EPPO Datasheet: *Entoleuca mammata*

Last updated: 2023-05-12

IDENTITY

Preferred name: *Entoleuca mammata*
Authority: (Wahlenberg) Rogers & Yu
Taxonomic position: Fungi: Ascomycota: Pezizomycotina: Sordariomycetes: Xylariomycetidae: Xylariales: Xylariaceae
Other scientific names: *Hypoxylon holwayi* Ellis, *Hypoxylon mammatum* (Wahlenberg) J.H.Miller, *Hypoxylon pruinatum* (Klotzsch) Cooke, *Nemania mammata* (Wahlenberg) Granmo, *Rosellinia pruinata* (Klotzsch) Saccardo, *Sphaeria mammata* Wahlenberg, *Sphaeria pruinata* Klotzsch
Common names: canker of aspen, canker of poplar, hypoxylon canker of poplar
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EPPO Categorization: A1/A2 (formerly)
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EU Categorization: PZ Quarantine pest (Annex III)
EPPO Code: HYPOMA

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Notes on taxonomy and nomenclature

Entoleuca mammata (Wahlenb.) Rogers et Ju (1996) is a fungus of the genus *Entoleuca* (family Xylariaceae) which consists of both saprobic and plant pathogenic species (Jayawardena *et al.*, 2019). *E. mammata* was moved from the genus *Hypoxylon* to the genus *Entoleuca* following a revision of the genus (Rogers and Ju, 1996) during which the genus *Entoleuca* was re-established.

HOSTS

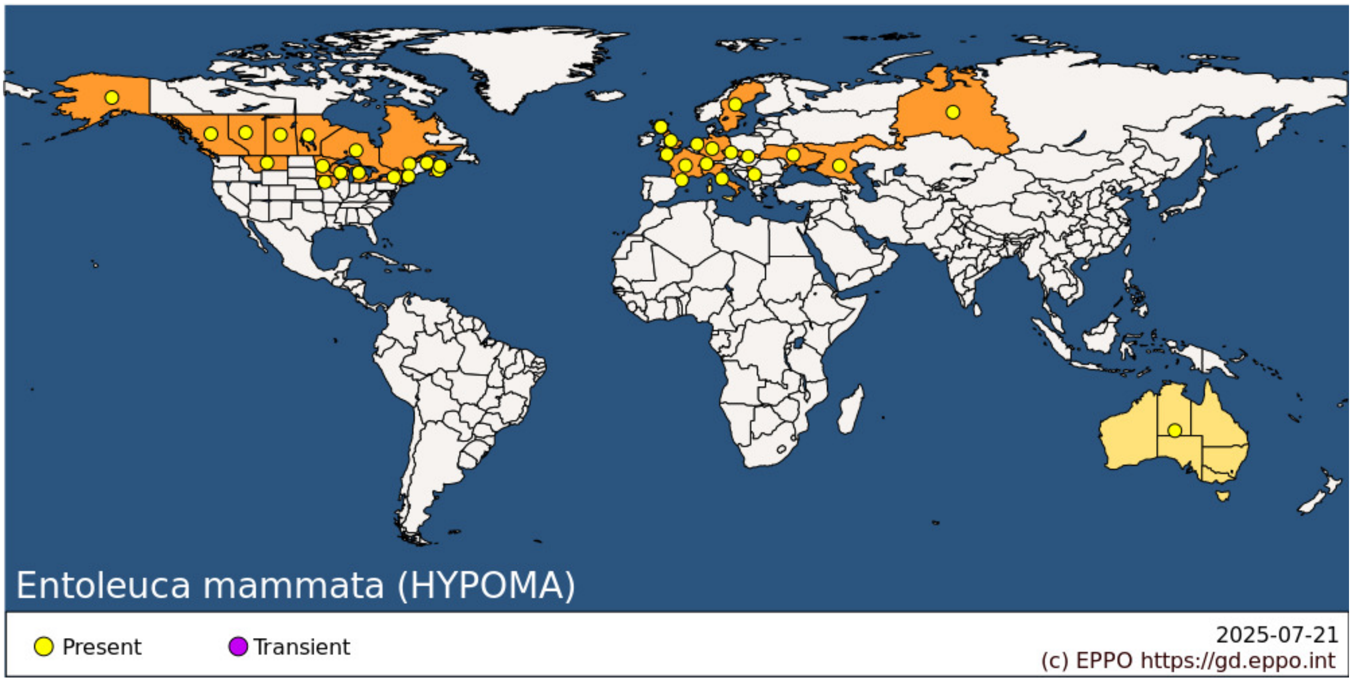
In Europe, the principal host is the native species *Populus tremula* (common aspen, especially its mountain race), and, in North America, *P. tremuloides* (quaking aspen), which has also been introduced into Europe, as well as the hybrid aspen (*Populus tremula* ×?*P. tremuloides*) (Ostry and Anderson, 2009). However, as *E. mammata* can infect various *Populus* species, it has a high potential to damage monocultural hybrid aspen plantations in Northern Europe (Lutter *et al.*, 2019). Hypoxylon canker for hybrid aspen has been reported in clonal comparison trials in Sweden (Stener and Karlsson, 2004) and Latvia (Lutter *et al.*, 2019). The fungus has also been reported on other aspens and poplars, *Salix myrsinifolia* and other willow species (e.g., *S. daphnoides*), rowan (*Sorbus aucuparia*), Sitka alder (*Alnus viridis*), birch (*Betula* spp.), apple (*Malus* spp.), oak (*Quercus* spp.), and hop-hornbeam (*Ostrya* spp.) (Kasansen *et al.*, 2004; Eriksson, 2014; EFSA, 2017; NBN Atlas, 2022). *E. mammata* also occurs as a saprobe or innocuous pathogen on other trees: *Betula* spp., *Fagus* spp., *Malus* spp., *Quercus* spp., *Ostrya* spp. The main species at risk in Europe is the commercially exploited *P. tremuloides* (*P. tremula* mainly grows as a wild species, especially in mountain areas) but a range of other ecologically and economically important hosts may also be affected.

Host list: *Alnus sinuata*, *Betula sp.*, *Fagus sp.*, *Malus sp.*, *Ostrya sp.*, *Populus adenopoda*, *Populus alba*, *Populus balsamifera*, *Populus grandidentata*, *Populus hybrids*, *Populus tremula*, *Populus tremuloides*, *Populus trichocarpa*, *Populus x wettsteinii*, *Quercus sp.*, *Salix caprea*, *Salix cinerea*, *Salix daphnoides*, *Salix myrsinifolia*, *Salix pentandra*, *Salix phylicifolia*, *Salix sp.*, *Salix triandra*, *Sorbus aucuparia*

GEOGRAPHICAL DISTRIBUTION

The analyses of various isolates from different continents and countries demonstrates that *E. mammata* is native to North America and that it was introduced into Eurasia (Kasanen *et al.*, 2004). *E. mammata* is reported in North

America, Europe, Asia (western Siberia of Russia), and Australia (Jeger *et al.*, 2017). The pathogen has been reported in many EU countries. Its presence does not seem to be limited by the different ecoclimatic conditions in the EU, but it mainly has (with the exception of Sweden) a restricted distribution (Jeger *et al.*, 2017).



EPPO Region: Czechia, France (mainland), Germany, Italy (mainland), Netherlands, Russian Federation (the) (Southern Russia, Western Siberia), Serbia, Slovakia, Sweden, Switzerland, Ukraine, United Kingdom (Channel Islands, England, Scotland)
North America: Canada (Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Québec, Saskatchewan), United States of America (Alaska, Iowa, Michigan, Minnesota, Montana, New Hampshire, New York, Wisconsin)
Oceania: Australia

BIOLOGY

E. mammata is the causal agent of hypoxylon canker of quaking aspen (*P. tremuloides*) and other poplars *(Populus* spp.). Hypoxylon canker's life cycle takes at least four growing seasons (Sinclair and Lyon, 2005). Ascospores are wind-disseminated. Spores infect host trees by entering the xylem through damaged bark, e.g. via pruning wounds or insect galleries. In the USA, a high proportion of cankers have been found to originate from insect wounds, notably galls caused by the cerambycid beetle *Saperda inornata* or cicada oviposition wounds (Ostry and Anderson, 2009; Ostry, 2013). The fungus is not thought to infect hosts via buds, leaves, petioles, or leaf axils (Ostry, 2013).

The fungus only damages live wood, and it does not expand far into dead wood (Ostry and Anderson, 2009; Jeger *et al.*, 2017). Aspen bark contains natural fungicide substances that inhibit mycelia growth, so the pathogen invades the bark from within or through dying branches and then continues the expansion into the stem to avoid these compounds (Jeger *et al.*, 2017; Lutter *et al.*, 2019). Cankers result from infection by single ascospores (Ostry and Anderson, 2009). The period of colonization of aspen tissue by *E. mammata* before symptoms develop has been called both endophytic or latent phase and lasts on average 24 months (Ostry and Anderson, 2009).

Different studies (Anderson, 1964; Ostry and Anderson, 2009; Jeger *et al.*, 2017; Lutter *et al.*, 2019) showed that trees of all ages can be attacked, but disease incidence is often low and there are clonal differences in the resistance and susceptibility to hypoxylon canker. Host-specific toxins are involved in pathogenesis (Stermer *et al.*, 1984; Ostry, 2013).

For more information, see Ostry and Anderson (2009), Ostry (2013), and Jeger *et al.* (2017).

DETECTION AND IDENTIFICATION

Symptoms

Symptoms may vary depending on the stage of disease development. Symptoms appear on average two years after ascospore infection, cankers develop on branches and the trunk (Ostry, 2013). No signs are produced during the first year of infection. At the beginning, cankers become visible as slightly sunken, yellow-orange irregular areas (Sinclair and Lyon, 2005). Dying branches have yellow undersized leaves, dead branches have brown adhering leaves (Sinclair and Lyon, 2005). The outermost bark (periderm) becomes blistered and eventually hyphae break through and reveal a grey layer of fungal tissue with conidia (Ostry and Anderson, 2009). Hyphal pillars are produced during the second year and stromata with perithecia begin to form during the third year. A typical several year-old canker is elongated, may be up to 2.5 m in length and is usually centered at branch bases or galls induced by *Saperda* sp. (poplar gall longhorn beetle) and may be found near the site of wounds caused by wood boring insects or damage caused by woodpeckers foraging for insect larvae (Sinclair and Lyon, 2005; Ostry 2013; Jeger *et al.*, 2017). From a distance, an infected trunk appears mottled while the canker has one or a few wood ridges and cracked bark (Sinclair and Lyon, 2005). The cankers expand at the margins, elongating 7–8 cm per month during the summer and a few mm per month during the winter (Sinclair and Lyon, 2005). Cankers usually expand too fast for callus to develop.

For more information, see Sinclair and Lyon (2005), Ostry (2013), Jeger *et al.* (2017).

Morphology

Cutting the infected yellow-orange bark of young cankers, or near the margin of old ones reveals a laminated or mottled, black and yellowish-white cortex (Sinclair and Lyon, 2005). This distinguishes hypoxylon canker from bark yellowing due to other pathogenic fungi (e.g., *Valsa* spp.). White mycelial fans occur in the cambial zone at the margin of the cankers, and can be seen when the bark is removed. Characteristic ‘conidial pillars’ formed below the periderm can be seen (Sinclair and Lyon, 2005).

Conidia are produced in grey, powdery masses under the blistered bark in a grey mat of fungal tissue; one-celled, nearly colourless, oblong-ovoid, hyaline, 5.5–8.0 x 1.5–4.0 µm in size (Sinclair and Lyon, 2005). The conidia are not infectious but are thought to function as spermatia and are thus important for the sexual reproduction (Ostry, 2013). Perithecial stromata develop about 3 years after conidia on blackened, cracked bark and stromata are round in outline, erumpent, flattened, hard, whitish when young and black when mature, 2–5 mm in diameter and 1–2 mm thick (Sinclair and Lyon, 2005). Stroma are uni- to most often multiperitheciate, they contain up to 30 perithecia 0.7–1.0 mm in diameter, white pruinose when young, dull black with age, strongly carbonaceous, with well-exposed perithecial mounds (Ju and Rogers, 1996). Ascospores are unicellular, brown, oblong-ellipsoid ascospores emerge, 22–33 x 9–13 µm in size (Sinclair and Lyon, 2005; Jeger *et al.*, 2017). The ascospores are dispersed from perithecia during wet weather throughout most of the year when the air temperature is as low as ?4°C (Sinclair and Lyon, 2005). Germination occurs during humid conditions at temperatures above 16°C but is more rapid at 28–32°C (Sinclair and Lyon, 2005). Ascospores continue to be dispersed from cankers on felled trees which remain on the ground for up to 23 months (Jeger *et al.*, 2017).

For more information, see Hawksworth (1972), Ostry (2013), and Jeger *et al.* (2017).

Detection and inspection methods

E. mammata can be identified based on the very specific canker symptoms and the species specific morphological structures of perithecia and the ascospores (Jeger *et al.*, 2017). Due to the presence of clear papillate ostioles, *E. mammata* can be distinguished from the species belonging to the closely related genera such as *Amphirosellinia*, *Nemania*, and *Rosellinia* (Sinclair and Lyon, 2005; Jeger *et al.*, 2017). The whole genome of *E. mammata* is sequenced and available for the development of fungal specific primers for conventional PCR or real-time PCR tests or for population studies, phylogenetic studies, etc. (Lutter *et al.*, 2019).

PATHWAYS FOR MOVEMENT

E. mammata is able to spread via airborne ascospores, infected plants for planting, and wood with bark. Ascospores are expelled from perithecia throughout the year after rain, when stromata are wet and even at air temperatures as low as -4°C (Sinclair and Lyon, 2005). Airborne ascospores constitute the main inoculum for disease spread during a large part of the year (Rogers and Yu, 1996; Jeger *et al.*, 2017). As the latent period of infection is more than 2 years, the pathogen could also be moved over long distances on infected but asymptomatic plants (Jeger *et al.*, 2017). Several insects, mostly poplar borers and cicadas, cause wounds that may serve as entry points and hence may facilitate spread in localized areas (Ostry and Anderson, 2009). A strong association between pruning wounds and cankers has also been indicated (Sinclair and Lyon, 2005).

PEST SIGNIFICANCE

Economic impact

The area of *Populus* plantations has recently increased in Europe due to the demand for woody biomass and local *P. tremula* is highly valued for biodiversity purposes (Lutter *et al.*, 2019). Currently, hybrid aspen is the most frequently grown species for short-rotation forestry and long-term breeding programs, although, such monocultural plantations with a few clones might be highly susceptible to outbreaks of different pests including *E. mammata* (Lutter *et al.*, 2019). In the EPPO region, *E. mammata* has been recorded as occurring mainly on the mountain race of *P. tremula* which is widely distributed in Europe. Generally, *E. mammata* is not reported to be of significant economic importance in any European countries (Jeger *et al.*, 2017), although the risk presented by *E. mammata* in Europe depends on the susceptibility of the clones which are planted (Lutter *et al.*, 2019). In Sweden, hypoxylon canker has been reported to have caused extensive damage during the 1950s, as the fungus can severely affect vitality of the trees (Stener, 2010). Environmental impacts can be expected in some cases, and this provides an additional threat to the biodiversity of *Populus* spp., especially *P. nigra*, which is endangered through much of Western Europe because of the loss of floodplain forest habitats and replacement of *P. nigra* by the hybrid poplars (Jeger *et al.*, 2017).

Control

There are no available reports of eradication of *E. mammata* from an infested area. Also, there are no satisfactory control measures, although, in North America, aspen breeding for canker resistance has had some success (Ostry and Anderson, 2009; Jeger *et al.*, 2017; EPPO, 2023). However, the majority of interspecific hybrids were found to be susceptible to other bark and leaf diseases, and natural hybrids (*P. grandidentata* x *P. tremuloides*) were also vulnerable to other disease, including hypoxylon canker (Ostry and Anderson, 2009). Selection of resistant clonal material, and genetic improvements are actively continuing, and tissue culture screening methods are being used. Eradication of the pathogen inoculum by felling infected trees is not an optimal strategy to prevent new infections because a single overlooked canker can produce an abundance of spores, thus demonstrating the lack of feasibility of local eradication (Manion and Griffin, 1986). Site selection for new plantations with optimal conditions for planting and growth, winter pruning of infected branches before canker spread to the stem as well as maintaining high stocking densities (so removal of infected material will have a limited impact on overall production levels) are of key importance to reduce losses due to the infection of *E. mammata* (Ostry and Anderson, 2009; Jeger *et al.*, 2017).

Phytosanitary risk

Plants for planting and wood with bark are considered the host commodities which provide the main pathway for entry for the *E. mammata* (Ostry, 2013; EPPO, 2023).

E. mammata is already present in the EPPO region and has been reported from many EPPO countries. However, *E. mammata* has been removed from the EPPO lists of quarantine pests in 1984 as *E. mammata* was found to be much more widely distributed in the EPPO region than it was previously thought and European cultivars were practically all resistant, so the seriousness of the disease in relation to the EPPO region was felt to be unfounded (EPPO, 1988). On native species, it seems to have reached the limits of its potential distribution; on hybrid *Populus*, while it does present some danger, it is already a common pathogen (Pinon, 1986). Accordingly the Commission Implementing Regulation (EU) 2019/2072, *E. mammata* is included in Annex III (List of protected zones and the respective protected zone quarantine pests) for Ireland and United Kingdom (Northern Ireland) (EU, 2019).

PHYTOSANITARY MEASURES

E. mammata is a quarantine pest for protected zones (Ireland and United Kingdom (Northern Ireland)) (EU, 2019). It is also a quarantine pest in Israel (since 2009) and China (since 2021) (EPPO, 2023). Currently, EPPO does not recommend any particular phytosanitary measures for this pest. However, if needed, the following measures outlined in the EFSA pest categorization (Jeger *et al.*, 2017) might be followed:

- selecting suitable sites for planting and avoiding host wounding,
- nursery inspections to ensure that plantations or landscape plantings are not made with infected stock,
- selection of resistant clonal material and genetic improvement.

Import of host plants for planting and wood with bark from pest-free areas might also serve as phytosanitary measures for this pest.

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1983 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.

CABI/EPPO (1992/1997) *Quarantine Pests for Europe (1st and 2nd edition).* CABI, Wallingford (GB).

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