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Pest categorisation of *Entoleuca mammata*

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Abstract

Following a request from the European Commission, the EFSA Plant Health (PLH) Panel performed a pest categorisation of *Entoleuca mammata*, a well-defined and distinguishable fungus of the family Xylariaceae native to North America. The species was moved from the genus *Hypoxylon* to the genus *Entoleuca* following a revision of the genus. The former species name *H. mammatum* is used in the Council Directive 2000/29/EC. *E. mammata* is the causal agent of Hypoxylon canker of quaking aspen (*Populus tremuloides*) and other poplars (*Populus* spp.). The pathogen has been reported in 16 EU Member States (MS), without apparent limiting ecoclimatic factors, but mostly (with the exception of Sweden) with a restricted distribution. *E. mammata* is a protected zone (PZ) quarantine pest (Annex IIB) for Ireland and the UK (Northern Ireland). The main hosts present in the EU (*P. tremula*, *P. nigra* and hybrid poplars) are widespread throughout most of the risk assessment area, including the PZ. The main means of spread are wind-blown ascospores, plants for planting and wood with bark. *E. mammata* is not currently reported to be of significant economic importance in the EU MS where the pathogen is reported, but has been shown to cause significant damage in the USA. Risk reduction options include appropriate site selection for poplar plantations, avoiding wounds, and debarking wood. The main uncertainties concern the distribution of the pathogen in the EU, the susceptibility of cultivated hybrid poplars to the pathogen and thus the potential damage to poplar plantations in the RA area. The criteria assessed by the Panel for consideration as potential PZ quarantine pest are met. The criterion of plants for planting being the main pathway for spread for regulated non-quarantine pests is not met: plants for planting are only one of the means of spread of the pathogen.

Keywords: forest pathology, herbaria, nursery trade, plant health, *Populus* spp., risk assessment, tree plantations

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

Council Directive 2000/29/EC[1] on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community establishes the present European Union plant health regime. The Directive lays down the phytosanitary provisions and the control checks to be carried out at the place of origin on plants and plant products destined for the Union or to be moved within the Union. In the Directive's 2000/29/EC annexes, the list of harmful organisms (pests) whose introduction into or spread within the Union is prohibited, is detailed together with specific requirements for import or internal movement.

Following the evaluation of the plant health regime, the new basic plant health law, Regulation (EU) 2016/2031[2] on protective measures against pests of plants, was adopted on 26 October 2016 and will apply from 14 December 2019 onwards, repealing Directive 2000/29/EC. In line with the principles of the above mentioned legislation and the follow-up work of the secondary legislation for the listing of EU regulated pests, EFSA is requested to provide pest categorisations of the harmful organisms included in the annexes of Directive 2000/29/EC, in the cases where recent pest risk assessment/pest categorisation is not available.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 22(5.b) and Article 29(1) of Regulation (EC) No 178/2002[3], to provide scientific opinion in the field of plant health.

EFSA is requested to prepare and deliver a pest categorisation (step 1 analysis) for each of the regulated pests included in the appendices of the annex to this mandate. The methodology and template of pest categorisation have already been developed in past mandates for the organisms listed in Annex II Part A Section II of Directive 2000/29/EC. The same methodology and outcome is expected for this work as well.

The list of the harmful organisms included in the annex to this mandate comprises 133 harmful organisms or groups. A pest categorisation is expected for these 133 pests or groups and the delivery of the work would be stepwise at regular intervals through the year as detailed below. First priority covers the harmful organisms included in Appendix 1, comprising pests from Annex II Part A Section I and Annex II Part B of Directive 2000/29/EC. The delivery of all pest categorisations for the pests included in Appendix 1 is June 2018. The second priority is the pests included in Appendix 2, comprising the group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), the group of Tephritidae (non-EU), the group of potato viruses and virus-like organisms, the group of viruses and virus-like organisms of *Cydonia* Mill., *Fragaria* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Ribes* L., *Rubus* L. and *Vitis* L. and the group of *Margarodes* (non-EU species). The delivery of all pest categorisations for the pests included in Appendix 2 is end 2019. The pests included in Appendix 3 cover pests of Annex I part A section I and all pests categorisations should be delivered by end 2020.

For the above mentioned groups, each covering a large number of pests, the pest categorisation will be performed for the group and not the individual harmful organisms listed under "such as" notation in the Annexes of the Directive 2000/29/EC. The criteria to be taken particularly under consideration for these cases, is the analysis of host pest combination, investigation of pathways, the damages occurring and the relevant impact.

Finally, as indicated in the text above, all references to 'non-European' should be avoided and replaced by 'non-EU' and refer to all territories with exception of the Union territories as defined in Article 1 point 3 of Regulation (EU) 2016/2031.

[1] Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. OJ L 169/1, 10.7.2000, p. 1–112.

[2] Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants. OJ L 317, 23.11.2016, p. 4–104.

[3] Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31/1, 1.2.2002, p. 1–24.

1.1.2.1. Terms of Reference: Appendix 1

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Aleurocantus spp.
Anthonomus bisignifer (Schenkling)
Anthonomus signatus (Say)
Aschistonyx eppoi Inouye
Carposina niponensis Walsingham
Enarmonia packardi (Zeller)
Enarmonia prunivora Walsh
Grapholita inopinata Heinrich
Hishomonus phycitis
Leucaspis japonica Ckll.
Listronotus bonariensis (Kuschel)
Numonia pyrivorella (Matsumura)
Oligonychus perditus Pritchard and Baker
Pissodes spp. (non-EU)
Scirtothrips aurantii Faure
Scirtothrips citri (Moultex)
Scolytidae spp. (non-EU)
Scrobipalpopsis solanivora Povolny
Tachypterellus quadrigibbus Say
Toxoptera citricida Kirk.
Unaspis citri Comstock

(b) Bacteria

Citrus variegated chlorosis
Erwinia stewartii (Smith) Dye
Xanthomonas campestris pv. *oryzae* (Ishiyama) Dye and pv. *oryzicola* (Fang. et al.) Dye

(c) Fungi

Alternaria alternata (Fr.) Keissler (non-EU pathogenic isolates)
Anisogramma anomala (Peck) E. Müller
Apiosporina morbosa (Schwein.) v. Arx
Ceratocystis virescens (Davidson) Moreau
Cercoseptoria pini-densiflorae (Hori and Nambu) Deighton
Cercospora angolensis Carv. and Mendes
Elsinoe spp. Bitanc. and Jenk. Mendes
Fusarium oxysporum f. sp*. albedinis* (Kilian and Maire) Gordon
Guignardia piricola (Nosa) Yamamoto
Puccinia pittieriana Hennings
Stegophora ulmea (Schweinitz: Fries) Sydow & Sydow
Venturia nashicola Tanaka and Yamamoto

(d) Virus and virus-like organisms

Beet curly top virus (non-EU isolates)
Black raspberry latent virus
Blight and blight-like
Cadang-Cadang viroid
Citrus tristeza virus (non-EU isolates)
Leprosis
Little cherry pathogen (non- EU isolates)
Naturally spreading psorosis
Palm lethal yellowing mycoplasm
Satsuma dwarf virus
Tatter leaf virus
Witches' broom (MLO)

Annex IIB

(a) Insect mites and nematodes, at all stages of their development

Anthonomus grandis (Boh.)
Cephalcia lariciphila (Klug)
Dendroctonus micans Kugelan
Gilphinia hercyniae (Hartig)
Gonipterus scutellatus Gyll.
Sternochetus mangiferae Fabricius
Ips amitinus Eichhof
Ips cembrae Heer
Ips duplicatus Sahlberg
Ips sexdentatus Börner
Ips typographus Heer

(b) Bacteria

Curtobacterium flaccumfaciens pv. flaccumfaciens (Hedges) Collins and Jones

(c) Fungi

Glomerella gossypii Edgerton

Gremmeniella abietina (Lag.) Morelet

Hypoxylon mammatum (Wahl.) J. Miller

1.1.2.2. Terms of Reference: Appendix 2

List of harmful organisms for which pest categorisation is requested per group. The list below follows the categorisation included in the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Group of Cicadellidae (non-EU) known to be vector of Pierce's disease (caused by *Xylella fastidiosa*), such as:

1) *Carneocephala fulgida* Nottingham
2) *Draeculacephala minerva* Ball
3) *Graphocephala atropunctata* (Signoret)

Group of Tephritidae (non-EU) such as:

1) *Anastrepha fraterculus* (Wiedemann)
2) *Anastrepha ludens* (Loew)
3) *Anastrepha obliqua* Macquart
4) *Anastrepha suspensa* (Loew)
5) *Dacus ciliatus* Loew
6) *Dacus curcurbitae* Coquillet
7) *Dacus dorsalis* Hendel
8) *Dacus tryoni* (Froggatt)
9) *Dacus tsuneonis* Miyake
10) *Dacus zonatus* Saund.
11) *Epochra canadensis* (Loew)
12) *Pardalaspis cyanescens* Bezzi
13) *Pardalaspis quinaria* Bezzi
14) *Pterandrus rosa* (Karsch)
15) *Rhacochlaena japonica* Ito
16) *Rhagoletis completa* Cresson
17) *Rhagoletis fausta* (Osten-Sacken)
18) *Rhagoletis indifferens* Curran
19) *Rhagoletis mendax* Curran
20) *Rhagoletis pomonella* Walsh
21) *Rhagoletis suavis* (Loew)

(c) Viruses and virus-like organisms

Group of potato viruses and virus-like organisms such as:

1) Andean potato latent virus
2) Andean potato mottle virus
3) Arracacha virus B, oca strain
4) Potato black ringspot virus
5) Potato virus T
6) non-EU isolates of potato viruses A, M, S, V, X and Y (including Yo, Yn and Yc) and Potato leafroll virus

Group of viruses and virus-like organisms of Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L., Rubus L. and Vitis L., such as:

1) Blueberry leaf mottle virus
2) Cherry rasp leaf virus (American)
3) Peach mosaic virus (American)
4) Peach phony rickettsia
5) Peach rosette mosaic virus
6) Peach rosette mycoplasm
7) Peach X-disease mycoplasm
8) Peach yellows mycoplasm
9) Plum line pattern virus (American)
10) Raspberry leaf curl virus (American)
11) Strawberry witches' broom mycoplasma
12) Non-EU viruses and virus-like organisms of *Cydonia Mill., Fragaria L., Malus Mill., Prunus L., Pyrus L., Ribes L., Rubus L.* and *Vitis L.*

Annex IIAI

(a) Insects, mites and nematodes, at all stages of their development

Group of *Margarodes* (non-EU species) such as:

1) *Margarodes vitis* (Phillipi)
2) *Margarodes vredendalensis* de Klerk
3) *Margarodes prieskaensis* Jakubski

1.1.2.3. Terms of Reference: Appendix 3

List of harmful organisms for which pest categorisation is requested. The list below follows the annexes of Directive 2000/29/EC.

Annex IAI

(a) Insects, mites and nematodes, at all stages of their development

Acleris spp. (non-EU)	*Longidorus diadecturus* Eveleigh and Allen
Amauromyza maculosa (Malloch)	*Monochamus* spp. (non-EU)
Anomala orientalis Waterhouse	*Myndus crudus* Van Duzee
Arrhenodes minutus Drury	*Nacobbus aberrans* (Thorne) Thorne and Allen
Choristoneura spp. (non-EU)	*Naupactus leucoloma* Boheman
Conotrachelus nenuphar (Herbst)	*Premnotrypes* spp. (non-EU)
Dendrolimus sibiricus Tschetverikov	*Pseudopityophthorus minutissimus* (Zimmermann)
Diabrotica barberi Smith and Lawrence	*Pseudopityophthorus pruinosus* (Eichhoff)
Diabrotica undecimpunctata howardi Barber	*Scaphoideus luteolus* (Van Duzee)
Diabrotica undecimpunctata undecimpunctata Mannerheim	*Spodoptera eridania* (Cramer)
Diabrotica virgifera zeae Krysan & Smith	*Spodoptera frugiperda* (Smith)
Diaphorina citri Kuway	*Spodoptera litura* (Fabricus)
Heliothis zea (Boddie)	*Thrips palmi* Karny
Hirschmanniella spp., other than *Hirschmanniella gracilis* (de Man) Luc and Goodey	*Xiphinema americanum* Cobb sensu lato (non-EU populations)
Liriomyza sativae Blanchard	*Xiphinema californicum* Lamberti and Bleve-Zacheo

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt
Chrysomyxa arctostaphyli Dietel
Cronartium spp. (non-EU)
Endocronartium spp. (non-EU)
Guignardia laricina (Saw.) Yamamoto and Ito
Gymnosporangium spp. (non-EU)
Inonotus weirii (Murril) Kotlaba and Pouzar
Melampsora farlowii (Arthur) Davis
Mycosphaerella larici-leptolepis Ito et al.
Mycosphaerella populorum G. E. Thompson
Phoma andina Turkensteen
Phyllosticta solitaria Ell. and Ev.
Septoria lycopersici Speg. var. *malagutii* Ciccarone and Boerema
Thecaphora solani Barrus
Trechispora brinkmannii (Bresad.) Rogers

(c) Viruses and virus-like organisms

Tobacco ringspot virus
Tomato ringspot virus
Bean golden mosaic virus
Cowpea mild mottle virus
Lettuce infectious yellows virus
Pepper mild tigré virus
Squash leaf curl virus
Euphorbia mosaic virus
Florida tomato virus

(d) Parasitic plants

Arceuthobium spp. (non-EU)

Annex IAII

(a) Insects, mites and nematodes, at all stages of their development

Meloidogyne fallax Karssen
Popillia japonica Newman
Rhizoecus hibisci Kawai and Takagi

(b) Bacteria

Clavibacter michiganensis (Smith) Davis et al. ssp. *sepedonicus* (Spieckermann and Kotthoff) Davis et al.
Ralstonia solanacearum (Smith) Yabuuchi et al.

(c) Fungi

Melampsora medusae Thümen
Synchytrium endobioticum (Schilbersky) Percival

Annex I B

(a) Insects, mites and nematodes, at all stages of their development

Leptinotarsa decemlineata Say
Liriomyza bryoniae (Kaltenbach)

(b) Viruses and virus-like organisms

Beet necrotic yellow vein virus

1.2. Interpretation of the Terms of Reference

Hypoxylon mammatum is the species name listed in the Council Directive 2000/29/EC and the Terms of Reference (ToR). The species was renamed as *Entoleuca mammata* following a stricter definition of the genus (Rogers and Ju, 1996).

E. mammata is one of a number of pests listed in the Appendices to the ToR to be subject to pest categorisation to determine whether it fulfils the criteria of a quarantine pest or those of a regulated non-quarantine pest (RNQP) for the EU.

Since *E. mammata* is regulated in the protected zones (PZ) only (the Republic of Ireland and the UK (Northern Ireland)), the scope of the categorisation is the territory of the PZ, thus the criteria refer to the PZ instead of the EU territory.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search (until May 2017) on *E. mammata* was conducted in Web of Science and Scopus at the beginning of the categorisation. Both *E. mammata* and its previous accepted name *H. mammatum* were used as search terms. Further references and information were obtained from experts, from citations within the references and within the grey literature.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the EPPO Global Database (https://gd.eppo.int) and other publications/databases, as detailed in Section 3.2.

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network launched by the Directorate General for Health and Consumers (DG SANCO), and is a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. The Europhyt database manages notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the MS and the phytosanitary measures taken to eradicate or avoid their spread.

Information on EU imports of *Populus* plants for planting from North America were sought in the ISEFOR database (Eschen et al., 2017).

2.2. Methodologies

The Panel performed the pest categorisation for *E. mammata* following the guiding principles and steps presented in the EFSA guidance on the Harmonised Framework for Pest Risk Assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was started following an evaluation of the EU's plant health regime. Therefore, to facilitate the decision-making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for a Union quarantine pest and for a Union RNQP in accordance with Regulation (EU) 2016/2031 on protective measures against pests of plants, and includes additional information required as per the specific ToR received by the European Commission. In addition, for each conclusion, the Panel provides a short description of its associated uncertainty.

Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. All relevant criteria have to be met for the pest to potentially qualify either as a quarantine pest or as an RNQP. If one of the criteria is not met, the pest will not qualify. Note that a pest that does not qualify as a quarantine agent may still qualify as an RNQP which needs to be addressed in the opinion. For the pests regulated in the PZ only, the scope of the categorisation is the territory of the PZ, thus the criteria refer to the PZ instead of the EU territory.

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regards to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, the Panel will present a summary of the observed pest impacts. Economic impacts are expressed in terms of yield and quality losses and not in monetary terms, while addressing social impacts is outside the remit of the Panel, in agreement with the EFSA guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

Table 1: Pest categorisation criteria under evaluation, as defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35)	Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest
Identity of the pest (Section 3.1)	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?	Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? Briefly describe the pest distribution	Is the pest present in the EU territory? If not, it cannot be a PZ quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest (RNQP). A RNQP must be present in the risk assessment area
Regulatory status (Section 3.3)	If the pest is present in the EU but not widely distributed in the RA area, it should be under official control or expected to be under official control in the near future	The PZ system aligns with the pest free area system under the International Plant Protection Convention (IPPC) The pest satisfies the IPPC definition of a quarantine pest that is not present in the PRA area (i.e. protected zone)	Is the pest regulated as a quarantine pest? If currently regulated as a quarantine pest, are there grounds to consider its status could be revoked?
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways	Is the pest able to enter into, become established in, and spread within, the PZ areas? Is entry by natural spread from EU areas where the pest is present possible?	Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects? Clearly state if plants for planting is the main pathway
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?	Would the pest introduction have an economic or environmental impact on the PZ areas?	Does the presence of the pest on plants for planting have an unacceptable economic impact, as regards the intended use of those plants for planting?
Available measures (Section 3.6)	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated?	Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU such that the risk becomes mitigated? Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the PZ?	Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria above for consideration as potential PZ quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria above for consideration as a potential regulated non-quarantine pest were met, and (2) if not, which one(s) were not met

The Panel will not state in its conclusions of the pest categorisation whether to continue the risk assessment process, but, following the agreed two-step approach, will continue only if requested by the risk managers. However, during the categorisation process, experts may identify key elements and knowledge gaps that could contribute significant uncertainty to a future assessment of risk. It would be useful to identify and highlight such gaps so that potential future requests can specifically target the major elements of uncertainty, perhaps suggesting specific scenarios to examine.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? **Yes**

E. mammata (Wahlenb.) Rogers and Ju (1996) is a fungus of the family Xylariaceae.

The species was moved from the genus *Hypoxylon* to the genus *Entoleuca* following a revision of the genus (Rogers and Ju, 1996). The former species name *H. mammatum* is used in the Council Directive 2000/29/EC.

There are many more species synonymies: *Anthostoma blakei*, *Anthostoma morsei*, *Fuckelia morsei*, *Hypoxylon blakei*, *Hypoxylon holwayi*, *Hypoxylon morsei*, *Hypoxylon pauperatum*, *Hypoxylon pruinatum*, *Nemania mammata*, *Rosellinia pruinata*, *Sphaeria mammata, Sphaeria pruinata* (Index Fungorum, http://www.indexfungorum.org/names/names.asp).

3.1.2. Biology of the pest

E. mammata is the causal agent of Hypoxylon canker of quaking aspen (*Populus tremuloides*) and other poplars (*Populus* spp.). Ascospores infect through wounded xylem most commonly on branches near the intersection with the stem and then grow into the main stem causing stem cankers, but the fungus can also infect branches and twigs throughout the crown (Ostry, 2013). Cankers result from infection by single ascospores (Ostry and Anderson, 2009). Only live wood is infected and the fungus does not expand far into dead wood (Ostry, 2013). Wounds caused by wood boring insects such as *Saperda* spp. play an important role for the infection as well as damage caused by woodpeckers foraging for insect larvae (Ostry et al., 1982; Ostry and Anderson, 1998). Symptoms appear on average 2 years after ascospore infection (Ostry and Anderson, 2009). *E. mammata* produces toxins that are thought to be involved in the pathogenesis (Ostry, 2013).

Cankers first become visible as slightly sunken, yellow-orange irregular areas. The periderm (outermost bark) then becomes blistered and eventually hyphae break through and reveal a grey mat of fungal tissue with, so called hyphal pegs exposing conidia. The conidia are not infectious but are thought to function as spermatia and are thus important for the sexual reproduction (Griffin et al., 1992; Ostry and Anderson, 2009). Ascospores develop in hard, cushion-like stromata that are first white and then turn grey to black, produced 1–2 years later in the oldest part of the cankers. Ascospores are single celled, dark brown, elongate ellipsoid and range from 9.0–12.0 $\times$ 20.0–33.0 μm in size. The cankers expand at the margins, elongating 7–8 cm per month during the summer and a few mm per month during winter (Sinclair and Lyon, 2005) and can eventually girdle branches or stems. Flags may be seen when cankers girdle branches and the wood decay may result in branch or stem breakage. Cankers usually expand too fast for callus to develop.

The ascospores are dispersed from perithecia during wet weather throughout most of the year when the air temperature is above -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 left on the ground for up to 23 months (Froyd and French, 1967).

Trees of all ages can become infected but there are clonal differences in the resistance and susceptibility to Hypoxylon canker (Ostry et al., 2004). Callus production and ability to close the cankers may explain differences in resistance and susceptibility of poplar clones. Water stress has been found to increase canker susceptibility (Bagga and Smalley, 1974a).

3.1.3. Intraspecific diversity

Whether *E. mammata* has been introduced into Europe from North America or if it is an indigenous species in the whole temperate zone of the Northern hemisphere has been debated (Pinon, 1986; EPPO, 1997). However, analyses of DNA markers in isolates from North America and Europe indicate that *E. mammata* is a native fungus in North America and that it was introduced into Europe (Kasanen et al., 2004). The authors further suggest that the introduction may have occurred several centuries ago and that the relatively high genetic variation in Europe suggests that the introduction most likely occurred in several locations (Kasanen et al., 2004). The degree of genetic variation is relatively high in Europe but considerably less than in North America (Kasanen et al., 2004). There is thus the potential for newly introduced isolates from North America to cause more serious problems than those currently observed.

Population genetics studies of the population structure of *E. mammata* within plantations (Griffin et al., 1992; Ostry and Anderson, 2009) have revealed that each canker in the populations studied was genetically different, supporting single spore mediated infection processes. From these studies, it was also concluded that somatic incompatibility keeps individual canker isolates genetically isolated. These genetically unique field isolates result from ascospore infections and since there are no infectious asexual spores, 'pathogenic races of the fungus cannot develop' (Ostry and Anderson, 2009).

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?	**Yes**

E. mammata can be identified based on the specific symptoms and the species morphological structures, i.e. fruiting bodies (perithecia) and the ascospores (Miller, 1961). The fungus is unlikely to be confused with any other species in North America because of the specific symptoms produced while some similarity with *Hypoxylon confluens* and *Hypoxylon udum* may be found in Europe (www.mycobank.org). But those species can be separated by the ascospore characteristics (Miller, 1961).

The whole genome of *E. mammata* is currently being sequenced with the aim to develop methods for detection (JGI Genome Portal; http://genome.jgi.doe.gov/). Some studies have successfully used the ITS-5.8S rDNA region to conduct phylogenetic studies including *E. mammata* and other related species (Mazzaglia et al., 2001; Peláez et al., 2008). However, the use of molecular identification to identify the species from environmental samples has yet to be validated.

3.2. Pest distribution

E. mammata is reported in North America, Europe and Australia (EPPO Global Database) (Figure 1).

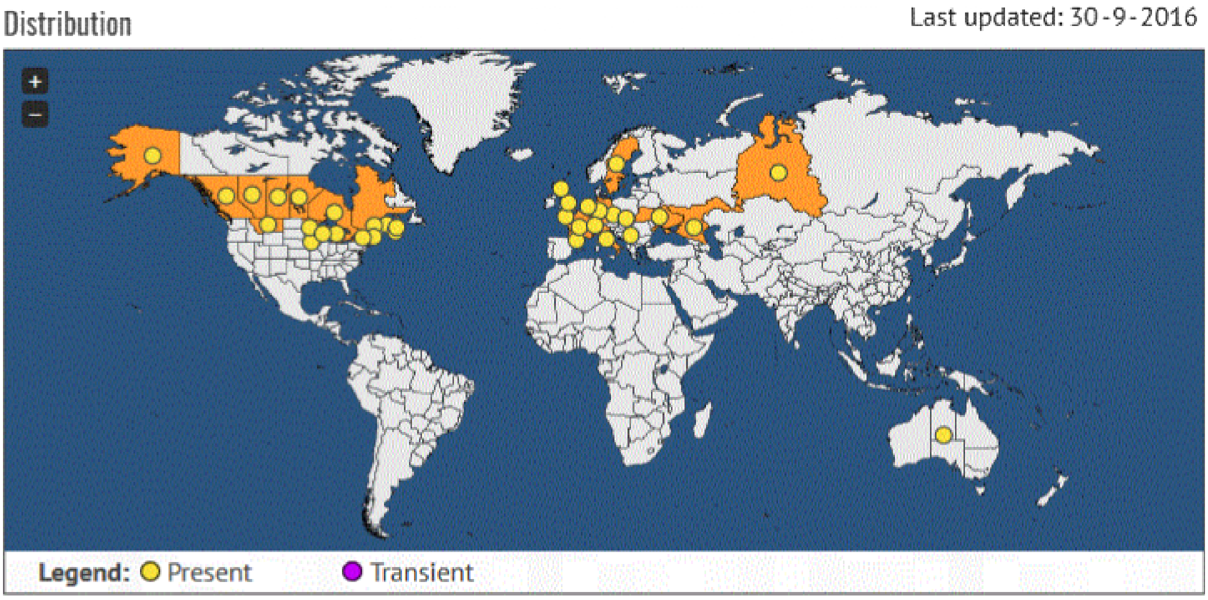

Figure 1: Global distribution map for *Entoleuca mammata* (extracted from EPPO Global Database, accessed May 2017). There are no reports of transient populations in this particular case

3.2.1. Pest distribution outside the EU

The pathogen is widely distributed in Canada, the North-Eastern and Lake States regions of the USA (Ostry, 2013).

In non-EU Europe, the fungus has been reported from Andorra, Russia, Serbia, Switzerland, Ukraine (EPPO Global Database). There are also reports from Norway (http://artsdatabanken.no/ScientificName/98781), as well as Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia and Montenegro (DAISIE database: http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50585#).

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? **Yes,** it is reported from 16 MS, but in most of them with only few occurrences or a restricted distribution.

E. mammata is present in the EU and has been reported from 16 MS (Table 2). These countries range from the Mediterranean (Croatia and Italy) to Scandinavia (Finland and Sweden). However, with the exception of Sweden (where it is reported as widespread), the pathogen is mostly reported with a restricted distribution.

In the EPPO Global Database, no records are listed for Ireland and the pest is reported as 'Absent, confirmed by survey' (official survey in 2009; EPPO Global Database) in the UK (Northern Ireland), which are the countries for which the PZ status applies according to Council Directive 2000/29/EC (Table 3). However, the DAISIE database of invasive species in Europe reports *E. mammata* as present in Ireland (as of June 2017; an erroneous record; Marie-Laure Desprez-Loustau, INRA, France, personal communication, 21 June 2017) and in the UK (without specifying whether this includes Northern Ireland or not). According to the DEFRA Risk Register, in the UK the pathogen is present in England and the Channel Islands (https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=11840).

Table 2: Current distribution of *Entoleuca mammata* in the 28 EU MS based on information from the EPPO Global Database and the DAISIE database of alien species

Country	EPPO Global Database Last update: 30/9/2016 Date accessed: 8/5/2017	Other sources
Austria	–	Present (DAISIE)
Belgium	–	Present (DAISIE)
Bulgaria	–	–
Croatia	–	Present (DAISIE)
Cyprus	–	–
Czech Republic	Present, restricted distribution	Present (DAISIE)
Denmark	–	–
Estonia	–	–
Finland	Absent, invalid record	Present (DAISIE); Miller (1961), Kasanen et al. (2004)
France	Present, restricted distribution	Present (DAISIE); Pinon (1979)
Germany	Present, few occurrences	Present (DAISIE); Miller (1961)
Greece	–	Present (DAISIE)
Hungary	–	–
Ireland	Absent, confirmed by survey	Present (DAISIE); erroneous record (please see above)
Italy	Present, restricted distribution	Present (DAISIE); Kasanen et al. (2004)
Latvia	–	–
Lithuania	–	Present (DAISIE)
Luxembourg	–	–
Malta	–	–
Poland	–	–
Portugal	–	–
Romania	–	–
Slovak Republic	Present, restricted distribution	–
Slovenia	–	Present (DAISIE)
Spain	–	–
Sweden	Present, widespread	Present (DAISIE), Miller (1961)
The Netherlands	Present, no details	–
United Kingdom	Present, few occurrences	Present (DAISIE), Present in parts of the UK (England and the Channel Islands) (DEFRA Risk Register)

–: implies that no information was available.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

E. mammata is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *E. mammata* in Council Directive 2000/29/EC

Annex II, Part B	**Harmful organisms whose introduction into, and whose spread within, certain protected zones shall be banned if they are present on certain plants or plant products**		
(c)	Fungi		
	Species	Subject of contamination	Protected Zones
3.	*Hypoxylon mammatum* (Wahl.) J. Miller	Plants of *Populus* L., intended for planting, other than seeds	Ireland and UK (Northern Ireland)

3.3.2. Legislation addressing plants and plant parts on which *E. mammata* is regulated

Table 4: Regulated hosts and commodities that may involve *E. mammata* in Annexes III and V of Council Directive 2000/29/EC

Annex III, Part A	**Plants, plant products and other objects the introduction of which shall be prohibited in all member states**
Description	Country of origin
3. Plants of *Populus* L., with leaves, other than fruit and seeds	North American countries
8. Isolated bark of *Populus* L.	Countries of the American continent
Annex V	Plants, plant products and other objects which must be subject to a plant health inspection (at the place of production if originating in the Community, before being moved within the Community – in the country of origin or the consignor country, if originating outside the Community) before being permitted to enter the Community
Part A	Plants, plant products and other objects originating in the Community
Section I	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community and which must be accompanied by a plant passport
2.1. Plants intended for planting, other than seeds, of the genus *Populus* L.	
Part B	Plants, plant products and other objects originating in territories, other than those territories referred to in part A
Section I	Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire Community
2. Parts of plants, other than fruits and seeds, of the genus *Populus* L.	
5. Isolated bark of *Populus* L.	
6. Wood within the meaning of the first subparagraph of Article 2(2), where it: (a) has been obtained in whole or part from one of the order, genera or species as described hereafter, except wood packaging material defined in Annex IV, Part A, Section I, Point 2:	*Populus* L., including wood which has not kept its natural round surface, originating in countries of the American continent

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

E. mammata infects various species within the genus *Populus*. The main host in Europe is the native *Populus tremula* and in North America *Populus tremuloides* is mainly infected (EPPO, 1997).

In Europe, the hybrid *P. tremula* x *P. tremuloides, Populus alba* and *Populus trichocarpa* have all been reported as hosts (Ostry, 2013). *P. nigra* is listed as being a minor host of *E. mammata* (EPPO Global Database).

In North America, the pathogen has also been found on *Populus grandidentata*, *Populus balsamifera*, and several different hybrids (Ostry, 2013).

Other hardwoods, e.g. *Salix* spp. have been reported as hosts (Sinclair and Lyon, 2005), but evidence confirming a pathogenic association with these hosts is lacking (Ostry, 2013).

Clones of *Populus deltoides*, *Populus canadensis* and *P. trichocarpa* have been resistant in inoculation tests (EPPO, 1997), but hybrid poplar clones may be affected by *E. mammata* if one of the parent lines is susceptible (Manion and Griffin, 1986).

3.4.2. Entry

Is the pest able to enter into the Protected Zone areas of the EU territory? **Yes,** the pest has been reported from 16 EU MS and could enter the EU PZ.

E. mammata is already present in the EU territory and was first reported in the 1970s from France (Pinon, 1976), but herbarium specimens collected in the nineteenth century reveal that the species has been present in Europe much earlier than that (references in Kasanen et al., 2004). Currently *E. mammata* has been reported from 16 EU MS (Table 2).

According to EUROSTAT, the EU imported about 5,000 tonnes of poplar wood in the rough (code: 44039910) from the USA over the period 2011–2015. Of those, about 150 tonnes were imported by Ireland. No data were available for the EU import of poplar wood from Canada.

Host commodities providing a pathway for entry in the PZ for the pest (EPPO Global Database; EPPO, 1997; Ostry, 2013) are considered to be:

- plants for planting,
- and wood with bark.

As of May 2017, there are no records of interception of *E. mammata* in the Europhyt database.

3.4.3. Establishment

Is the pest able to become established in the Protected Zone areas of the EU territory? **Yes,** the pest is already established in 16 EU MS, some of which (e.g. the Netherlands) have a climate similar to the one found in the PZ (Ireland and Northern Ireland).

3.4.3.1. EU distribution of main host plants

The fungus is already present and established in many MS (see Table 2). The main native host species Eurasian aspen (*Populus tremula*) is widely distributed in the EU except for some of the Mediterranean countries (Figure 2). Given the wide distribution of European black poplar (*Populus nigra*) (Figure 3) and white poplar (*Populus alba*), it can be concluded that available hosts are present throughout the EU (Figure 4).

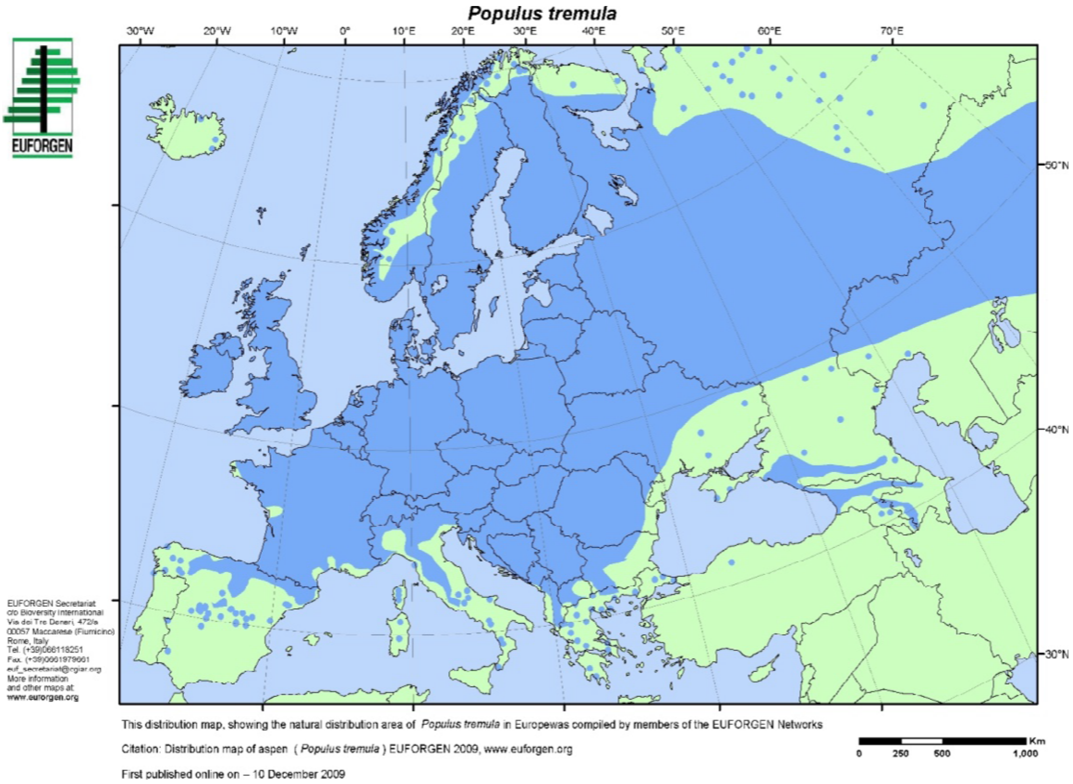

Figure 2: Native range of *Populus tremula* in Europe (map prepared by EUFORGEN in 2009, available at http://www.euforgen.org/species/populus-tremula/). Blue dots represent isolated occurrences of the species

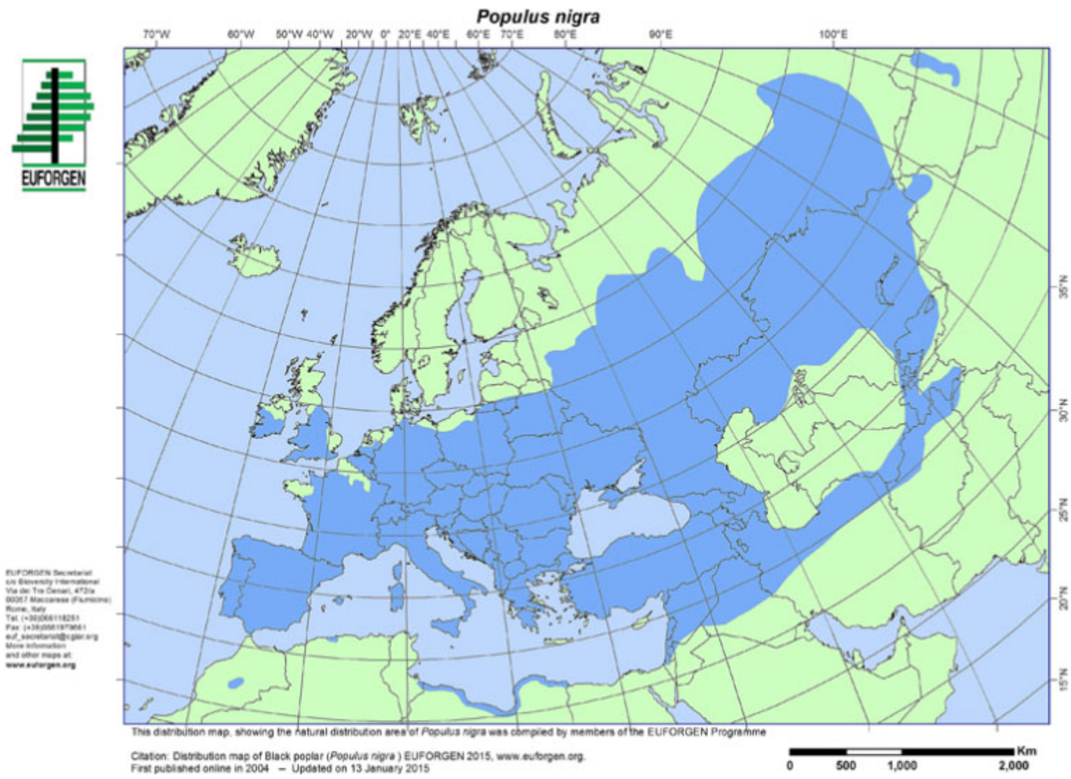

Figure 3: Native range of *Populus nigra* in Europe (map prepared by EUFORGEN in 2015, available at http://www.euforgen.org/species/populus-nigra/)

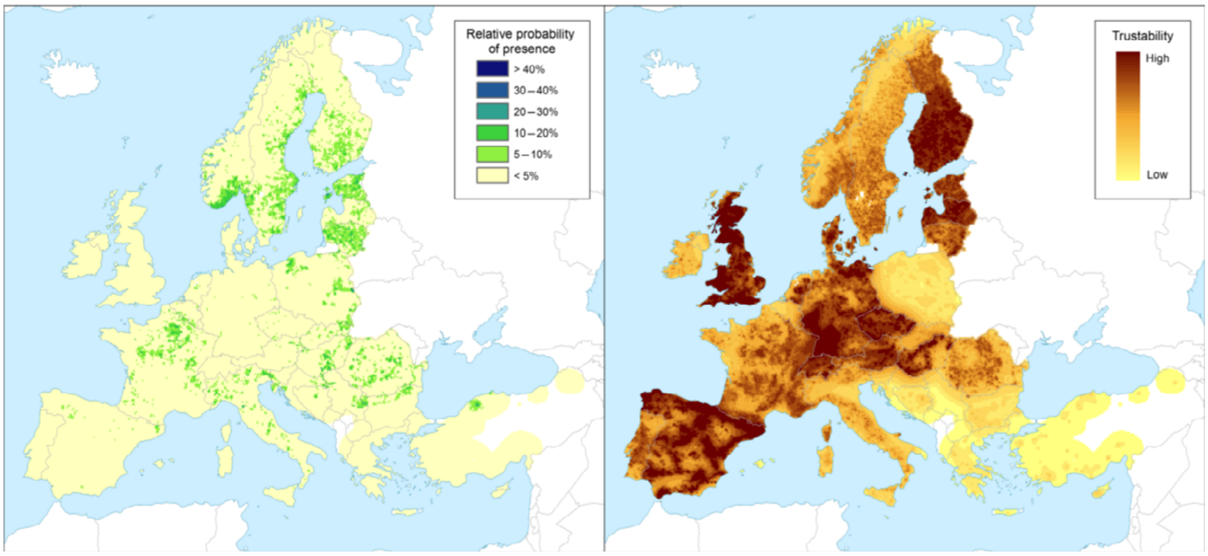

Figure 4: Distribution map of *Populus* spp. (*P. tremula, P. nigra, P. alba, P. canescens, P. x hybrids* and *P. candicans*) in Europe based on forest inventories (relative probability of presence; left-hand panel), together with a map of the uncertainty associated with it (right-hand panel) (courtesy of JRC, 2017) (see Appendix A)

3.4.3.2. Climatic conditions affecting establishment

Given that *E. mammata* has been reported from EU regions with a wide variety of climatic and ecological conditions (e.g. from Tuscany to Sweden and from the Netherlands to Lithuania), there are no obvious ecoclimatic factors limiting its establishment.

3.4.4. Spread

Is the pest able to spread within the Protected Zones of the EU territory following establishment? How?
Yes, via airborne ascospores, infected plants for planting and wood with bark.
RNQPs: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?
No, plants for planting are only one of the means of spread.

Airborne ascospores constitute the main inoculum for disease spread. Dispersal of ascospores appears to be possible throughout a large part of the year (see Bagga and Smalley (1974b) for references). As it may take more than 2 years from infection to symptom development, the pathogen could also be moved long distances on infected but asymptomatic plants.

Ascospores or mycelium of the fungus can be carried over long distances by infected wood too, particularly wood with bark (EPPO, 1997).

In the ISEFOR database of plants for planting, there are no records of *Populus* plants for planting imported by the PZ (Ireland and Northern Ireland) from North America or from the 16 EU MS with reports of *E. mammata*.

Wounding caused by cicada oviposition have been reported to cause new infection sites and hence may facilitate spread in localised areas (Ostry and Anderson, 1983). The role of insects and birds in disseminating ascospores is unknown.

3.5. Impacts

Would the pest introduction have an economic or environmental impact on the Protected Zones of the EU?
Yes, the introduction of *E. mammata* in the PZ could have an economic and environmental impact to plantations of susceptible poplar hybrids and species.

The main host species of *E. mammata* in its native range is quaking aspen (*Populus tremuloides*) (Figure 5). Symptoms of infection by *E. mammata* are rather variable depending on the stage of disease development. Young cankers first become visible as slightly sunken, yellowish orange areas with irregular margins (Ostry, 2013). Later, the outermost bark (periderm) within the canker becomes blistered, eventually cracking open, and exposing a powdery grey mat of fungal tissue, conidial pillars and conidia (Ostry, 2013). The incidence and impact of *E. mammata* canker is greatest in the first 20 years of a developing aspen stand. In this case, cankers are generally found on the lower part of the stem, resulting in the death of affected trees. In older trees, cankers form in the upper stem and are generally not lethal if the tree is able to develop new leaders (Ostry, 2013).

In the US Lake States, it was estimated that *E. mammata* killed 1–2% of the aspen volume each year, based on surveyed plots predominantly from the 1950s, which was equivalent to 31% of the net annual growth (Anderson, 1964). The estimated yearly volume loss in Ontario (Canada) due to *E. mammata* was 2 million m^3 (Pitt et al., 2001). In a further study, it was estimated that in the Lake States *E. mammata* caused losses of 4.4 million US$ a year at harvest (Marty, 1972).

Figure 5: Quaking aspen (*Populus tremuloides*) tree broken during a windstorm at the point of *E. mammata* infection (With kind permission of: United States Department of Agriculture, Forest Service, available online at https://www.na.fs.fed.us/spfo/pubs/fidls/hypoxylon/hypoxylon.htm)

The main European host of *E. mammata* is *Populus tremula*, which is widely distributed in Europe (see Section 3.4.3.1). In general, *E. mammata* is not reported to be of significant economic importance in any of the European countries where the pathogen is reported (EPPO, 1997). In a comparison of the economic importance of various poplar diseases, *E. mammata* was judged to be of relatively low significance (Anselmi et al., 2006). However, the risk presented by *E. mammata* in Europe depends on the susceptibility of the clones which are planted (EPPO, 1997). Impacts due to Hypoxylon canker can occur also on ornamental poplar trees planted along avenues and used for landscaping.

In France, Pinon (1986) reported that 75% of surveyed *P. tremula* stands in the Alps and southern Jura were affected by *E. mammata*, with up to 10% of the trees affected, but the proportion of affected trees and affected stands was lower in other French regions and varied through time. In Italy, the pathogen was reported in the 1980s from stands in the Siena province, where up to 50% of *P. tremula* trees were infected in affected stands (Capretti, 1983).

In Sweden, Hypoxylon canker has been reported to have caused extensive damage during the 1950s (Stener and Stenlid, 2001). In a 26-year-old trial in southern Sweden, cankers were found on

43% of the investigated hybrid trees (*P. tremula* x *P. tremuloides*) (Ilstedt and Gullberg, 1993). In later trials on selected clones, the occurrence of cankers was lower and was found to vary between 1% and 19% of trees in different locations and no mortality was reported (but cankers were thought to be caused by either *E. mammata* or *Lecustoma niveum*; Stener and Karlsson, 2004). Additional reports conclude that the damage levels observed in these trials did not severely affect the vitality of the trees (Stener, 2010). Canker diseases are still considered as potentially important in aspen plantations in Sweden and only clones that have shown low susceptibility in trials are used as planting material (Rytter et al., 2011).

Environmental impacts can be expected in affected poplar plantations, where poplar mortality could lead to the increased availability of deadwood in these monocultures. Deadwood is an important habitat for many organisms, which has become rare in managed forests (Lonsdale et al., 2008). At the same time, Hypoxylon canker may in some cases provide an additional threat to the biodiversity of *Populus nigra*, a tree species endangered through much of Western Europe by the loss of floodplain forest habitat and by the genetic introgression from planted hybrid poplars (de Rigo et al., 2016b).

3.6. Availability and limits of mitigation measures

Are there measures available to prevent the entry into, establishment within or spread of the pest within the EU Protected Zones such that the risk becomes mitigated?

Please see below (Section 3.6.1).

Is it possible to eradicate the pest in a restricted area within 24 months (or a period longer than 24 months where the biology of the organism so justifies) after the presence of the pest was confirmed in the PZ?

There are no available reports of eradication of *E. mammata* from a restricted area. Eradication of cankered trees is impractical because a single overlooked canker can produce an abundance of spores (Manion and French, 1965). An attempt was made every year between 1960 and 1963 to remove all the cankered trees of one *Populus tremuloides* stand (of about 1.2 ha) in Minnesota, USA, which was isolated by a surrounding stand of *Pinus banksiana*. In 1964, 23 newly infected trees were found in the stand, thus demonstrating the unfeasibility of local eradication (Manion and French, 1965).

3.6.1. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest

- The endophytic phase of *E. mammata* within infected plants (incubation period) is on average of 2 years.
- Apparently, there are no validated molecular diagnostic protocols available for the detection of the pathogen.

3.6.2. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting

- Nursery inspection (to ensure plantations or landscape plantings are not made with infected stock (Ostry, 2013)) is made difficult by the extended endophytic phase (see above), which hinders the ability to promptly identify the presence of the pest on the source material.

3.6.3. Control methods

- Selection of resistant clonal material and genetic improvement.
- The selection of a suitable site for planting is important, taking into account that plant water stress due to drought increases the disease severity (Bruck and Manion, 1980).
- Maintaining high stocking densities seems to be important to reduce losses due to *E. mammata* (Perala, 1977; Ostry and Anderson, 2009).
- Eradication of the pathogen inoculum by felling infected trees is not an optimal strategy to prevent new infections. However, pruning infected branches before the canker reach the main stem could be important (reviewed by Ostry, 2013).
- Avoid wounding and injuries is of pivotal importance to prevent new infections.
- Debarking of *Populus* wood will reduce the risk of spread via this pathway.

3.7. Uncertainty

There is some uncertainty on the distribution of *E. mammata* in the EU, both for MS having reported it (it is uncertain how widespread the pathogen is there) and for MS that have not (it is not certain whether the pathogen is really absent there). As far as the PZ are concerned, the surveys to confirm the absence of the pathogen were conducted in 2009 for Northern Ireland and in 1993 for Ireland; thus, it is not known whether the pathogen is currently absent there.

There is some uncertainty on the susceptibility of cultivated hybrid poplars to the pathogen and thus on the potential damage to *Populus* plantations in the PZ. However, *E. mammata* has been assessed to be of low economic importance compared to other poplar diseases (Anselmi et al., 2006). Nonetheless, the UK Plant Health Risk Register rated the impact risk of the disease as 4 out of 5 (https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=11840).

There is a lack of data on the trade in *Populus* plants for planting from the EU MS to the PZ.

Other hardwoods such as *Salix* spp. may serve as carriers for the pathogen.

4. Conclusions

The Panel conclusions are summarised in Table 5.

Table 5: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Protected Zone quarantine pests (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pests	Uncertainties
Identity of the pest (Section 3.1)	The identity of the pest is established	The identity of the pest is established	None
Absence/ presence of the pest in the EU territory (Section 3.2)	*E. mammata* has been reported from 16 EU MS, but in most of them (with the exception of Sweden) with restricted distribution. It is not known whether the pathogen is currently present in the PZ	*E. mammata* has been reported from 16 EU MS, but in most of them (with the exception of Sweden) with restricted distribution. It is not known whether the pathogen is currently present in the PZ	It is uncertain how widespread the pathogen is in the MS where it has been reported and whether the pathogen is really absent in the MS that have not. As far as the PZ are concerned, the surveys to confirm the absence of the pathogen were conducted in 2009 for Northern Ireland and in 1993 for Ireland (EPPO Global Database)
Regulatory status (Section 3.3)	*E. mammata* is regulated by Council Directive 2000/29/EC on plants of *Populus* for Protected Zones (Annex II, Part B) (Ireland and the UK (Northern Ireland))	*E. mammata* is regulated by Council Directive 2000/29/EC on plants of *Populus* for Protected Zones (Annex II, Part B) (Ireland and the UK (Northern Ireland))	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Protected Zone quarantine pests (articles 32–35)	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pests	Uncertainties
Pest potential for entry, establishment and spread in the PZ of the EU (Section 3.4)	Entry: the pest has been reported from 16 EU MS and could enter the EU PZ Establishment: the pest is already established in 16 EU MS, some of which (e.g. the Netherlands) have a climate similar to the one found in the PZ (Ireland and Northern Ireland) Spread: the pest would be able to spread within the PZ of the EU following establishment, via airborne ascospores, infected plants for planting and wood with bark	The pathogen can be spread by plants for planting, but also through movement of infected wood with bark and airborne ascospores	There is uncertainty over the host status of hosts not currently regulated, e.g. *Salix*
Potential for consequences in the PZ of the EU (Section 3.5)	The introduction of *E. mammata* in the PZ could have an economic and environmental impact to plantations of susceptible poplar hybrids and species	*E. mammata* could be of economic importance on the use of plants for planting in the EU MS where it is reported	Lack of knowledge on the susceptibility of different poplar hybrids cultivated in the EU. The interactions of the disease with other environmental factors need to be investigated
Available measures (Section 3.6)	Selecting suitable sites for planting and avoiding host wounding are measures likely to reduce the risk of impacts. Eradication of *E. mammata* from a restricted area is unlikely to succeed	Nursery inspections to ensure that plantations or landscape plantings are not made with infected stock. Selection of resistant clonal material and genetic improvement	Lack of data on the effectiveness of the control measures
Conclusion on pest categorisation	The criteria assessed above by the Panel for consideration as potential PZ quarantine pest are met	The criterion on plants for planting as main pathway for spread is not met, as plants for planting are only one of the means of spread of the pathogen	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	Nursery practices, how the industry is structured for sourcing poplar plants for planting Trade in *Populus* plants (especially to the PZ) Introduction of new strains from North America Role of *Salix* spp. and other hardwoods as carriers of the pathogen		

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
EU MS	European Union Member State
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
JRC	Joint Research Centre of the European Commission
PZ	Protected Zone
RA	Risk assessment
RNQP	Regulated non-quarantine pest
RPP	Relative probability of presence
ToR	Terms of Reference

Appendix A – Methodological notes on Figure 4

The relative probability of presence (RPP) of *Populus* spp. shown in Figure 4 is based on the European Atlas of Forest Tree Species (de Rigo et al., 2016a; San-Miguel-Ayanz et al., 2016), aggregated at a 100 km^2 pixel resolution. Data rely on forestry inventories. Thus, cultivated poplars are not taken into account in this map, as plantations of these poplars are considered as an agricultural activity. RPP is defined as the probability of finding a species/taxon in a given area, irrespective of the probability of finding other taxa (de Rigo et al., 2017). As a consequence, the sum of all RPPs for different taxa in the same area does not need to be 100%. The estimates are based on constrained spatial multi-scale frequency analysis (de Rigo et al., 2014, 2016a, 2017): this is a spatial multi-scale frequency analysis of field observations, constrained to enhance the estimates' consistency with the frequency of broadleaved and coniferous taxa derived from Corine Land Cover (Bossard et al., 2000; Büttner et al., 2012). The trustability of RPP is a qualitative measure of the reliability of the distribution map and is based on the multiscale aggregation of the number of field observations (i.e. the local density of data) for each pixel and taxon. The colour scale of the trustability map is based on the quantiles of this data density (de Rigo et al., 2014, 2016a).