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Pest categorisation of *Melampsora farlowii*

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Abstract

Following a request from the European Commission, the EFSA Panel on Plant Health performed a pest categorisation of *Melampsora farlowii*, a well-defined and distinguishable fungus of the family Melampsoraceae. *M. farlowii* is the causal agent of a leaf and twig rust of hemlocks (*Tsuga* spp.) in eastern North America. The pathogen is regulated in Council Directive 2000/29/EC (Annex IAI) as a harmful organism whose introduction into the EU is banned. *M. farlowii* is not reported to be present in Europe and could enter the EU via host plants for planting and cut branches. Cones and fruits are listed as plant parts that can carry the pest in trade and transport, but are not regulated. The pathogen could establish in the EU, as climatic conditions are favourable and *Tsuga* spp. have been planted as ornamentals and in plantations in several EU countries. *M. farlowii* would be able to spread following establishment by human movement of host plants for planting and cut branches, as well as natural spread. Should the pathogen be introduced in the EU, impacts can be expected on *Tsuga* spp. plantations, ornamental trees and especially nurseries. Hemlock rust is considered a destructive rust attacking *Tsuga* spp., particularly *Tsuga canadensis* in nurseries. The main uncertainties concern whether the impact of the pathogen in plantations under European conditions could be different than observed in eastern North America, whether fruit/cones of *Tsuga* can be a pathway of entry, and the dissemination potential of the pathogen under European conditions. However, *M. farlowii* is found in North America in most of the natural distribution range of *T. canadensis*, suggesting little dispersal limitation of the pathogen. The criteria assessed by the Panel for consideration as a potential quarantine pest are met, whilst, for regulated non-quarantine pests, the criterion on the pest presence in the EU is not met.

Keywords: European Union, forest pathology, hemlock twig rust, pest risk, plant pest, quarantine, tree health

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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 categorizations 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 are 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

Aleurocanthus 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.
Ips amitinus Eichhof
Ips cembrae Heer
Ips duplicatus Sahlberg
Ips sexdentatus Börner
Ips typographus Heer
Sternochetus mangiferae Fabricius

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

Melampsora farlowii is one of a number of pests listed in the Appendices to the Terms of Reference (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 area of the EU.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *M. farlowii* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as well as its synonyms as search terms. The literature on the pest is limited (CABI, 2018), and most if not all available papers have been reviewed by the Panel.

2.1.2. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plan Protection Organization (EPPO) Global Database (EPPO, 2018) and relevant publications.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt database was consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTE) of the European Commission, 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 Member States (MS) and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *M. farlowii*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018) 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 quantitative pest risk assessment in the EU (EFSA PLH Panel, 2018), this work was started following an evaluation of the EU 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 in accordance with the specific terms of reference 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 a RNQP. If one of the criteria is not met, the pest will not qualify. A pest that does not qualify as a quarantine pest may still qualify as a RNQP that needs to be addressed in the opinion. For the pests regulated in the protected zones only, the scope of the categorisation is the territory of the protected zone; thus, the criteria refer to the protected zone instead of the EU territory.

It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regard 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, whereas addressing social impacts is outside the remit of the Panel, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018).

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? Describe the pest distribution briefly!	Is the pest present in the EU territory? If not, it cannot be a protected zone quarantine organism	Is the pest present in the EU territory? If not, it cannot be a regulated non-quarantine pest. (A regulated non-quarantine pest 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 risk assessment area, it should be under official control or expected to be under official control in the near future	The protected zone 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 risk assessment 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 protected zone 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 pests' introduction have an economic or environmental impact on the protected zone areas?	Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?

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
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 protected zone areas 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 protected zone?	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 assessed by EFSA 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 assessed by EFSA above for consideration as potential protected zone quarantine pest were met, and (2) if not, which one(s) were not met	A statement as to whether (1) all criteria assessed by EFSA 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 indicate 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

M. farlowii (Arthur) Davis is a fungus of the family Melampsoraceae.

The species is also referred to using the synonyms *Chrysomyxa farlowii* and *Necium farlowii* (EPPO, 2018).

3.1.2. Biology of the pest

M. farlowii is the causal agent of a leaf and twig rust of hemlocks (*Tsuga* spp.) throughout eastern North America (EPPO, 1997; Kenaley and Hudler, 2010). It is an autoecious rust of which only the teliospore and basidiospore stages are known. *M. farlowii* is not known to alternate between hemlock and a taxonomically unrelated plant (Kenaley and Hudler, 2010). The life cycle of the pathogen was first described by Hepting and Toole (1939) and was then reviewed and summarised by EPPO (1997) and Kenaley and Hudler (2010). *M. farlowii* overwinters as telia on cones and twigs killed by the pathogen the previous spring. In the presence of favourable meteorological conditions (i.e. cool, wet

weather) (Kenaley and Hudler, 2010), the overwintered teliospores germinate *in situ* mostly during hemlock bud burst, and produce basidiospores in spring and early summer (May–June). Basidiospores infect current season's growth and cones, and shortly after (within 2–4 weeks from infection), further telia appear although teliospores do not germinate until the following spring.

Factors influencing the germination of basidiospores are unclear; however, conditions conducive to teliospore germination appear to be sufficient for basidiospore germination and the infection of hemlock (Kenaley and Hudler, 2010). Based on field observations, 10 or more continuous hours of rain appear to be required for teliospore germination and the subsequent production of basidiospores (Hepting and Toole, 1939). The duration of the rain appears to be more important than the amount. Dew is not sufficient for teliospore germination to occur (Hepting and Toole, 1939).

Disease severity has been reported to vary with altitude; it was reported as being severe in nurseries at 1,200 and 1,300 m and almost absent from a nursery nearby at 830 m; it may be that the lower temperatures at higher altitudes favour the development of the rust (Hepting and Toole, 1939).

3.1.3. Intraspecific diversity

No information was found on the intraspecific diversity of *M. farlowii*.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, detection and identification methods are available.

The disease can be identified based on symptoms as previously described (Hepting and Toole, 1939; EPPO, 1997; Kenaley and Hudler, 2010).

Morphological descriptions of telia, teliospores and basidiospores are available (Arthur, 1962; EPPO, 1997).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

M. farlowii is only reported from eastern North America (EPPO, 2018) (Figure 1). In Canada, the pathogen is reported as present with no further detail in Nova Scotia. In the USA, the disease is reported as present with no further detail in the following states: Michigan, New Hampshire, New York, North Carolina, Pennsylvania, Vermont, Virginia and Wisconsin (EPPO, 2018). In the southern parts of its distribution range, the pathogen is mainly found at higher altitudes (CABI, 2018).

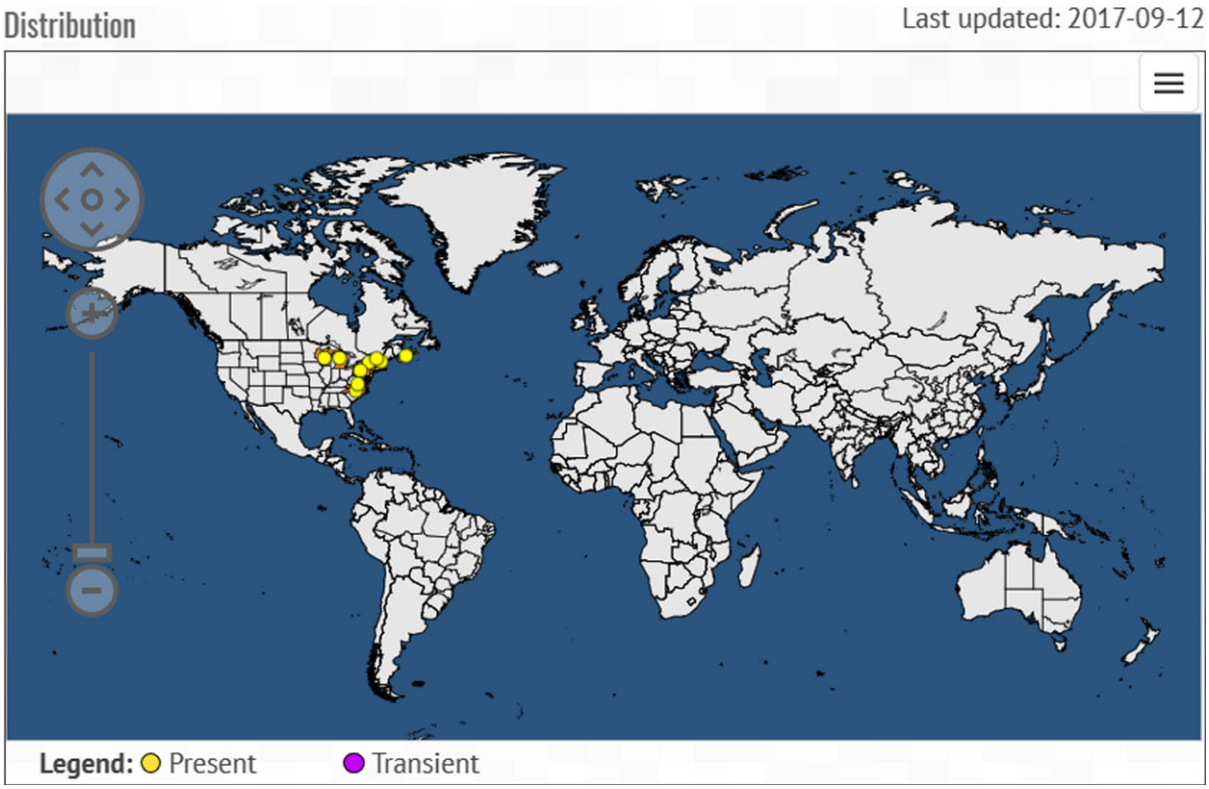

Figure 1: Global distribution map for *Melampsora farlowii* (extracted from EPPO, 2018; accessed April 2018). There are no reports of transient populations for this species

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest widely distributed within the EU?

No, the pest is not reported to be present in the EU.

M. farlowii has not been reported from the EU. The pathogen is reported as absent in Slovenia (no pest record, 2017) (EPPO, 2018) and in the UK (UK Plant Health Risk Register, accessed May 2018, https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=11278). There are no reports of absence available to the Panel that have been confirmed by survey.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

M. farlowii is listed in Council Directive 2000/29/EC. Details are presented in Tables 2 and 3.

Table 2: *Melampsora farlowii* in Council Directive 2000/29/EC

Annex I, Part A	**Harmful organisms whose introduction into, and spread within, all member states shall be banned**
Section I	**Harmful organisms not known to occur in any part of the community and relevant for the entire community**
(c)	Fungi
	Species
8.	*Melampsora farlowii* (Arthur) Davis

3.3.2. Legislation addressing the hosts of *Melampsora farlowii*

Table 3: Regulated hosts and commodities that may involve *Melampsora farlowii* in Annexes III, IV 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
	Plants of [...] *Tsuga* Carr. [...], other than fruit and seeds	Non-European countries

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The main host of *M. farlowii* is *Tsuga canadensis* (EPPO, 2018).

Tsuga caroliniana as well as *Tsuga* as a genus are reported as minor hosts (EPPO, 2018).

In Council Directive 2000/29/EC, the pest is not regulated on a particular host or commodity; its introduction into the EU is banned (Annex IAI).

3.4.2. Entry

Is the pest able to enter into the EU territory?

Yes, *M. farlowii* could enter the EU via host plants for planting and cut branches.

The main host commodities on which the pathogen could enter into the EU are (EPPO, 2018):

- plants for planting of *Tsuga* spp.
- cut branches of *Tsuga* spp.

Both pathways are regulated due to the ban on importing plants of *Tsuga* spp., other than fruit and seeds, from non-European countries. However, cones and fruits are listed by CABI as plant parts that can carry the pest in trade and transport (CABI, 2018). There is no information available on the possible import of *Tsuga* cones.

As of March 2018, there were no records of interception of *M. farlowii* in the Europhyt database.

3.4.3. Establishment

Is the pest able to become established in the EU territory?

Yes, the pest could establish in the EU. The hosts are non-native but are present in several EU MS.

3.4.3.1. EU distribution of main host plants

Various *Tsuga* spp. have been introduced in the EU as ornamental trees (Figure 2). For instance, *T. canadensis* is reported as a monumental tree in several European countries (Belgium, Germany, Italy, the Netherlands, Poland, Slovakia and the UK) (https://www.monumentaltrees.com/en/europe-tsugacanadensis/). *T. canadensis* is reported as an established exotic species in Poland and Sweden by the DAISIE database (http://www.europe-aliens.org/speciesFactsheet.do?speciesId=507#). The species is reported as present in Austria, France, Germany, Luxembourg, the Netherlands, Norway, Poland, Spain, Sweden and the UK in the European Alien Species Information Network (EASIN) database (https://easin.jrc.ec.europa.eu/).

In addition, *Tsuga heterophylla* is a relatively important forest species in, e.g. Ireland, the Netherlands and the UK (though not recorded as a host of *M. farlowii*) (EPPO, 1997). *T. heterophylla* is reported as an established exotic species in France, Norway and the UK by the DAISIE database (http://www.europe-aliens.org/speciesFactsheet.do?speciesId=512#). The species is reported as present in Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Spain, Sweden and the UK by the EASIN database. The DAISIE database also reports *Tsuga mertensiana* as an established exotic species in Sweden (http://www.europe-aliens.org/speciesFactsheet.do?specie

sId=514#), whilst there are no data in the EASIN database about the presence of *T. mertensiana* in European countries.

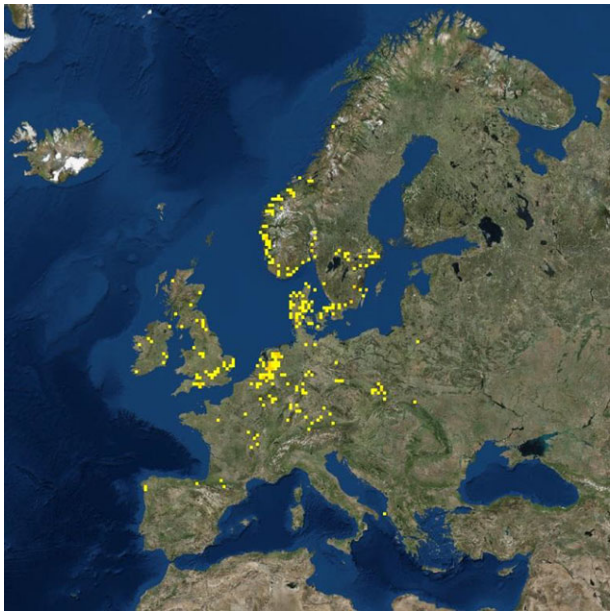

Figure 2: Reported presence of *Tsuga* spp. in Europe. Map kindly prepared by the Joint Research Centre (JRC) in 2017 based on the information provided by the Global Biodiversity Information Facility (GBIF) portal (https://www.gbif.org)

3.4.3.2. Climatic conditions affecting establishment

M. farlowii is found in North America (Figure 1; section 3.2.1) in most of the natural distribution range of *T. canadensis* and *T. caroliniana*, encompassing areas characterised by cool and wet weather in spring (warm temperate: Cfa and Cfb Köppen-Geiger climate categories; Peel et al., 2007). These conditions are common in central and northern EU. Therefore, climate is assumed not to be a limiting factor for the establishment of the pathogen in the EU.

3.4.4. Spread

Is the pest able to spread within the EU territory following establishment? How?

Yes, by natural dispersal and movement of infected plants for planting and cut branches.

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 not the main means of spread of the pathogen.

Under natural conditions the spread of the disease is ensured by basidiospore dispersal (CABI, 2018). However, the dissemination potential of the fungus under European conditions is largely unknown. Nevertheless, the UK Plant Health Risk Register rates the spread potential (by natural dispersal only) of *M. farlowii* as 5 on a scale from 1 to 5 (https://secure.fera.defra.gov.uk/phiw/riskRegister/viewPestRisks.cfm?cslref=11278). *M. farlowii* can also be carried on infected host planting material and cut branches (EPPO, 1997).

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes, the pest introduction could have an impact, especially in nurseries.

RNQPs: Does the presence of the pest on plants for planting have an economic impact, as regards the intended use of those plants for planting?[4]

Yes, the introduction of the pest could have an impact on the intended use of plants for planting.

M. farlowii causes the blighting of the current season's shoots of *T. canadensis* and *T. caroliniana* (Figure 3); leaves, cones and twigs are generally attacked (Hepting and Toole, 1939). In addition to causing death and malformation of branches, the disease also causes abortion of newly formed cones (EPPO, 1997). Hemlock rust can be a destructive rust attacking *Tsuga* spp., particularly *T. canadensis* in nurseries (EPPO, 1997); however, in the forest, this rust apparently does little damage, killing only occasional twigs and aborting cones (Hepting and Toole, 1939). Since diseased cones produce no seed, the rust can also affect seed crop (Hepting and Toole, 1939). Infected cones are frequently discoloured, shrivelled and mummified (CABI, 2018).

In North America, while the disease can be commonly found in natural forest stands, the attack is usually so light as to be inconspicuous (Hepting and Toole, 1939). However, hemlock twig rust can cause considerable damage in commercial tree nurseries, where cultural conditions favour the development of disease (Kenaley and Hudler, 2010). Plants a few years old are often rendered unsaleable following attack (EPPO, 1997; CABI, 2018). Repeated attacks dwarf trees and sometimes result in their death (Hepting and Toole, 1939).

Figure 3: Eastern hemlock (*Tsuga canadensis*) infected by *Melampsora farlowii* (Photo by Bruce Watts, University of Maine, USA, Bugwood.org; Available online: https://www.forestryimages.org/browse/detail.cfm?imgnum=0660079

Should *M. farlowii* be introduced into the EU, impacts can be expected to *Tsuga* spp. plantations, ornamental trees and especially nurseries.

[4] See section 2.1 on what falls outside EFSA's remit.

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 such that the risk becomes mitigated?

Yes, there is an import prohibition in place for the main pathway *Tsuga* plants (see Sections 3.3, 3.4.2 and 3.6.1)

RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated?

Yes, should the pathogen be introduced in the EU, production of plants for planting in pest free areas can prevent pest presence on plants for planting.

3.6.1. Identification of additional measures

Phytosanitary measures are currently applied to the host species of *M. farlowii* (see Section 3.3.2).

3.6.1.1. Additional control measures

Potential additional control measures are listed in Table 4.

Table 4: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Information sheet title (with hyperlink to information sheet if available)	Control measure summary	Risk component (entry/establishment/spread/impact)
Chemical treatments on crops including reproductive material	Treatments with triadimefon, neem oil or mancozeb once when buds break and twice at 7-/14-day intervals (Kenaley and Hudler, 2010)	Impact
Crop rotation, associations and density, weed/volunteer control	Avoiding planting pure stands of *Tsuga* spp. can reduce impacts Where disease is severe, planting of susceptible hemlocks should be avoided as inoculum produced within infected nursery beds or cultures will persist (Kenaley and Hudler, 2010)	Impact

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

- Infection is not limited to small trees or the lower parts of large trees, but can also occur copiously on the top of large trees (Hepting and Toole, 1939).
- Excluding the pathogen from nurseries by removing and burning all infected twigs and cones before growth starts in the spring would be difficult to achieve (Hepting and Toole, 1939).
- Use of fungicides in nurseries may mask symptom development.

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

- Nursery-grown trees provide especially good conditions for hemlock rust development because of the trimming of the trees, their proximity to each other and the resulting extensive areas of compact foliage (Hepting and Toole, 1939).

3.7. Uncertainty

- There is little available literature on this pathogen.
- There is relatively limited information on the distribution and abundance of host trees in Europe.
- There is uncertainty on whether fruit/cones of *Tsuga* can be a pathway of entry.

- The potential dispersal range under European conditions of *M. farlowii* basidiospores is unknown. However, *M. farlowii* is found in North America in most of the natural distribution range of *T. canadensis* and *T. caroliniana*, thus suggesting little dispersal limitation of the pathogen.
- There is uncertainty about whether the impact of the pathogen in plantations under European conditions could be different than observed in Eastern North America.

4. Conclusions

M. farlowii meets the criteria assessed by EFSA for consideration as potential quarantine pests (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 Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of *M. farlowii* as a species is clear	The identity of *M. farlowii* as a species is clear	None
Absence/presence of the pest in the EU territory (Section 3.2)	The pest is not reported to be present in the EU	The pest is not reported to be present in the EU	None
Regulatory status (Section 3.3)	*M. farlowii* is regulated by Council Directive 2000/29/EC (Annex IAI) as a harmful organism whose introduction into, and spread within, all Member States shall be banned	*M. farlowii* is regulated by Council Directive 2000/29/EC (Annex IAI) as a harmful organism whose introduction into, and spread within, all Member States shall be banned	None
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Entry: the pest could enter the EU via host plants for planting and cut branches. Cones and fruits are listed as plant parts that can carry the pest in trade and transport Establishment: the hosts are non-native but are present in several EU MS. Climatic conditions are favourable in the risk assessment area Spread: the pest could spread following establishment by movement of host plants for planting and cut branches, as well as natural spread	Plants for planting are not the main pathway of spread, given the potential contribution of cut branches and natural spread	The dissemination potential of the fungus under European conditions is largely unknown There is uncertainty on whether fruit/cones of *Tsuga* can be a pathway of entry
Potential for consequences in the EU territory (Section 3.5)	The introduction of *M. farlowii* would have economic and environmental impacts in *Tsuga* spp. plantations, ornamental trees and especially nurseries	The introduction of the pest could have an impact on the intended use of plants for planting	There is uncertainty about whether the impact of the pathogen in plantations under European conditions could be different than observed in eastern North America

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest	Key uncertainties
Available measures (Section 3.6)	Import prohibition of host plants for planting is an available measure to reduce the risk of introduction Avoiding planting pure stands of *Tsuga* spp. can reduce impacts	Production of plants for planting in pest free areas can prevent pest presence on plants for planting	None
Conclusion on pest categorisation (Section 4)	The criteria assessed by the Panel for consideration of *M. farlowii* as a potential quarantine pest are met	The criterion on the pest presence in the EU is not met	
Aspects of assessment to focus on/scenarios to address in future if appropriate	The main uncertainties concern whether the impact of the pathogen in plantations under European conditions could be different than observed in eastern North America and the dissemination potential of the pathogen under European conditions. However, *M. farlowii* is found in North America in most of the natural distribution range of *T. canadensis* and *T. caroliniana*, thus suggesting little dispersal limitation of the pathogen The present categorisation has explored most if not all of the limited available literature on these uncertainties		

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Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 1995, 2017)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 1995, 2017)
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2017)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2017)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2017)
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2017)
Measures	Control (of a pest) is defined in ISPM 5 (FAO 2017) as 'Suppression, containment or eradication of a pest population' (FAO, 1995) Control measures are measures that have a direct effect on pest abundance Supporting measures are organisational measures or procedures supporting the choice of appropriate Risk Reduction Options that do not directly affect pest abundance
Pathway	Any means that allows the entry or spread of a pest (FAO, 2017)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2017)
Protected zones (PZ)	A Protected zone is an area recognised at EU level to be free from a harmful organism, which is established in one or more other parts of the Union.
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2017)
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO, 2017)
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2017)

Abbreviations

DG SANTE	Directorate General for Health and Food Safety
EASIN	European Alien Species Information Network
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
GBIF	Global Biodiversity Information Facility
IPPC	International Plant Protection Convention
JRC	Joint Research Centre
MS	Member State
PLH	EFSA Panel on Plant Health
RNQP	regulated non-quarantine pest
RRO	Risk Reduction Option
ToR	Terms of Reference