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Needle and shoot diseases of pine

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Fig. 1. Mature Scots pine *(Pinus sylvestris)* with a healthy appearance. Drawing: Vivanne Dubach.

Pine trees are an integral part of the forest landscape across Switzerland (see Fig. 4). In recent years, they have come under increasing pressure, not least due to new fungal diseases that have been introduced from abroad. Needle and shoot diseases play a major role for pine health. The Swiss Forest Protection Group has been documenting diseases affecting Swiss tree species since 1984.

When the appearance (habitus) of an infested pine changes, the tree attracts attention. Needle and shoot diseases are clearly visible and thus easily change the appearance of the tree. Pines in particular are susceptible to many such diseases, also in comparison with other conifers such as Norway spruce *(Picea abies)* and silver fir *(Abies alba*). This is also reflected by the comparatively high level of attention devoted to the pine tree both in research and in the advisory activities of the Swiss Forest Protection Group.

Needle diseases not only change the appearance of the tree, however. They can also weaken the tree, and thus increase its susceptibility to other biotic and abiotic influences. Conversely, biotic and abiotic stress factors make a tree susceptible to infection with needle disease: the weaker the tree, the more easily additional infections occur. Examples of abiotic stress factors include drought, hail or sudden waterlogging. An example of a biotic damaging influence is the infection with a root pathogen such as the honey fungi *Armillaria*, to which Scots pine *(Pinus sylvestris)* is particularly susceptible (Nierhaus-Wunderwald *et al.* 2012).

Significance of needle and shoot diseases in pines

Pines make up about 4.7 % of trees in the Swiss forest (stem count Swiss National Forest Inventory (NFI)4; Abegg *et al.* 2020). According to the fourth Swiss National Forest Inventory, the Scots pine *(Pinus sylvestris)* is the most common forest species, accounting for 2.3 % of the total forest area in Switzerland, followed by the Swiss mountain pine (*Pinus mugo*, 1.2 %), the stone pine (*Pinus cembra,* 1.2 %), the black pine (*Pinus nigra,* 0.04 %), and other, non-native pine species (0.01 %).

The pine is a pioneer tree species. At lower altitudes, it usually disappears from the stand as the forest develops if it is not silviculturally promoted, due to its need for light. Pines therefore often occur in mixed stands, or they are displaced by competition on to dry, shallow or very moist extreme sites (ETH 1995). Scots pine, mountain pine and stone pine in particular are able to survive on difficult sites. In some areas, pines also form whole stands (e. g. the Swiss stone pine forests of the subalpine vegetation zone; the Swiss mountain pines of upland moors), and are thus essential for forest functions to be delivered (e. g. protection against rockfall and soil erosion in particular).

For some years now, pines in Switzerland have been increasingly affected by two "new" needle diseases: the red band needle blight, caused by the fungi *Dothistroma septosporum* and *Dothistroma pini*, and the brown spot needle blight, caused by *Lecanosticta acicola*. As both diseases can cause great damage to pines, they are classified as "particularly dangerous organisms" ("BgSO" [Swiss plant protection ordinance]). Since 2020, they have been considered to be "regulated non-quarantine organisms" ("GNQO"; PGesV-WBF-UVEK, SR 916.201 [under the Swiss plant protection ordinance]). To keep an eye on the damage potential and spread of these newcomers, the Swiss Forest Protection Group has been monitoring the diseases since 2009. In the course of these activities, numerous other needle diseases have been detected.

This leaflet draws on the wealth of information gathered by the Swiss Forest Protection Group since 1984, and presents the pathogens of the most common needle and shoot diseases of pine trees in Switzerland (Tab. 1). Physiological needle blight (also known as physiological needle cast), which is often confused with disease and therefore reported to the Swiss Forest Protection Group, is a natural process of needle ageing – a process undergone by all needles as time goes by. As it is not a disease, it does not appear in the list. However, it is described further on in the leaflet.

The most common needle and shoot diseases of pines in Switzerland

Records kept by the Swiss Forest Protection Group since 1984 show that the *Lophodermium* pine needle cast diseases (*L. seditiosum* and *L. pinastri*) are among the most frequently recorded needle and shoot diseases (Fig. 2a). Three other fungi are also very strongly represented in the database. The pathogens of brown spot needle blight *(Lecanosticta acicola)* and red band needle blight (*Dothistroma* spp.) have become the focus of increasing attention since 2009 because of their potential to cause damage (Dubach *et al.* 2018). Selective data has been greatly improved as a result, as shown in the comparison of data since and before 2009 (Fig. 2b). This comparison shows that, after the relevant initial findings, there were very few reports of red band disease and brown spot needle blight. It was not until the Swiss Forest Protection Group began their active monitoring of the diseases that the data situation and thus knowledge about these two dangerous

Tab. 1. Overview of the most significant needle and shoot diseases of pines in Switzerland.

Name (scientific)	Synonyms	Name (english)	Most frequently affected tree organ
Cenangium ferruginosum	*C. abietis*	*Cenangium* dieback, shoot dieback of pine	Shoot
Cronartium pini	*C. flaccidum, C. asclepiadeum*	Pine blister rust, stem rust of pine	Shoot
Cyclaneusma minus	*Naemacyclus minor*	*Cyclaneusma* needle cast, *Naemacyclus* needle cast	Needle
Coleosporium spp.		*Coleosporium* pine needle rust	Needle
Diplodia sapinea	*Sphaeropsis sapinea*	*Diplodia* tip/shoot blight of pine	Shoot
Dothistroma spp. *(D. septosporum, D. pini)*	for *D. septosporum: Scirrhia pini*	Red band needle blight	Needle
Gremmeniella abietina	*Ascocalyx abietina, Scleroderris abietina*	*Scleroderris* dieback / *Brunchorstia* dieback	Needle and shoot
Herpotrichia pinetorum	*H. juniperi*	Black snow mould, brown felt blight	Needle and shoot
Lecanosticta acicola		Brown spot needle blight	Needle
Lophodermella conjuncta		Swedish pine needle cast	Needle
Lophodermella sulcigena		Swedish pine needle cast	Needle
Lophodermium pinastri		*Lophodermium* needle cast	Needle
Lophodermium seditiosum		*Lophodermium* needle cast	Needle
Gremmenia infestans	*Phacidium infestans*	Snow blight, Swiss stone pine snow fungus	Needle and shoot
Sydowia polyspora	*Sclerophoma pithyophila, Phoma pithyophila, Dothidea polyspora, Hormonema dematioides*	*Sydowia* dieback of pine	Needle, shoot and wood

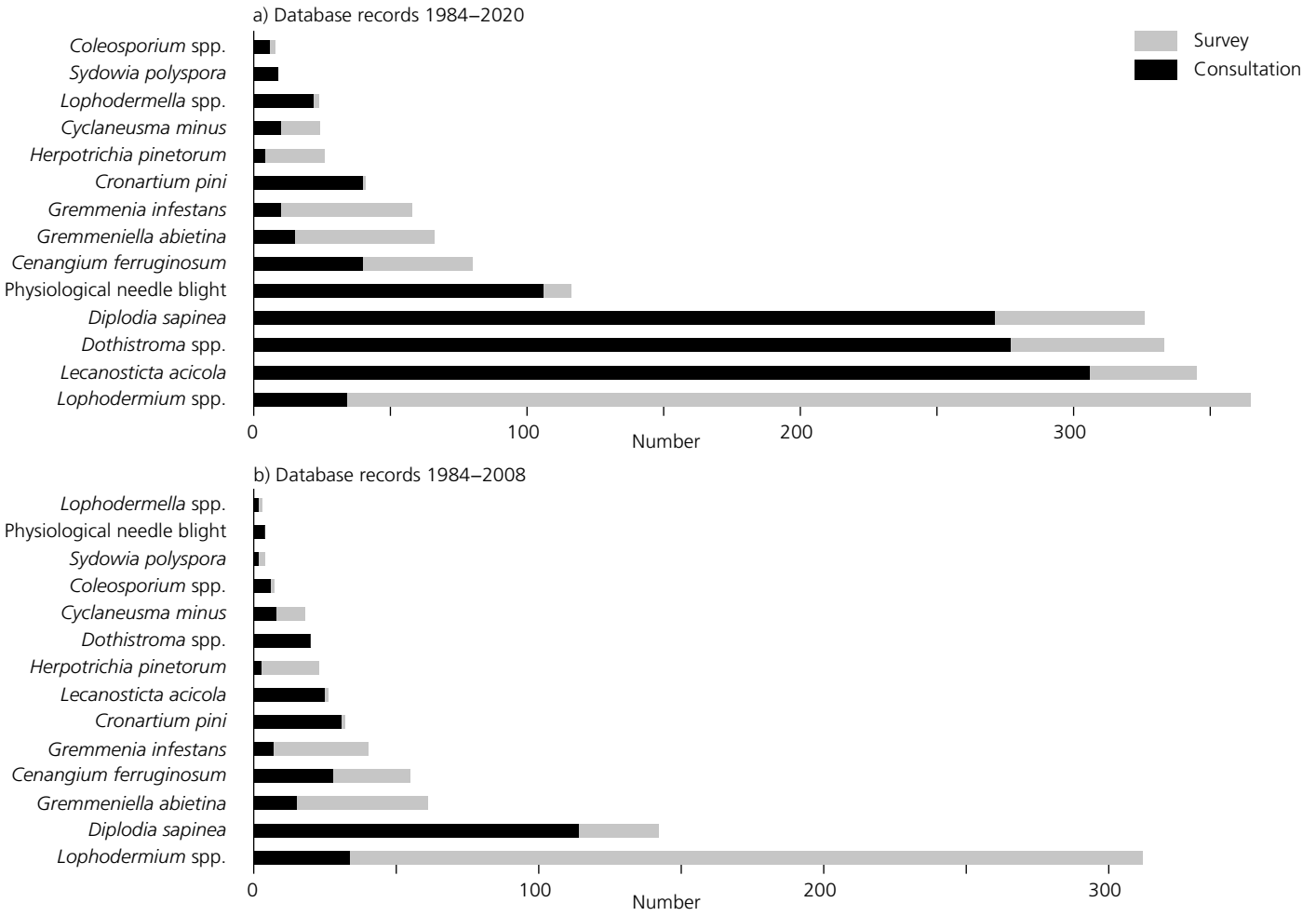


Fig. 2. Evaluation of the Swiss Forest Protection Group database (1984–2020) on needle and shoot diseases of pine. a) Period from 1984 to 2020. b) Period from 1984 to 2008. All categories of native pine species were considered: Scots pine *(Pinus sylvestris)*, mountain pine *(P. mugo)*, black pine *(P. nigra)* and stone pine *(P. cembra)* as well as pines in general (if no more precise information on the tree species could be provided). Consultancy: all findings that were entered by employees of the Swiss Forest Protection Group either in consultancy or in the course of their own observations. Survey: Data from the annual Swiss forest protection survey as well as summarised spontaneous reports from the forestry and green sectors.

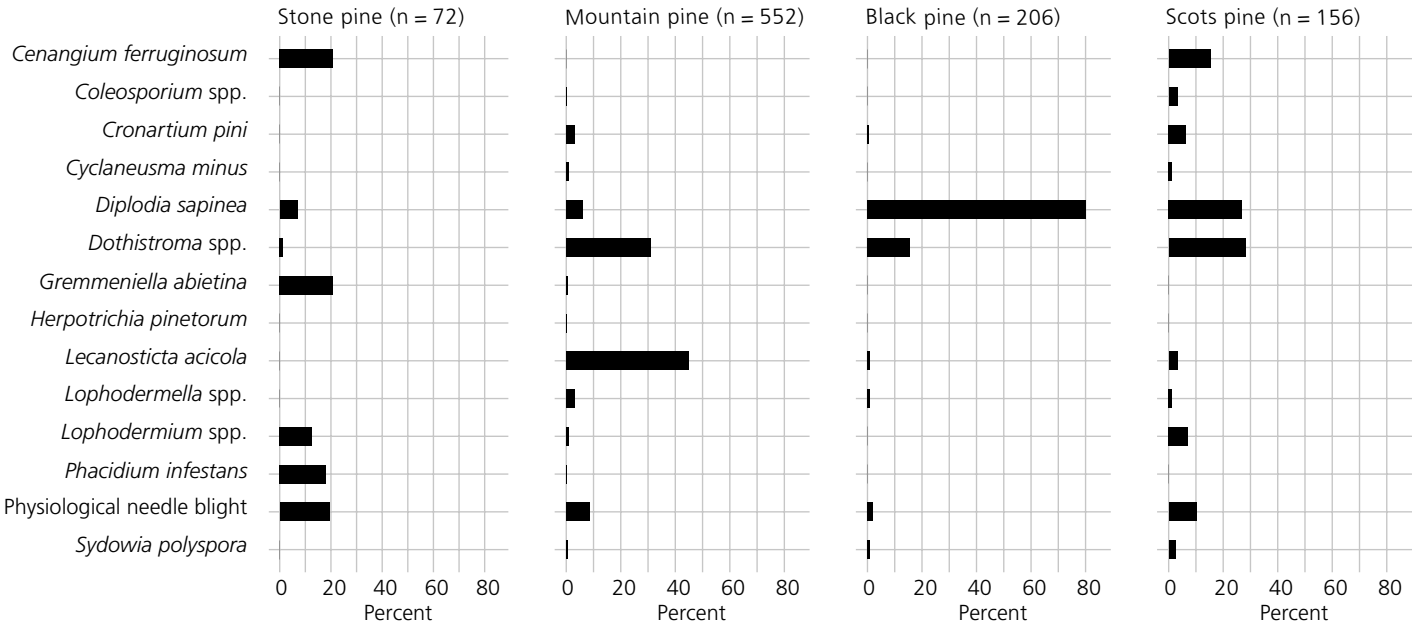


Fig. 3. Distribution of the most frequently observed needle and shoot diseases among the different pine species. Only the pathogens described in this leaflet were considered for these evaluations. Data for which the pine species was not precisely specified as well as data from the survey were not included in this analysis. n = number of database entries.

fungi improved. As a result of this monitoring, the detection rate of pine shoot dieback *(Diplodia sapinea)* can also be seen to have increased. Its striking symptoms have often been observed in the course of the active searches.

The most common fungi on the different species of pine

Cenangium shoot dieback *(C. ferruginosum)* and *Scleroderris* shoot dieback, also known as *Scleroderris* canker *(Gremmeniella abietina)*, were the diseases most frequently found on needles and shoots of the stone pine (Fig. 3, Swiss stone pine). Also common were snow blight *(Phacidium infestans)* and physiological needle blight (natural ageing of the needles, not a fungal disease). The latter is not surprising, since all needles die after a few years. Physiological needle blight (PNB) in principle thus affects all pines. Damage to Swiss stone pine caused by the red band needle blight (*Dothistroma* spp.) originates in urban areas. As stone pines have relatively thin needles, symptoms of red band needle blight are sometimes more difficult to see. It is thus more likely to be detected in gardens than in the forest. Brown spot needle blight *(Lecanosticta acicola)* has not yet been found on Swiss stone pine. Of all the pine species described here, mountain pine is most affected by brown spot needle blight (Fig. 3, mountain pine). On mountain pine, these two imported diseases, the redband needle blight and brown spot needle blight, together account for more than 75 % of the observed infestations of mountain pine. The third most common condition observed was physiological needle blight.

There are clear differences between black pine and the other pine species (Fig. 3, black pine); in black pine, damage caused by *Diplodia* shoot dieback *(D. sapinea)* dominates. Red band needle blight is the second most common disease affecting this species, but occurs much less frequently. All other pathogens described here are responsible for only a small proportion of the damage reported on black pine.

On the most common Swiss pine species, the Scots pine, red band needle blight is the most frequently recorded cause of damage, closely followed by *Diplodia* shoot dieback (Fig. 3, Scots pine). *Cenangium* dieback also occurs frequently on Scots pine, as does physiological needle blight.

How to identify the most common pines in Switzerland

Scots pine *(Pinus sylvestris)*
- Distribution: from lowlands up to 1800 m, sometimes up to 2200 m a. s. l. (Engadine, Valais)
- Tree height rarely exceeds 40 m
- Maximum age: around 600 years
- Bark: orange-brown in upper crown, peels off in thin flakes; darker on lower trunk, with fissures and scaly plates
- Needles: 2 per short shoot; 4–7 cm; life span of 1–8 years, depending on the site
- Cones: curved downwards in the first year; mature cones egg-shaped to conical, 3–7 cm long, pendulous

Mountain pine *(Pinus mugo)*
- Distribution: *P. mugo* ssp. *uncinata* from 600 to 2350 m a. s. l.; *P. mugo* ssp. *mugo* up to 2400 m a. s. l.
- Tree height *P. mugo* ssp. uncinata up to 25 m
- Maximum age: *P. mugo* ssp. *uncinata* around 300 years, *P. mugo* ssp. *mugo* around 100 years
- Bark: greyish-brown, initially peels off in flakes, then develops fissures and coarser scales
- Needles: 2 per short shoot; 3–4 cm long, rarely up to 8 cm; life span of 5–10 years, depending on the site
- Cones: not turned downwards in the first year; mature cones egg-shaped to conical, 2–7 cm long, almost sessile, inclined or diverging horizontally from the branch, remain on the tree for a long time

Fig. 4. Modelled distribution areas of Swiss pine species from the MoGLi project (Modelling of shrub species LFI), based on records of the National Forest Inventory LFI (Wüest *et al.* 2021). Data were pooled at the community level (B. A. Augustinus 2021). Black pine is not part of this dataset, as it hardly occurs in the forest.

Black pine *(Pinus nigra)*
- Distribution: From lowlands up to 2000 m a. s. l.
- Tree height up to 50 m
- Maximum age around 500 years
- Bark: light to dark greyish-brown, with same colour reaching into crown; develops fissures and coarse scaly plates with age
- Needles: 2 per short shoot; 8–16 cm long; have a life span of 4–8 years, depending on the site; they fall off with the fascicle sheath
- Cones: have very short stalks; young cones obliquely upright, more mature ones usually at right-angles to branch; egg-shaped to conical, 4–10 cm long

Swiss stone pine *(Pinus cembra)*
- Distribution: from lowlands up to 2600 m a. s. l.
- Tree height up to 25 m
- Maximum age: around 600 years
- Needles: 5 per short shoot; 5–12 cm long, triangular; life span of 3–6 years; fascicle sheath falls off in the first year
- Cones: have short-stalks, obliquely upright or protruding; purple when young; ovoid, 6–8 cm long; fall off with the ripe seeds

Short portraits of needle and shoot diseases of pines

Lophodermium needle cast

The needle cast disease caused by the fungus *Lophodermium seditiosum* results in a mass, premature loss of needles and short shoots in pines. Infected needles are shed until early summer, while infected short shoots are shed throughout the year. These symptoms are not to be confused with needle loss due to physiological needle blight. In summer, the sexual fruiting bodies of *L. seditiosum* form in the litter or on needles on the tree (needle on the left in the picture). They are about 1 mm long, black and oval, and have a longitudinal fissure with a greenish shimmer. The fissure opens when moist to release spores. The spores then infect the youngest needles. The higher the humidity in the summer months, the wetter and warmer the autumn and the milder the winter, the better *L. seditiosum* develops (Behnke-Borowczyk *et al*. 2019).

Lophodermium pinastri (needle on the right in the picture) is considered to be a fairly harmless endophyte, whereas *L. seditiosum* can cause problems, especially in tree nurseries. Both species can occur latently as endophytes in the needle for a long time without causing symptoms. The occurrence of *L. pinastri* increases with the age of the needle (Behnke-Borowczyk *et al*. 2019). It is a significant coloniser of dying needles, contributing as a saprobiont to needle decomposition. The fruiting bodies are very similar to those of *L. seditiosum*. In *L. pinastri*, however, the fissure is often reddish and there are black demarcation lines visible on the needle.

Nowadays, a distinction is made between three different groups of *L. pinastri* (Reignoux *et al.* 2014), which are pathogenic to varying degrees.

Since *L. pinastri* is one of the fungi most frequently found in pine needles, while *L. seditiosum* is not always present (Patejuk *et al.* 2021; Lazarevic and Menkis 2020), it is suspected that *L. pinastri* occupies the same infection sites and thus partially prevents colonisation by *L. seditiosum*. While *L. seditiosum* seems to prefer the Scots pine in Switzerland, *L. pinastri* is found most frequently on Swiss stone pine.

There are no effective countermeasures in Switzerland, as the application of chemical agents such as fungicides is prohibited in the forest. In gardens, it is possible to try to rake up the majority of the needles regularly and thus to reduce the risk of infection.

Brown spot needle blight

The brown spot needle blight *(Lecanosticta acicola*), a non-native pathogen, was first observed in Switzerland in the canton of Zurich in 1995 and first detected in the forest in 2016.

On green needles that are one or more years of age, yellow to brown spots develop in spring, usually with a yellow edge. They are initially 1–2 mm in diameter, before widening into bands. The centre soon turns brown. This is where the fruiting body (0.2–0.8 mm) develops, pushing the epidermis of the needle upwards to form a band. The spores give the fruiting body a slightly olive-green colour. The symptoms are most clearly visible in early summer. Infected needles turn brown and are shed from the summer onwards. The pattern of infestation follows a characteristic course within the tree: the infestation spreads from the bottom to the top and from the inside to the outside. In advanced stages, it is often only the freshly sprouted needles of the youngest generation that remain green. Especially when the dead needles are shed, bare branches with tufts of new needles at the branch tips may look a bit like trimmed poodles' tails.

The fungus overwinters on dead needles, which remain infectious on the tree or in the litter for up to six months. It is spread mainly by rainsplash or water droplets that carry spores from infected needles to other trees. The fungus thrives particularly well at temperatures of 17–22 °C.

Mountain pine (*P. mugo*, 83 %) is particularly susceptible to this fungus. Other pine species are also affected, but to a much lesser degree: Scots pine *(P. sylvestris)* 7.5 %; black pine *(P. nigra)* 2 %; and stone pine *(P. cembra)* and other pine species < 1 % (Rigling *et al.* 2021).

In Switzerland, the only effective countermeasure is to remove an infected tree from the stand. While the wood is not infectious and can be used as firewood, all needles should be burnt on site or disposed of safely (waste incineration). Tool hygiene is important (disinfection with 70 % alcohol).

The symptoms can be confused with those of physiological needle blight or infections caused by other needle cast fungi such as *Dothistroma* spp., *Lophodermium seditiosum* or *Cyclaneusma minus*. A fresh infection on the needles may be mistaken for the bore holes or feeding sites of insects such as the pine needle weevil *(Brachonyx pineti)*.

Red band needle blight

The non-native red band needle blight (*Dothistroma* spp.) is one of the most significant diseases of pines. There are two species that cause the disease: *Dothistroma septosporum,* and *Dothistroma pini*. They can only be distinguished by means of molecular methods.

Since the 1990s, an increase in both the occurrence and intensity of infestation with the red band needle blight has been observed, mainly in the northern hemisphere. There are two factors contributing to this development: it is related to changing climatic conditions such as altered rainfall patterns on the one hand, but on the other hand also to the planting of already infected or susceptible young trees. Whereas *D. septosporum* is found worldwide, *D. pini* seems to be less widespread for the time being. After its first discovery in Switzerland, red band needle blight was mainly found in urban green areas, usually on single trees or small groups of trees. From 2013 onwards, it has also been found locally in forests, where usually a dozen to several hundred trees are affected.

Infected are mainly pines, but to a lesser extent also genera such as spruce *(Picea)*, fir *(Abies)*, larch *(Larix)*, Douglas fir *(Pseudotsuga)* or cedar *(Cedrus)*. In Switzerland, mountain pine (*P. mugo*, 69 % of cases) is most affected, followed by Scots pine and black pine (17.5 %, 6 % respectively). In Scots pines, the disease is most clearly visible on young plants. If we look at *D. pini* separately, we see that black pines are most frequently affected. So far, other species such as the Swiss stone pine (*P. cembra*; 1.3 %), other pine species (< 1 %), and spruce (*Picea abies*; 0.4 %) are less frequently infected by *Dothistroma* spp. (Rigling *et al.* 2021).

The symptoms of red band and brown spot needle blight are very similar. In red band needle blight, however, instead of the olive-green spots, there are usually characteristic vermilion or orange-red spots or bands that form. In the centre of each band, a dark fruiting body develops. The fruiting body measures 0.2–0.8 mm in diameter and pushes the epidermis of the needle upwards in a similar way to that of brown spot needle blight, forming bands. The red band needle blight and brown spot needle blight are also similar in terms of their infestation patterns, overwintering, control measures and possibilities of confusion with other diseases. The three pathogens that cause red band and brown spot needle blight can also occur together, not only on the same tree, but even on the same needle.

Diplodia pine tip / shoot blight

Pine tip blight (*Diplodia sapinea*, syn. *Sphaeropsis sapinea*) is one of the most common diseases afflicting pine trees, not only in Switzerland but worldwide. Conifers from other genera (e. g. *Picea, Abies, Cedrus, Larix, Pseudotsuga*) can also be affected, but the infestation is usually less severe.

In Switzerland, there has been a notable increase in pine tip blight since 2016. The causes are the hot and dry summers on the one hand, and severe hail storms on the other (Queloz *et al.* 2018). Black pine remains the most susceptible pine species, but mountain and Scots pine are also severely affected in some cases (Queloz *et al.* 2018). Very severe infestation can cause the trees to die. Among the most obvious symptoms are the stunted brown needles on the dead brown shoot tips. Usually only the tip (i. e. the youngest needles) is affected. The fungus is easily recognisable as soon as these symptoms appear.

When a shoot is infected, one of the first signs is the secretion of small droplets of resin from the buds. Infected buds stop growing. This is why the needles do not reach their normal size. They remain on the tree for a long time. New buds do sprout to replace the dead ones, but they are also infected. Eventually, the shoots become bent – a symptom that can be exacerbated by insect larvae. The asexual fruiting bodies are small, black, and spherical. They occur on the needle, the bark or the cones. On the needle, they are to be found especially under the fascicle sheath at the needle's base, but in severe cases they appear all over the needle. If the infection has not arisen after damage caused by hail, crown parts close to the ground are often more severely affected. If the infection spreads to the bark of branches, bark necroses develop and there may sometimes be strong secretion of resin. If *D. sapinea* penetrates into the wood, the wood turns bluish in colour.

The virulence of the fungus depends on predisposing factors such as drought. The link between drought and disease is the subject of many studies. Among the diseases that are favoured by drought, there are several that are accompanied by canker and dieback. Pathogens from genera such as *Botryosphaeria, Diplodia, Cytospora* and *Biscognauxia (Hypoxylon)* are among the best-known pathogens in this context (Desprez-Loustau *et al.* 2006). While drought generally has a negative effect on fungal growth, these genera benefit from the weakening of the host.

D. sapinea can remain in the tissue of the tree at the endophytic life stage for a long time. The growth of other fungi such as *Bjerkandera adusta, Botrytis cinerea* and at least one species of each of *Armillaria* and *Rhizoctonia* appears to be inhibited by the presence of *D. sapinea* (DE OLIVEIRA *et al.* 2019).

In gardens, attempts can be made to control the fungus by pruning infested shoots back to healthy wood. Tool hygiene through disinfection with 70 % alcohol is essential here.

Cenangium dieback

The fungus *Cenangium ferruginosum* occurs predominantly as a saprobiont on dead branches on all pine species in Switzerland. As a parasite that exploits weakness, it occasionally kills the bark and cambium of twigs and branches weakened by environmental factors, other pests, diseases or natural ageing. The fungus has also been found in the needles, leading to the assumption that these could act as a reservoir storing the pathogen during unfavourable conditions (SIEBER *et al.* 1999).

At the beginning of spring, the needles of individual twigs or whole branches first turn yellowish-green, then yellow, before turning brown from the base upwards. They eventually fall off in summer. If the bark is removed at the base of dead branches, a sharp line between healthy and dead tissue becomes visible. The fungal fruiting bodies develop at the beginning of summer. They are dark brown, 2–3 mm long, and grow out of the stomata of the pine branches. In humid surroundings, the fruiting bodies open up to form plate-like structures that are ochre-yellow on the inside. Under the microscope, *Cenangium* can be identified by its sexual fruiting bodies and the spores they contain. The club-shaped asci contain eight unicellular, elliptical ascospores (10–13 × 5–7 µm).

Infestation is not fatal for the tree. It is not necessary to treat this disease in the forest.

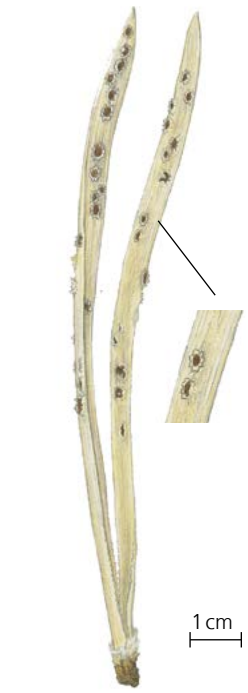
Scleroderris dieback / *Brunchorstia* dieback

Scleroderris dieback is one of the more serious diseases infecting conifers. It causes shoot dieback, but can also lead to extensive damage to the bark in severe cases. The pathogen *Gremmeniella abietina* (syn. *Scleroderris lagerbergii*) comprises several varieties and subgroups, some of which favour different pine species. It is widespread and occurs not only in Central Europe, but also in East Asia and North America on conifers native to these regions. While damage caused by this pathogen in Europe before 1960 mainly occurred in Scandinavian Scots pine stands, it increased in central Europe between 1960 and 1970 (STEPHAN 1979). Other coniferous genera such as spruce *(Picea)*, fir *(Abies)*, larch *(Larix)* and Douglas fir (*Pseudotsuga)* can also be infected. In winter, resinous lesions form at the base of needles and buds, especially on one- and two-year old branches. The resinous areas expand and may encircle the whole branch. The affected areas wither and die. The needles turn brown from the base onwards, with the infection subsequently spreading from the shoot tip to the needles of older generations. Over time, bushy growth may occur as the tree attempts to replace dead branches with new shoots. Over the years, depending on whether conditions are favourable for the fungus (summers with high levels of precipitation), or a drier phase slows down its growth, the trees may die or recover.

From the first year of infestation, asexual fruiting bodies form on the dead twigs and buds. From the second year onwards, sexual fruiting bodies also appear, in the form of brownish black cuplets measuring 0.5–1 mm in diameter.

Only silvicultural measures are worth considering when it comes to minimising damage caused by this disease in the forest. Cool-moist stands should for example be thinned at an early stage, and afforestation under canopy should be avoided.

Snow blight



Snow blight (*Gremmenia infestans,* syn. *Phacidium infestans*) is a typical disease of high altitudes. The fungus has adapted to winter conditions in the mountains. It exclusively attacks needles that are covered by snow. It is even able to grow in snow (temperatures below °C). This ability allows the fungus to spread from one needle to the next, or from one shoot to another. Small trees and seedlings that are completely covered by snow can die after just one year if infested. Besides pines, spruces *(Picea)*, firs *(Abies)* and junipers *(Juniperus)* are also potential hosts – although they are infected far less frequently.

With snowmelt in the spring, symptoms become visible on the trees. Infested needles have a pale yellow to light brown appearance. Over the course of the year, they continue to discolour, eventually becoming a brownish light grey. The tiny fruiting bodies, up to 1 mm in diameter, push to the surface from August onwards (often on the underside of the needle). The epidermis of the needle tears open in a star shape as this happens and reveals the reddish beige mass of fruiting bodies. The spores infect freshly sprouted needles of the same year and develop internally during the winter months.

Heavily infested trees can be pruned back to health. For this, it is necessary to prune all affected areas right down to healthy wood. Ensuring a mixture of different tree species can help prevent the spread of the fungus.

General source: Kurkela 1996

Pine blister rust

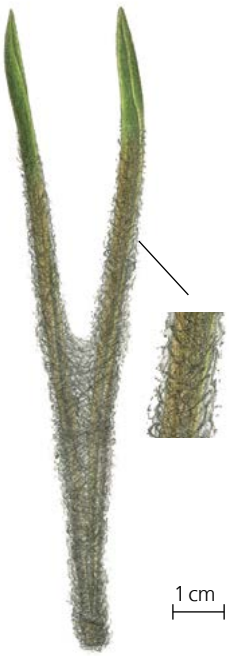
Pine blister rust (*Cronartium pini,* syn. *C. flaccidum*) mainly attacks Scots and mountain pines in Switzerland, but also other two-needled pine species. The disease is very noticeable with its large yellowish-orange blisters.

The fungus infects young shoots, growing initially in their bark for one to two years without triggering symptoms. Then, in spring, blister-like white formations erupt, usually around the branch whorls, turning orange over time. The shoots normally die within a couple of years. From the shoots the fungus penetrates into the trunk, and the tree responds by secreting more resin in affected areas. This leads to a blockage of the vascular vessels in the cambium (resinification), and thus to an inhibition or complete interruption of the water and nutrient transport. Tree parts above resinified areas die.

Every year, more bark tissue is killed as the fungal mycelium continues to grow. The tree reacts with callus growth that partially overgrows the affected zone. Over time, affected areas appear flattened and deformed. Once the tree is infected, the fungus cannot be eradicated anymore. On old pines and after years of infestation, the disease leads to complete crown dieback. On young pines, death comes as soon as the affected area encompasses the whole trunk.

To complete its life cycle, *C. flaccidum* changes hosts, like most rust fungi. Gentians *(Gentiana)*, peonies *(Paeonia)*, swallow-wort *(Vincetoxicum)* and some other herbaceous plants are possible intermediate hosts. Unusually, there is an asexual form of the fungus that does not depend on this change of host and can be transmitted directly from pine to pine. This form is more common in northern Europe. It has not been conclusively clarified whether these are two distinct species (*C. pini* non-host alternating and *C. flaccidum* host alternating), or whether they are two forms of the same species.

Black snow mould



The black snow mould, also known as brown felt blight (*Herpotrichia pinetorum*, syn. *H. juniperi*), like white snow blight, is a conspicuous disease of high altitudes. Several species/varieties exist, but morphologically they are hardly distinguishable. One of them, *H. coulteri* (syn. *Neopeckia coulteri*), is only found on mountain pine above 2000 m a. s. l.. Its bicellular spores distinguish it from *H. pinetorum,* the spores of which are quadricellular. The distinction can thus only be made with the help of microscopic analysis. In the subalpine zone, *H. pinetorum* attacks mountain pine, juniper *(Juniperus)* and spruce *(Picea)*; at lower altitudes it can also occur on fir *(Abies)*.

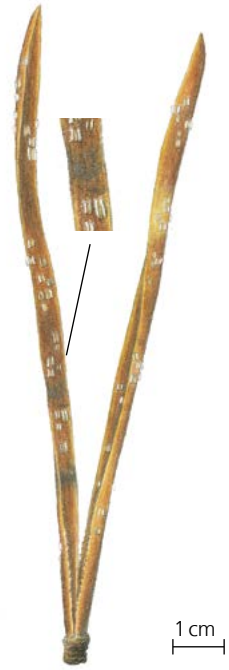
The most striking symptom is the fine brown-black mycelium that completely envelopes the needles and shoots. Often the areas close to the ground are infected, but occasionally whole trees or shrubs. The fungus grows in cavities under the snow cover (down to –5 °C). It stops growing when the snow melts, and its mycelium survives the dry summer until the next snowfall. The needles within the felt-like mycelium are still green at first, but die off over time, turning brown in the process. The fungus spreads from the needles to the shoots, causing them to die as well. Only after a while do the affected needles and shoots fall off.

In the second year, spherical black fruiting bodies form, either on the surfaces of dead needles (pine and spruce) or within the epidermis (juniper). Spores formed in the fruiting bodies in late autumn infect healthy needles. New needles and shoots can also be infected by the mycelium in winter, similar to the process of infection with snow blight.

The only effective means of dealing with this fungus is to remove and burn the infested material.

General source: Nierhaus-Wunderwald 1996

Cyclaneusma needle cast



The fungus *Cyclaneusma minus* (syn. *Naemacyclus minor*) triggers the disease *Cyclaneusma* needle cast (also *Naemacyclus* needle cast). Along with *Lophodermium pinastri, L. seditiosum* and *Cenangium ferruginosum,* it is one of the most common endophytes affecting pine needles.

Once older needles have turned yellow in summer and autumn – often with brown-reddish bands reminiscent of physiological needle blight – the sexual fruiting bodies form in the litter and on dead needles on the tree in late winter and spring. The fruiting bodies are barely 1 mm in diameter, cream-coloured and, when open, resemble little windows with light-coloured shutters. These also serve for identification. Around these fruiting bodies, the needle often fades to an ochre brown. The milder and wetter the winter, the more the fungus spreads. Asexual conidia are produced throughout the year and continuously infect the needles.

The spatial distribution of *C. minus* is rarely even. Trees with and without symptoms are usually found in close proximity. Infestation can lead to severe needle cast, but is normally more or less imperceptible. It is thus not necessary to take any countermeasures.

Swedish pine needle cast

Swedish needle cast is caused by *Lophodermella sulcigena* and is more common in northern Europe. It attacks various pine species, but especially Scots pine, mountain pine and black pine.

During its one-year life cycle, it infects needles in summer. These subsequently die from the tip, and turn a yellowish light brown. The base of the needle, on the other hand, remains green, and is separated from the dead needle material by a clearly defined brownish-purple band. The needles and infected short shoots remain on the tree until the following year. They continue to fade to a greyish white. Elliptical black fruiting bodies of 2–20 mm in length develop on the dead needles (needle on the left in the picture). Affected shoots and crown areas appear to be pinkish brown from a distance.

This fungus is a dangerous pathogen, especially in Scandinavia. In Switzerland, it only occurs on an isolated, local basis, and does not cause any major damage. The removal and burning of infested trees has proven effective in controlling the disease.

A sister species of this fungus *(L. conjuncta)* has also recently been found in Switzerland. This species differs from *L. sulcigena* in that its fruiting bodies are far shorter (max. 4 mm in length) and its spores are different (on the right in the picture).

General source: Queloz *et al.* 2019

Sydowia dieback of pine

Sydowia polyspora is a widespread and extremely polyphagous fungus that takes advantage of weakened trees and which, as an endophyte, can also occur in the needles without triggering symptoms. It probably has the widest range of hosts in comparison with other fungi associated with conifers. It is also able to colonise all organs of the tree. The only exception are the roots, where it rarely occurs.

In slightly symptomatic needles of Scots pine (yellow to brown spots), the fungus is found particularly frequently. In the litter it is often found together with fungi that colonise deadwood. It also often occurs on trees that have died from other causes. Its growth is not limited to the needles. It is also able to colonise shoots and even wood. The wood then discolours, turning grey. In many conifers, the fungus is found mainly in its asexual form *(Sclerophoma pithyophila)*. The asexual fruiting bodies are very small (200–300 µm), black, and spherical, and protrude irregularly from the colonised plant tissue.

S. polyspora is very often found in association with pathogenic fungi and also with insect pests. In the literature, it is sometimes described as pathogenic, although its pathogenicity has not been proven so far. Most likely it is involved in complex diseases, but does not have a strong damaging effect on trees on its own.

As the pathogenicity of *S. polyspora* has not as yet been fully clarified, there are no reliable control measures. It is also unclear whether the removal of diseased parts of the tree right down to healthy tissue would be beneficial. As a preventive measure, the strengthening of the general health of the tree, i. e. through adequate watering and fertilisation, could prevent damage as the fungus profits from its host's weakness.

Pine needle rust

Pine needle rust is caused by the rust fungus *Coleosporium tussilaginis* and other very closely related species. To reproduce, it needs two different hosts (host change) - pines on the one hand, and various herbaceous plants on the other. In the case of *C. tussilaginis* in the narrower sense, the latter are often coltsfoot *(Tussilago).*

An infection with a rust fungus is very obvious. The blister-shaped fruiting bodies are 1–3 mm wide and protrude from the epidermis of still green needles. With their flesh-coloured yellowish to orange colouring, they stand out against the green needles. At a mature stage, the thin skin of the fruiting body tears open, whereupon a yellowish-orange spore powder is released.

Unlike other needle diseases presented here, usually only a few needles become infected. Scots pines usually survive an infestation without any problems.

Physiological needle blight

Physiological needle blight is a natural process resulting from needle ageing, and one that every needle goes through. Accordingly, it is mainly older needle generations that are affected. Although it is not a disease, the phenomenon is listed here for the sake of completeness. It is often reported to the Swiss Forest Protection Group having been mistaken for a real disease.

Pine needles reach different ages, depending on the species. While the needles of the mountain pine are shed after 5–10 years, the needles of the Scots pine are shed after 1–8 years (ETH 1995).

As the needles die, they turn brown. Depending on the chemical substances deposited in the dying needles, individual parts of the needles turn to different shades of brown to red.

Literature

Abegg, M.; Brändli, U.-B.; Cioldi, F.; Fischer, C.; Herold, A.; Meile, R.; Rösler, E.; Speich, S.; Traub, B., 2020: Schweizerisches Landesforstinventar LFI. Ergebnistabellen und Karten der LFI-Erhebungen 1983–2017 (LFI1, LFI2, LFI3, LFI4) im Internet. [Published online 10.6.2020] Available from World Wide Web <www.lfi.ch/resultate> Birmensdorf, Eidg. Forschungsanstalt WSL. https://doi.org/10.21258/1382821.

Behnke-Borowczyk, J., 2018: Biodiversity of fungi community on Scots pine needles infected of the autumn needle cast. SYLWAN 62, 4: 288–294.

Behnke-Borowczyk, J.; Kwasna, H.; Kulawinek, B., 2019: Fungi associated with *Cyclaneusma* needle cast in Scots pine in the west of Poland. Forest Pathology 49, 2: e12487.

Butin, H., 2011: Krankheiten der Wald und Parkbäume: Diagnose, Biologie, Bekämpfung, 4. Auflage. Ulmer, Stuttgart, 318 S.

de Oliveira, C.F.; Moura, PF.; Rech, KS.; Paula de Oliveira, C.D.P.; Hirota, B.C.K.; de Oliveira, M.; da Silva, C.B.; de Souza, A.M.; Dias, J.D.G.; Miguel, O.G.; Auer, C.G.; Miguel, M.D., 2019: Antagonistic activity of *Diplodia pinea* against phytopathogenic fungi. Folia Microbio. 64, 3: 415–419.

Desprez-Loustau, M.L.; Marcais, B.; Nageleisen, L.M.; Piou, D.; Vannini, A., 2006: Interactive effects of drought and pathogens in forest trees. Ann. For. Sci. 63, 6: 597–612.

Dubach, V.; Meyer, J.B.; Schneider, S.; Ruffner, B.; Queloz, V., 2018: Nationales Monitoring von zwei besonders gefährlichen Föhrenkrankheiten 2016. Suivi national de deux maladies du pin particulièrement dangereuses 2016. Monitoraggio nazionale di due malattie particolarmente pericolose del pino 2016. 34 S.

ETH Professur für Waldbau, Professur für Forstschutz und Dendrologie, 1995: Mitteleuropäische Waldbaumarten. Artbeschreibung und Ökologie unter besonderer Berücksichtigung der Schweiz. Zürich: ETH Vorlesungsskript. S. 248.

Kurkela, T., 1996: Ascospore production period of *Phacidium infestans*, a snow blight fungus on *Pinus sylvestris*. Scand. J. For. Res. 11: 1–4, 60–67.

Lazarevic, J.; Menkis, A., 2020: Fungal Diversity in the Phyllosphere of *Pinus heldreichii* H. Christ – An Endemic and High-Altitude Pine of the Mediterranean Region. Diversity 12, 5: 172 S.

Nierhaus-Wunderwald, D., 1996: Pilzkrankheiten in Hochlagen – Biologie und Befallsmerkmale. Merkbl. Prax. 27. 8 S.

Nierhaus-Wunderwald, D.; Engesser, R.; Rigling, D., 2012: Hallimasch – Biologie und forstliche Bedeutung. 2. überarbeitete Aufl. Merkbl. Prax. 21. 8 S.

PATEJUK K.; CIEŚNIEWSKA, A.B.; KACZMAREK-PIEŃCZEWSKA, A.; PUSZ, W., 2021: Mycobiota of peat-bog pine (*Pinus* × *rhaetica*) needles in the Stołowe Mountains National Park, Poland. Nova Hedwigia 112, 1–2: 253–265.

QUELOZ, V.; BUSER, C.; DUBACH, V.; HÖLLING, D.; MEYER, JB.; SCHNEIDER, S.; PROSPERO, S.; CORNEJO, C.; RIGLING, D., 2018: Überwachung von besonders gefährlichen Schadorganismen für den Wald – Jahresbericht 2017. Waldschutz Schweiz/Phytopathologie WSL, S. 48.

QUELOZ, V.; FORSTER, B.; BEENKEN, L.; STROHEKER, S.; ODERMATT, O.; HÖLLING, D.; MEYER, J.B.; DUBACH, V., 2019: Waldschutzüberblick 2018. WSL Ber. 79: 33 S.

REIGNOUX, S.N.A.; GREEN, S.; ENNOS, R., 2014: Molecular identification and relative abundance of cryptic *Lophodermium species* in natural populations of Scots pine, *Pinus sylvestris* L. Fungal Bio. 118: 835–845.

RIGLING, D.; DUBACH, V., BEENKEN, L.; SCHNEIDER, S.; HÖLLING, D.; PROSPERO, S.; CORNEJO, C.; RUFFNER, B.; AUGUSTINUS, B.; BROCKERHOFF, E.; QUELOZ, V., 2021: Überwachung von besonders gefährlichen Schadorganismen für den Wald – Jahresbericht 2020. Surveillance des organismes nuisibles particulièrement dangereux pour la forêt – Rapport annuel 2020. Monitoraggio degli organismi nocivi particolarmente pericolosi per il bosco – Rapporto annuale 2020. WSL Ber. 108. 99 S.

SIEBER, T.; RYS, J.; HOLDENRIEDER, O., 1999: Mycobiota in symptomless needles of *Pinus mugo* ssp. uncinate. Mycol. Res. 103, 3: 306–310.

SINCLAIR, W.; LYON H., 2005: Diseases of trees and shrubs. 2nd edition. Cornell University Press, New York. 616 p.

STEPHAN, B.R., 1979: Beobachtungen über das Vorkommen und die Variation von *Scleroderris lagerbergii* Gremmen in Norddeutschland. Z. Mykol. 45, 1: 45–53.

WÜEST, R.O.; BERGAMINI, A.; BOLLMANN, K.; BRÄNDLI, U.B.; BALTENSWEILER, A., 2021. Modellierte Verbreitungskarten für die häufigsten Gehölzarten der Schweiz. Schweiz. Z. Forstwes. 172, 4: 226–233. https://doi.org/10.3188/szf.2021.0226

Further information

Used standard references:
Butin 2011, SINCLAIR und LYON 2005

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