea sitchensis</i> )		HS	HS	HS	HS	HS	HS
Norway spruce ( <i>P. abies</i> )		HS	HS	R	R	HS	HS
Serbian spruce ( <i>P. omorika</i> )		HS	MS	MS	MS	HS	MS
Larches <sup>2</sup> ( <i>Larix</i> spp)		SS	HS	MS	MS	MS	MS
Douglas fir ( <i>Pseudotsuga menziesii</i> )		SS	MS	MS	MS	MS*	—
Western hemlock ( <i>Tsuga heterophylla</i> )		HS	HS	R	R	MS*	—
Western red cedar ( <i>Thuja plicata</i> )		HS	HS	R	R	MS*	—
Lawson cypress <sup>3</sup> ( <i>Chamaecyparis lawsoniana</i> )		HS	MS	R	R	MS	—
Grand fir <sup>4</sup> ( <i>Abies grandis</i> )		SS	R or SS	R	R	MS*	—

<sup>1</sup> Similar ratings for Corsican pine (*Pinus nigra* var. *maritima*) and Lodgepole pine (*P. contorta*).

<sup>2</sup> Includes European (*Larix decidua*), Japanese (*L. kaempferi*) and Hybrid larch (*L. × eurolepis*).

<sup>3</sup> Similar ratings for Leyland cypress (*Cupressocyparis leylandii*).

<sup>4</sup> Similar ratings for Noble fir (*Abies procera*) and other Silver firs (*Abies* spp).

\* The susceptibility rating is taken from studies outside Britain.

## FURTHER READING

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