EPPO Datasheet: *Lecanosticta acicola*

Last updated: 2023-01-20

IDENTITY



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Preferred name: *Lecanosticta acicola*
Authority: (von Thümen) Sydow
Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Dothideomycetes: Dothideomycetidae: Mycosphaerellales: Mycosphaerellaceae
Other scientific names: *Cryptosporium acicola* von Thümen, *Dothiostroma acicola* (von Thümen) Schischkina & Tsanava, *Lecanosticta pini* Sydow, *Mycosphaerella dearnessii* Rostrup, *Oligostroma acicola* Dearness, *Scirrhia acicola* (Dearness) Siggers, *Septoria acicola* (von Thümen) Saccardo, *Systremma acicola* (Dearness) Wolf & Barbour
Common names: brown spot needle blight, brown spot of pine, needle blight of pine
view more common names online...
EPPO Categorization: A2 list
view more categorizations online...
EU Categorization: RNQP ((EU) 2019/2072 Annex IV)
EPPO Code: SCIRAC

Notes on taxonomy and nomenclature

Lecanosticta acicola was described by De Thuemen in 1878 as *Cryptosporium aciculum* (De Thuemen, 1878).

HOSTS

Potentially all species of *Pinus* are hosts. The main hosts in the EPPO region are: *P. contorta*, *P. halepensis*, *P. mugo* , *P. nigra*, *P. pinaster*, *P. pinea*, *P. radiata* and *P. sylvestris*. Certain species, such as *P. banksiana*, have been shown to be highly resistant (Skilling & Nicholls, 1974), whilst traces of infection were noted on *Picea glauca* artificially exposed to a heavy spore inoculum. Recently, the pathogen was reported from *Cedrus libani* in Turkey (Oskay *et al.*, 2020) and *C. atlantica* in France (Schenck *et al.*, 2022).

Host list: *Cedrus atlantica, Cedrus libani, Pinus arizonica, Pinus attenuata, Pinus ayacahuite, Pinus banksiana, Pinus brutia, Pinus canariensis, Pinus caribaea, Pinus cembra, Pinus cembroides, Pinus clausa, Pinus contorta var. latifolia, Pinus contorta, Pinus coulteri, Pinus cubensis, Pinus densiflora, Pinus echinata, Pinus elliottii, Pinus engelmannii, Pinus glabra, Pinus halepensis, Pinus jeffreyi, Pinus maximinoi, Pinus mugo subsp. uncinata, Pinus mugo var. pumilio, Pinus mugo, Pinus muricata, Pinus nigra subsp. laricio, Pinus nigra subsp. pallasiana, Pinus nigra, Pinus oocarpa, Pinus palustris, Pinus patula, Pinus pinaster subsp. escarena, Pinus pinaster, Pinus pinea, Pinus ponderosa var. scopulorum, Pinus ponderosa, Pinus radiata, Pinus resinosa, Pinus rigida, Pinus serotina, Pinus strobus, Pinus sylvestris, Pinus taeda, Pinus tecunumanii, Pinus thunbergii, Pinus virginiana, Pinus x rhaetica , Pinus x sondereggeri*

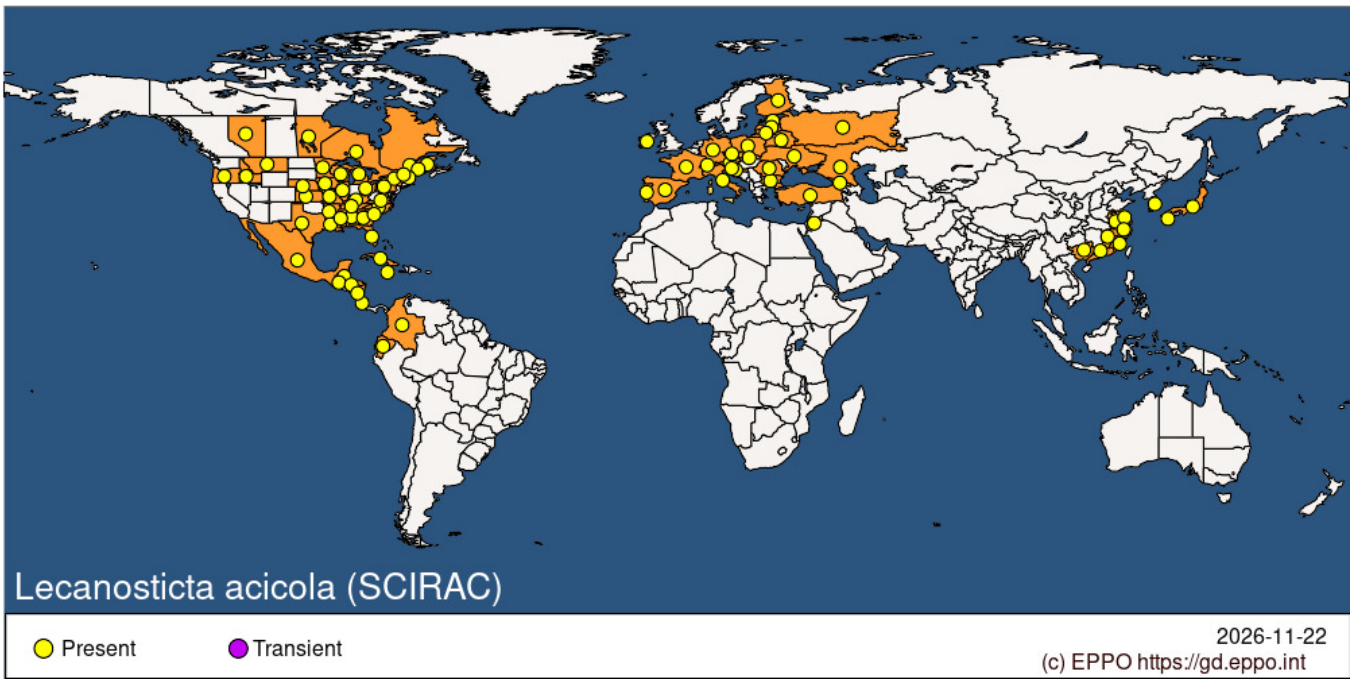
GEOGRAPHICAL DISTRIBUTION

Lecanosticta acicola, was isolated for the first time in 1876 from needles of *Pinus caribaea* in South Carolina, USA. In the 20th century the disease became common in the south-eastern parts of the USA on the highly susceptible *Pinus palustris* (long leaf pine). Later the disease spread to northern parts of the USA, to Canada and to Europe, Asia and South America (Janoušek *et al.*, 2016). Nearly 50% of all reports of the pathogen are from 2009-2019 and this reflects the ongoing increasing spread of the species (van der Nest *et al.*, 2019a). In Europe the first records of the

disease were in 1942 (Spain; Martinez 1942) and 1976 (Croatia; Milatovi?,1976). In many countries the outbreaks were initially limited to urban sites, but from 2010 on they are increasingly reported from forests as well.

Eight of the known species of the genus *Lecanosticta* were described from Central America and therefore a Mesoamerican centre of development of the genus *Lecanosticta* is probable (Van Der Nest *et al.* 2019b). The only widespread species, *L. acicola* however, probably derives from southern North America and resolves in three lineages differing in cultural morphology and pathogenicity. One lineage from the Northern USA was likely introduced into Central and Northern Europe. The second lineage from the Southern USA was introduced into France, Spain and Columbia as well as into Asia. The third lineage, deriving from Mexico, is limited to Mexico up to now (Janoušek *et al.*, 2016). This lineage is the most diverse of all probably comprising one or more cryptic species (Huang *et al*. 1995; Janoušek *et al*., 2016; van der Nest *et al*. 2019b). For seven of the eight known species from Central America no records are known from other regions and pathogenicity is largely unknown.

L. acicola is heterothallic (Janoušek *et al*., 2014) and both mating types are present in Europe. In several European countries including Spain the ratio of mating type idiomorphs indicates frequent and widespread occurrence of sexual recombination (Janoušek *et al*., 2016). The sexual stage was recorded in Spain (Mesanca *et al.*, 2021a).



EPPO Region: Austria, Belarus, Bulgaria, Croatia, Czechia, Estonia, Finland, France (mainland), Georgia, Germany, Ireland, Italy (mainland), Jordan, Latvia, Lithuania, Poland, Portugal (mainland), Romania, Russian Federation (Central Russia, Southern Russia), Slovakia, Slovenia, Spain (mainland), Switzerland, Türkiye, Ukraine
Asia: China (Anhui, Fujian, Guangdong, Guangxi, Jiangsu, Jiangxi, Zhejiang), Japan (Honshu, Kyushu), Jordan, Korea, Republic of
North America: Canada (Alberta, Manitoba, New Brunswick, Ontario, Québec), Mexico, United States of America (Alabama, Arkansas, Florida, Georgia, Idaho, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Vermont, Virginia, Wisconsin)
Central America and Caribbean: Belize, Costa Rica, Cuba, Guatemala, Honduras, Jamaica, Nicaragua
South America: Colombia, Ecuador

BIOLOGY

Climate represents the main critical factor influencing disease intensity of *L. acicola*. Both temperature and precipitation directly affect production and dispersal of conidia, ascospores and infection rates. Conidia release occurs at temperatures between -5.5°C and 28°C (Siggers, 1944; Wyka *et al.*, 2018). Ascospores can be trapped at temperatures from 4°C upwards but are most commonly found at temperatures around 15°C (Kais, 1971). Peaks of

release are seen when weekly temperatures average 15.5°C, decrease measurably at 10°C and apparently cease around 4°C (Kais, 1971).

Under moist conditions, conidia exude from the acervulus in a mucilaginous, green, wedge-shaped cirrus and are dispersed by rain-splash (probably also by mist or fog moved by wind) to adjacent trees. Conidia are dispersed up to a distance of 60 m (Wyka *et al.*, 2018), but maximal distances of 1 km can be expected (Mullett *et al.*, 2016). For ascospores however, long distance spread by wind is likely.

Germination of conidia requires temperatures between 5°C and 32-35°C (Northern lineage of *L. acicola*). The Southern lineage tolerates higher temperatures (Huang *et al*., 1995). For infection, optimal temperatures are 30 °C during the day and 21 °C at night (Kais, 1975). The temperature amplitude for the survival of the pathogen is certainly wider: in plants, the pathogen resists long frost periods as well as extreme hot periods.

As numerous observations showed, conidial release is connected to rainfall patterns. This explains why disease spread is slower in dry summer periods (Beenken *et al*., 2018). Ascospores however are discharged with or without rainfall (Kais, 1971).

Conidia germinate with tubes entering the needles via stomata or wounds (Kais, 1978). Light stimulates the opening of stomata, and the germ tube penetrates the needle (Kais, 1975). Direct penetration via appressoria is uncertain. The incubation period depends on needle-age varying from 1-2 months on young needles to 4-7 months on older foliage and there are differences among pine species with respect to varying susceptibility of needles with age. On the needles acervuli develop. The disease cycle renews the following spring when the overwintering fruiting bodies release conidia as temperature and rainfall increase. In warmer climates, the conidia remain on the needle for many months. Ascostromata are formed on necrotic distal parts of living needles infected in the previous year (Henry, 1954; Jewell, 1983). Ascospores are forcibly expelled and dispersed by wind currents or rain splash driven by wind. Both sexual and asexual stages also develop and mature on cast needles and constitute an important source of interseasonal survival.

DETECTION AND IDENTIFICATION

Symptoms

L. acicola causes brown spot needle blight of pines. Symptoms on needles vary depending on the host species. On many hosts, the first visible symptoms are orange/yellow, often resin-soaked irregular circular spots, which later become dark brown in the centre, but often with a yellowish halo. The spots usually widen to bands encircling the needle and causing death of the distal parts. Lesions are always sharply delimited from the surrounding living tissue (Hedgcock, 1929). These spots turn brown, sometimes they appear resin-soaked, and they often have a yellowish-orange halo. Later brown bands develop from the spots. On the needle surface any trace of reddish (brick-red) discoloration, typical for *Dothistroma*, is usually missing (for probable exceptions see Evans, 1984). In some cases, as this has been reported for *P. strobus*, symptoms may only be displayed as chlorosis of the needles without banding (Broders *et al*., 2015). Diseased needles typically show dead tips, central zones with spots in green tissue, and green bases. Infected needles usually die from the apex to the base. Often the proximal part of the needle remains green for a while, and this gives a good indication (but not evidence) for presence of *L. acicola*. Eventually the whole needle turns brown and is shed. In *P. sylvestris* this typically occurs before the conidiomata become visible.

Initially only the second year and older needles are affected, leaving healthy new growth at the tips of the branches. Usually, infection starts in the lower parts of the canopy and then progresses upwards in the trees (Sinclair and Lyon, 2005; Skilling and Nicholls, 1974). Over several years, this may result in total loss of older needles leaving only the current year's needles, which are distinctly shorter ('paintbrush'-like branches) and often already visibly infected (brown tips or distal parts brown with conidiomata). Infection of the current year's needles often results in branch and later tree death. However, all these symptoms can be confused with those of other needle pathogens, above all *Dothistroma* needle blight.

Morphology

Anamorphic stage: acervuli are black to olive green, subepidermal, becoming erumpent and stromatic, elliptical to elongate, arranged parallel to the long axis of the needle, 200-800 x 150-200 µm in size. Stromata are flat, raising only slightly the epidermis and appearing somehow shiny. They open via a longitudinal slit to release the conidia. Excessive stroma development results in loculate acervuli. Conidia extremely variable in form, subhyaline to dark-brown, echinulate to verrucose or tuberculate, thick-walled, straight to curved, with one to five septa, fusiform to cylindrical (11)–31–(64) x (1)–3.4–(6) µm, with a rounded apex and truncate base (morphological variations see Evans, 1984). Spermogonia of an *Asteromella* synanamorph present in uniloculate or multiloculate stromata; spermatia subhyaline to pale-green, rod-shaped, 2-4 x 0.8-1.3 µm.

Sexual stage: ascostromata are scattered, linear, innate, subepidermal, becoming strongly erumpent, black, invariably multiloculate (two to 18 locules), 400-850(-1200) x 120-250 µm. Ascospores are hyaline, smooth, one-septate, usually four-guttulate, oblong to cuneate, 7.5-14 x 2-3.5 µm, bluntly rounded at one end, tapering and fusiform at other. Since ascostromata are produced irregularly they are not particularly useful for identification.

Culture characteristics: *L. acicola* can be isolated on Malt Extract Agar from symptomatic needles following surface sterilization (EPPO, 2015). Firstly, a white aerial mycelium appears which turns greenish olive to dark olive, forming stromatic and erumpent colonies producing an olive-green conidial slime. At 20°C in daylight, the mycelium grows 2.5–3 mm a week. Colonies produce a yellow diffusate.

Detailed descriptions of the morphology of *L. acicola* as well as characteristics in culture are to be found in the EPPO diagnostic protocol for *L. acicola* (EPPO, 2015).

Detection and inspection methods

Samples should preferably be taken on sites where hosts show striking loss of needles, living needles distinctly shorter than usual and a significant proportion of needles with a brown distal part. This reflects the symptom expression in an advanced infestation stage on a highly susceptible host (e.g. *P. mugo*) and can be detected even from a distance. On Scots pine (*P. sylvestris*) conidiomata often ripen on already cast needles, so apart from symptomatic needles from the canopy needles from the litter should also be sampled.

Following detection of needles showing brown dead tissues (dead tips, brown spots, bands or dead parts with black stroma spots) and structures indicating conidial tufts (hand-lens) or needles with an even yellowish discoloration (*P. strobus*), needle samples should be taken for identification by a diagnostic laboratory.

PATHWAYS FOR MOVEMENT

The movement of infected planting material between regions and countries (long-distance spread) is thought to be the main anthropogenic pathway of spread of *L. acicola* (van der Nest *et al.*, 2019a). This corresponds to the numerous incidents of single tree-outbreaks in several Northern and Central European countries.

Intercontinental movement is possible in seed lots contaminated with infested needle debris. In addition, people and livestock are also thought to transfer spores from infested areas (e.g. tourists transmitting the pathogen into sensitive nature reserves (Jankovský *et al*. 2009; Siggers, 1944).

The following sources of spread are documented for *L. acicola* (MacLeod *et al.*, 2012; Jurc & Piškur, 2017):

- Luggage of passengers
- Forestry tools and equipment (Skilling & Nicholls, 1974) and car tyres
- Clothing and shoes
- Seeds, if the seed lots are contaminated by needles
- Insects

PEST SIGNIFICANCE

Economic impact

In North America, *L. acicola* is an important pine foliage disease, particularly of *P. palustris* in south-eastern parts of the USA and on *P. sylvestris* grown as Christmas trees (Enebak & Starkey, 2012). In China, extensive outbreaks were recorded in the 1970s in pine plantations including those of *P. elliottii* (Ye & Wu, 2011). In Central America the pathogen was reported as omnipresent in native pine forests (*P. caribaea*, *P. oocarpa*, *P. maximinoi*, *P. patula*) but not associated with serious needle blight according to Evans (1984), whose identification was based on morphological examination techniques.

In Europe, impacts on *P. sylvestris* seem to be variable at present but generally relatively slight (Van der Nest, 2019a). *P. nigra* subsp. *nigra* appears not to be badly affected (Hintsteiner *et al.* 2012), however in Slovenia increasing loss of adult Austrian black pines is reported by Jurc & Piskur (2017). In Austria, the shrubby species *P. mugo* (Mountain pine) and the upright growing *P. uncinata*, locally affected by *L. acicola* in high elevation habitats (protection forests), are subject to decline (Steyrer *et al.*, 2017). In addition, heavy infestations of trees in bogs in Germany, Austria, Switzerland and the Czech Republic cause losses of *P. mugo* (Schwanda *et al.*, 2022; Beenken *et al.*, 2018; Jankovsky *et al.*, 2008; Straßer *et al.*, 2016).

Generally, the expected impact of *L. acicola* on Europe's extensive natural and planted pine forests is a major concern considering the apparent recent increase in the pathogen's range.

Control

Both cultural and chemical control techniques have been developed, tested and practiced in the USA and are mostly targeted at *P. palustris*. For this fire-tolerant species controlled burning to destroy infected litter on the ground was one of the oldest measures against *L. acicola* (Barnett *et al.*, 2011). However, in many European countries environmental concerns limit the practice of burning. Alternatively silvicultural and forest hygienic measures are apt to reduce spread of the disease in a stand. Avoidance of dense (damp), foggy or waterlogged sites to reduce humidity leads to a decrease in inoculum (Munck *et al.*, 2011; McIntire *et al.*, 2018). Increasing the airflow lowers the probability of an infection for neighbouring trees (McIntire *et al.*, 2018). Where practical, pruning out heavily infected lower branches and removing especially heavily infected trees has also reduced infection in the vicinity according to several studies (Glavaš, 1979; Mesanza *et al.*, 2021b). The effects of mixed aged afforestation on disease progression needs further study, especially regarding the European pine ecosystems.

It is extremely difficult to eradicate regional outbreaks of brown spot needle blight in natural environments by means of hygienic measures. Therefore, efforts are necessary to prevent further spread. Selective removal of pines from highly visited touristic areas is being tested in Slovenia (Piškur *et al.*, 2019; Zavrtanik & Kolšek, 2020).

As far as plant production products are concerned, chemical control using active ingredients such as sulphur, copper, calcium hydroxide, and calcium caseinate was already widely used against *L. acicola* in the first half of the 20th century. More recently chlorothalonil and dithiocarbamate were used (Kais, 1989; Parris, 1969). Systemic fungicides such as benomyl also reduced infection of pine seedlings (Kais *et al.*, 1986). In China, treatment of bare rooted seedlings of *P. taeda* and *P. elliottii* with carbendazim or thiophanate-methyl was also effective (Hang *et al.*, 1992). Inoculations of seedlings with mycorrhiza (*Pisolithus tinctorius*) proved most effective when combined with fungicides including benomyl (Kais *et al.*, 1981) and copper oxychloride (Ferrer *et al.*, 2000).

Fertilisation has been used to increase tree vigour and resistance to infection with mixed results (Siggers, 1944). Fertilisation applied as a measure against *L. acicola* requires knowledge of relations between disease and soil properties, but there is only little known about the impacts of soil structure, micronutrient content, etc. on susceptibility of trees to the pathogen (Toole, 1939).

Breeding for host resistance was successful in North America after 1970 but it was limited to *P. palustris* (Barnett *et al.*, 2011). Hybrids of *P. palustris* x *P. elliottii* have also been developed with some resistance to *L. acicola* (Derr, 1966; Lott *et al.*, 1966).

Another option is to apply 'species change' in a forest, i.e. replacement of susceptible species by more tolerant or

resistant pines or by other conifer genera (Siggers, 1944).

Successful management often needs a combination of different strategies. In North America, a combination of *P. palustris* varieties with low susceptibility to *L. acicola* with fungicide applications were the key for a successful disease control (Kais & Griggs, 1986). In China, resistance of *P. elliottii* clones was enhanced by fertiliser applications (Gong & Liang, 1988).

Phytosanitary risk

The local but widespread occurrences of *L. acicola* in many European countries, and the distinct increase in number of outbreaks both in urban sites and natural forests pose a high risk for European pine ecosystems. According to the recent finding of ascomata of *L. acicola,* sexual recombination is present in Europe increasing the risk according to probable changes in pathogenicity and in aerial long-distance spread.

PHYTOSANITARY MEASURES

Until 2019 *L. acicola* was listed as Annex I/AI quarantine organism (EU Directive 2000/29/EU), with legal requirements for exclusion, eradication and containment through phytosanitary measures and specific surveys in all EU countries. Now, the species is listed under the Regulated Non-Quarantine Pests (RNQP) according to Commission implementing regulation (EU) 2019/2072. Required measures are statutory inspections of all plants for planting (ornamental and forest plants for planting) to ensure freedom from *L. acicola* prior to sale. Surveillance and management requirements for outbreaks in forests and urban sites are now limited to national regulations and these differ among the European states. However, the common occurrence of *L. acicola* on urban trees requires surveillance and eradication systems to avoid infection centres spreading the disease into natural forests. In EPPO Standard PM 8/2 *Coniferae*, there is further information for National governments to support decisions on phytosanitary measures targeted at the prevention of introduction and spread of quarantine pests through *Coniferae* plants and plant products moving in international trade. For *L. acicola*, this concerns all kinds of plant stock including large trees as well as bonsais, but also cut branches intended for decorative use and not for planting.

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ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2023 by Thomas L. Cech, Federal Forest Research Centre Vienna, Austria. His valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2026) *Lecanosticta acicola*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 1979 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2023. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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Co-funded by the
European Union