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Pest categorisation of *Pseudopityophthorus minutissimus* and *P. pruinosus*

EFSA Panel on Plant Health (EFSA PLH Panel),
Claude Bragard, Katharina Dehnen-Schmutz, Francesco Di Serio, Paolo Gonthier, Marie-Agnès Jacques, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe Lucien Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen, Lucia Zappalà, Jean-Claude Grégoire, Virág Kertész and Panagiotis Milonas

Abstract

The Panel on Plant Health performed a pest categorisation of *Pseudopityophthorus minutissimus* and *Pseudopityophthorus pruinosus*, two well-defined insect species in the family Curculionidae, subfamily Scolytinae (Insecta: Coleoptera). They can be identified using taxonomic keys. *P. minutissimus* is present in parts of Canada and the USA, and *P. pruinosus* is present in parts of the USA, Guatemala, Honduras and Mexico. The main host plants of the two species are *Quercus* spp., but they also attack several other genera. The two species mostly colonise weakened or dead branches but can also attack the stems. They are mostly secondary pests but they vector the oak wilt fungus, *Bretziella fagacearum*, which causes heavy damage in American *Quercus* spp. populations. The fungus is mainly transmitted by the young adults during their maturation feeding on twigs, leaf petioles and young acorn stems. The beetles are polygamous and have two generations per year in most of their range. The main pathways are wood, bark, plants for planting, cut branches, chips and wood waste. These pathways are fully or partly regulated for the genera *Quercus*, *Castanea* and *Prunus*. However, the pathways are not regulated for the following genera: *Carpinus*, *Fagus*, *Hamamelis*, *Alnus*. *P. minutissimus* and *P. pruinosus* meet all the criteria assessed by EFSA for consideration as potential Union quarantine pest. The criteria for considering *P. minutissimus* and *P. pruinosus* as potential Union regulated non-quarantine pests are not met since neither species are known to be present in the EU.

Keywords: *Bretziella fagacearum*, European Union, oak bark beetle, pest risk, plant health, plant pest, quarantine

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Correspondence: alpha@efsa.europa.eu

Panel members: Claude Bragard, Katharina Dehnen-Schmutz, Francesco Di Serio, Paolo Gonthier, Marie-Agnès Jacques, Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod, Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell, Roel Potting, Philippe L. Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent, Jonathan Yuen and Lucia Zappalà.

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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, 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.
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	*Rhizoecus hibisci* Kawai and Takagi
Popillia japonica Newman	

(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

Pseudopityophthorus minutissimus and *Pseudopityophthorus pruinosus* are two of a number of pests listed in the Appendices to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether they fulfil the criteria of a quarantine pest or those of a regulated non-quarantine pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States (MS) referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores. The two species are treated together here because they have similar biology, attack *Quercus* spp. and are known vectors of the oak wilt pathogen *Bretziella* (*Ceratocystis*) *fagacearum* (see also the pest categorisation on *B. fagacearum* (EFSA PLH Panel, 2018b)).

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *P. minutissimus* and *P. pruinosus* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Relevant papers were reviewed and further references and information were obtained from experts, as well as from citations within the references and grey literature.

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 SANTÉ) 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 MS and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *P. minutissimus* and *P. pruinosus*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018a) and in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

This work was initiated 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 regulated non-quarantine pest 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 regulated non-quarantine pest. 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 regulated non-quarantine pest 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.

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?

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
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?
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, the identity of *P. minutissimus* and *P. pruinosus* is established. Both species can be identified at species level using conventional entomological keys.

P. minutissimus and *P. pruinosus* are bark beetles of the family Curculionidae, subfamily Scolytinae.[4] Their taxonomy is well established (Wood Stephen, 1982; Wood and Bright, 1992; Atkinson, 2018), a morphological key (Wood Stephen, 1982) and detailed photographs (Atkinson, 2018) allow accurate identification.

3.1.2. Biology of the pest

The biology of either or both species has been described by Ambourn et al. (2006), EPPO (2011), McMullen et al. (1955), Rexrode (1967, 1969), Rexrode and Jones (1970, 1971), Rexrode et al. (1965), Wood Stephen (1982).

After overwintering as larvae or immature adults (pupae appear sensitive to winter cold), the adults emerge in May, and proceed to maturation feeding in several organs of white and red oaks (respectively *Quercus alba* and *Quercus rubra*): twig crotches, leaf petioles, buds axils, immature acorns. During this process, they can introduce the oak wilt fungus, *B. fagacearum*, to a new host. They then attack dead or weakened branches or trunk portions. The males bore a longitudinal gallery, approximately 1 cm long, in the phloem and cambium and are joined by one or two females which bore transversal egg galleries perpendicular to the fibres, approximately 2 cm long each, starting in the middle of the entrance gallery and thus producing a cross-shaped pattern. The eggs are laid in niches along these egg galleries, and the larvae bore each a longitudinal gallery perpendicular to the egg gallery from which they originated. In *P. minutissimus*, McMullen et al. (1955) counted an average of 44 eggs per female, and, state that there are probably five larval instars. Pupation occurs in the phloem and cambium. In most of the beetles' range, there are two generations per year.

3.1.3. Intraspecific diversity

The literature does not mention any issues relative to intraspecific diversity in the two species.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?
Yes, the galleries have a distinct pattern and the adults have been clearly described.

Adult beetles are 1.5–2 cm long. A morphological key (Wood Stephen, 1982) and detailed photographs (Atkinson, 2018) allow accurate identification of the adults. *P. minutissimus* adults have been trapped with window traps (Ambourn et al., 2006), and both species respond to alpha-copaene (Kendra et al., 2011) as well as to ethanol (Roling and Kearby, 1975; Montgomery and Wargo, 1983). The entrance and egg-galleries are distinctly cross-shaped, and the larval galleries run along the grain in the phloem and cambium (see Section 3.1.2). The galleries are often found in smaller branches (1–10 cm in diameter) but could also occur in stems 40 cm in diameter.

As the presence of the beetles is often associated with that of *B. fagacearum*, the detection methods described in EFSA 2018 could also be applied.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

P. minutissimus is present only in North America. *P. pruinosus* has been reported from North and Central America (Figures 1 and 2, Table 2).

[4] Although the leading taxonomists in the 2000s (Wood Stephen, 1982; Bright and Skidmore, 2002) still considered the Scolytidae to be a family distinct from the Curculionidae according to morphological criteria, modern phylogenetics supports the position of scolytine beetles (Scolytinae) within the family Curculionidae (Knížek and Beaver, 2004; Hulcr et al., 2015). This is reflected by the growing number of citations in the Scopus database refering to Scolytinae (18 in 1990 vs 177 in 2016), as opposed to citations referring to Scolytidae (50 in 1990 vs 15 in 2016). The Scolytinae includes two subcategories, the 'bark beetles' which live in the phloem, and the 'ambrosia beetles' which live in the sapwood.

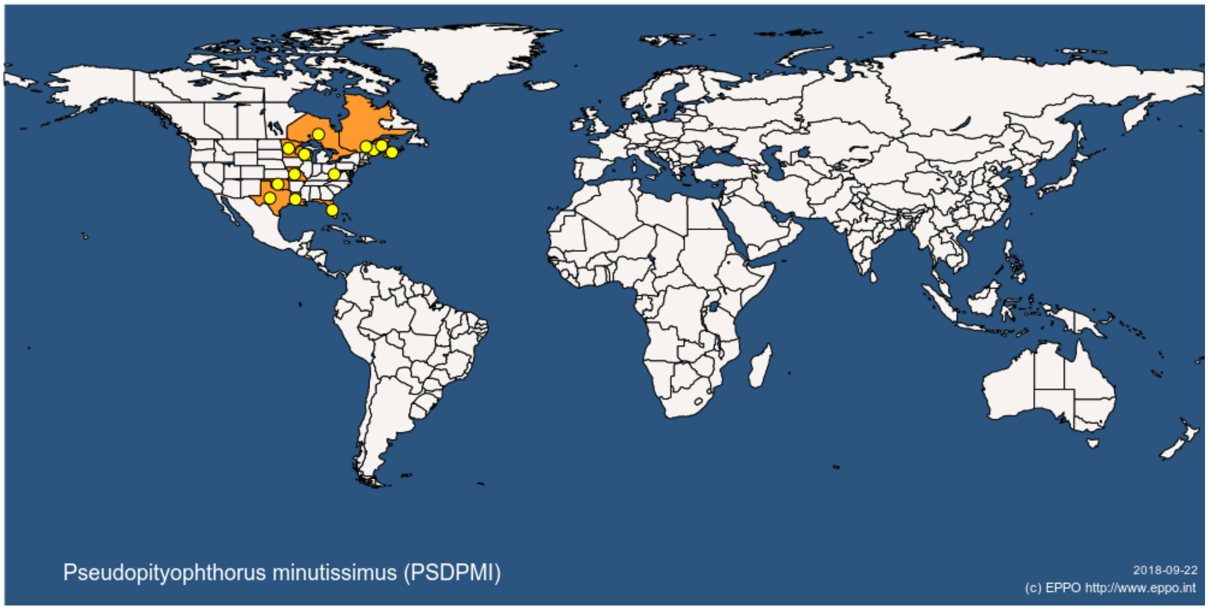

Figure 1: Global distribution map for *Pseudopityophthorus minutissimus* (extracted from the EPPO Global Database accessed on 22 September 2018)

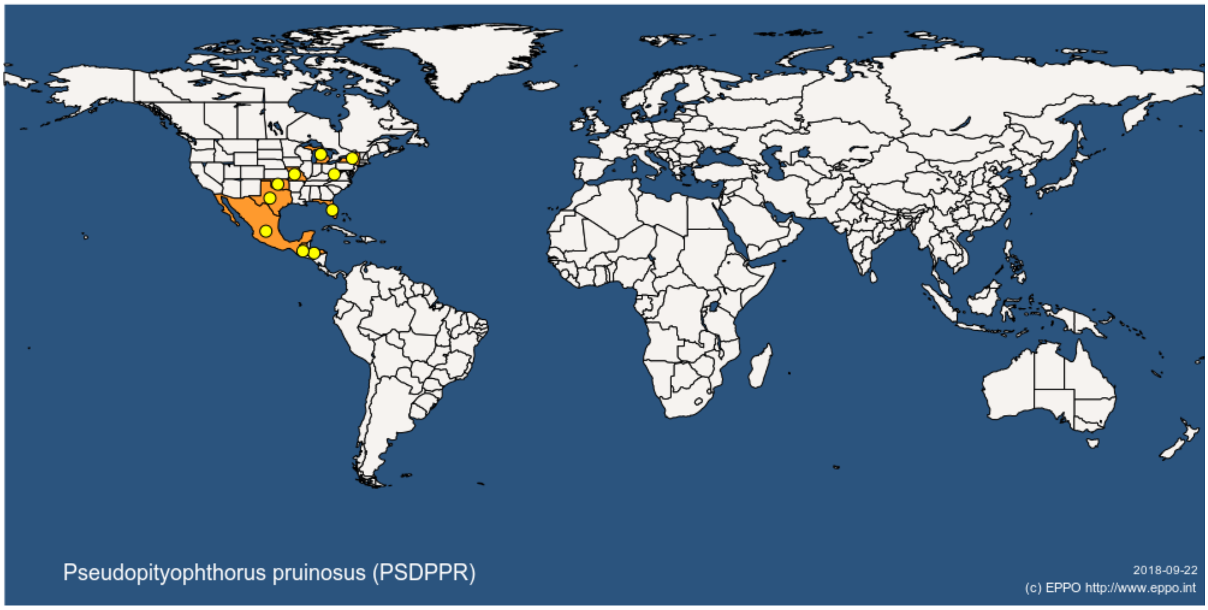

Figure 2: Global distribution map for *Pseudopityophthorus pruinosus* (extracted from the EPPO Global Database accessed on 22 September 2018)

Table 2: Current distribution of *Pseudopityophthorus minutissimus* and *P. pruinosus* outside Europe based on the information from the EPPO Global Database (accessed on 22 September 2018)

Continent	Country	State/Region	*Pseudopityophthorus minutissimus*	*Pseudopityophthorus pruinosus*
America	Canada	New Brunswick	x	
		Nova Scotia	x	
		Ontario	x	
		Quebec	x	
	Guatemala			x

Continent	Country	State/Region	*Pseudopityophthorus minutissimus*	*Pseudopityophthorus pruinosus*
	Honduras			x
	Mexico			x
	USA	Florida	x	x
		Louisiana	x	
		Maine	x	
		Michigan		x
		Minnesota	x	
		Missouri	x	x
		New York		x
		Oklahoma	X	x
		Texas	X	x
		West Virginia	X	x
		Wisconsin	X	

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, *P. minutissimus* and *P. pruinosus* have not been reported from the EU territory.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

P. minutissimus and *P. pruinosus* are listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.

Table 3: *Pseudopityophthorus minutissimus* and *P. pruinosus* 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**
(a)	Insects, mites and nematodes, at all stages of their development
	Species
18.	*Pseudopityophthorus minutissimus*
19.	*Pseudopityophthorus pruinosus*

3.3.2. Legislation addressing the hosts of *Pseudopityophthorus minutissimus* and *P. pruinosus*

P. minutissimus and *P. pruinosus* are Annex IAI pests, which implies that they are regulated for all plant genera and commodities. Table 4 shows the relevant regulation related to its major hosts: *Quercus* spp.

Table 4: Regulated hosts and commodities that may involve *Pseudopityophthorus minutissimus and P. pruinosus* 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
2.	Plants of [. . .] *Quercus* L., with leaves, other than fruit and seeds	Non-European countries
6.	Isolated bark of *Quercus* L., other than *Quercus suber* L.	North American countries

Annex IV, Part A	**Special requirements which shall be laid down by all member states for the introduction and movement of plants, plant products and other objects into and within all Member States**	
Section I	**Plants, plant products and other objects originating outside the community**	
	Plants, plant products and other objects	Special requirements
3	Wood of *Quercus* L., other than in the form of: • chips, particles, sawdust, shavings, wood waste and scrap, • casks, barrels, vats, tubs and other coopers' products and parts thereof, of wood, including staves where there is documented evidence that the wood has been produced or manufactured using heat treatment to achieve a minimum temperature of 176 °C for 20 minutes • Wood packaging material, in the form of packing cases, boxes, crates, drums and similar packings, pallets, box pallets and other load boards, pallet collars, dunnage, whether or not actually in use in the transport of objects of all kinds, except dunnage supporting consignments of wood, which is constructed from wood of the same type and quality as the wood in the consignment and which meets the same Union phytosanitary requirements as the wood in the consignment, but including wood which has not kept its natural round surface, originating in the USA.	Official statement that the wood: (a) is squared so as to remove entirely the rounded surface, or (b) is bark-free and the water content is less than 20% expressed as a percentage of the dry matter, or (c) is bark-free and has been disinfected by an appropriate hot-air or hot water treatment, or (d) if sawn, with or without residual bark attached, has undergone kiln-drying to below 20% moisture content, expressed as a percentage of dry matter, achieved through an appropriate time/temperature schedule. There shall be evidence thereof by a mark 'Kiln-dried' or 'KD' or another internationally recognised mark, put on the wood or on any wrapping in accordance with current usage.
7.2.	Whether or not listed among the CN codes in Annex V, Part B, wood in the form of chips, particles, sawdust, shavings, wood waste and scrap and obtained in whole or part from *Quercus* L. originating in the USA.	Official statement that the wood: (a) has undergone kiln-drying to below 20% moisture content, expressed as a percentage of dry matter achieved through an appropriate time/temperature schedule, or (b) (b) has undergone an appropriate fumigation to a specification approved in accordance with the procedure laid down in Article 18.2. There shall be evidence of the fumigation by indicating on the certificates referred to in Article 13.1.(ii), the active ingredient, the minimum wood temperature, the rate (g/m 3) and the exposure time (h), or (c) (c) has undergone an appropriate heat treatment to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood (including at its core), the latter to be indicated on the certificates referred to in Article 13.1.(ii)

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 genera [. . .] *Quercus* L., [. . .], intended for planting, and other than bulbs, corms, rhizomes, seeds and tubers.
Section II	**Plants, plant products and other objects which are potential carriers of harmful organisms of relevance for certain protected zones, and which must be accompanied by a plant passport valid for the appropriate zone when introduced into or moved within that zone**
1.2	Plants intended for planting, other than seeds, of [. . .] *Quercus* spp., other than *Quercus suber* [. . .]
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 [. . .] *Quercus* L., [. . .]
5.	Isolated bark of [. . .] *Quercus* L., other than *Quercus suber* 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: — *Quercus* L., including wood which has not kept its natural round surface, originating in the USA, except wood which meets the description referred to in (b) of CN code 4416 00 00 and where there is documented evidence that the wood has been processed or manufactured using a heat treatment to achieve a minimum temperature of 176°C for 20 minutes, (b) meets one of the following descriptions laid down in Annex I, Part two to Council Regulation (EEC) No 2658/87: 4403 91 00 - Oak wood (*Quercus* spp.) in the rough, whether or not stripped of bark or sapwood, or roughly squared, other than treated with paint, stains, creosote or other preservatives 4407 91 - Oak wood (*Quercus* spp.), sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm.

3.3.3. Legislation addressing the organisms vectored by *Pseudopityophthorus minutissimus* and *P. pruinosus* (Directive 2000/29/EC)

P. minutissimus and *P. pruinosus* are vectors of the quarantine organism *Bretziella* (*Ceratocystis*) *fagacearum* (Table 5).

Table 5: Organisms vectored by *Pseudopityophthorus minutissimus* and *P. pruinosus* 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
1.	*Ceratocystis fagacearum*

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

The main hosts of *P. minutissimus* are *Quercus* spp. According to Atkinson (2018), the pest has also been found on the following species:

- *Betula* sp.;
- *Carpinus caroliniana*;
- *Castanea floridana*;
- *Fagus grandifolia*;
- *Quercus borealis*, *Q. falcata*, *Q. laurifolia*, *Q. muhlenbergii*, *Q. nigra*, *Q. palustris*, *Q. prinus*, *Q. velutina*;
- *Hamamelis* sp.;
- *Amelanchier arborea*;
- *Prunus serotina*.

Quercus spp. are also the main hosts of *P. pruinosus*. Atkinson (2018) also records the following hosts:

- *Alnus* sp.;
- *Castanea floridana*;
- *Fagus grandifolia*;
- *Quercus buckleyi*, *Q. coccinea*, *Q. falcata*, *Q. hondurensis*, *Q. hypoleucoides*, *Q. laevis*, *Q. laurifolia*, *Q. laurina*, *Q. marylandica*, *Q. nigra*, *Q. palustris*, *Q. sapotaefolia*, *Q. stellata*, *Q. texana*, *Q. velutina*, *Q. virginiana*;
- *Persea* sp.;
- *Prunus angustifolia, P. serotina.*

3.4.2. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways!

Yes, although the pathway for the major host plants is currently regulated under EU legislation (Council Directive 2000/29/EC).

There are no records of interception of *P. minutissimus* and *P. pruinosus* in the Europhyt database. Pathways for the pest (in order of importance) are:

- wood of host plants
- bark of host plants
- plants for planting of host plants
- cut branches of host plants
- chips and wood waste.

For the following pathways, specific import requirements are currently specified in Annex III or Annex IV of 2000/29/EC:

- cut branches (with leaves) of *Quercus* spp., and *Castanea* spp. (prohibited Annex III A.2)
- cut branches of *Prunus* spp. (prohibited Annex III A.9)
- plants for planting (with leaves) of *Quercus* spp., and *Castanea* spp. (prohibited Annex III A.2)
- plants for planting of *Prunus* spp. (prohibited Annex III A.9)
- bark of *Quercus* (prohibited Annex III A.6)
- wood of *Quercus* (specified treatments in Annex IV A.3)
- Chips and wood waste of *Quercus* (specified treatments in Annex IV A.7.2).

(Note: there are Annex IV requirements in place for *Betula*, *Prunus*, *Amelanchier* and *Persea* in relation to other pests).

For all the other identified pathways (such as dormant *Quercus* plants without leaves, etc.), no import requirements are currently specified.

3.4.3. Establishment

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

Yes, the climatic conditions are favourable in parts of the EU territory, and potential host plants (*Quercus* spp.) are widespread.

3.4.3.1. EU distribution of main host plants

Host species of *P. minutissimus* and *P. pruinosus* (see Section 3.4.1) are distributed throughout the EU territory (Figure 3).

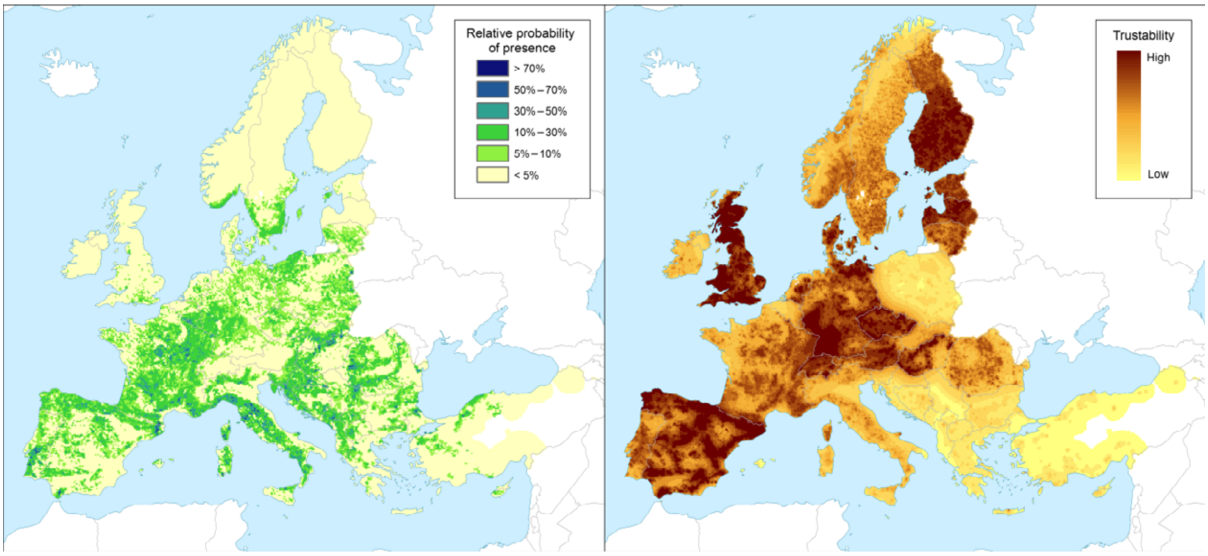

Figure 3: Left panel: Relative probability of presence (RPP) of the genus *Quercus* (based on data from the species: *Quercus cerris, Q. petraea, Q. robur, Q. pubescens, Q. rubra, Q. frainetto, Q. ilex, Q. suber, Q. trojana, Q. virgiliana, Q. palustris, Q. pedunculiflora, Q. coccifera, Q. vulcanica, Q. faginea, Q. pyrenaica, Q. canariensis, Q. macrolepis, Q. dalechampii, Q. congesta*, *Quercus* x *streimii*, *Q. alnifolia*) in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix A (courtesy of JRC, 2017). Right panel: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in forestry inventories. The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details see Appendix A).

3.4.3.2. Climatic conditions affecting establishment

Many parts of Canada and the USA where either or both species are established (Section 3.2.1 and Table 2) have climatic conditions comparable to those occurring at least in parts of the EU.

3.4.4. Spread

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

Yes, the pest is able to spread in the EU by flight and using the pathways listed in Section 3.4.2.

Regulated Non-Quarantine Pest (RNQPs): Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

No, *P. minutissimus* and *P. pruinosus* do not spread mainly via plants for planting.

The two species are able to fly, although their flight capacity is unknown. A European bark beetle species of similar size, *Pityogenes chalcographus*, has been observed to cover 86 km, presumably by non-assisted flight (Nilssen, 1984). Hitchhiking in vehicles is probably also possible, although not reported. Long-distance spread using the pathways listed in Section 3.4.2 is also possible.

3.5. Impacts

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

Yes, both species are known vectors of the oak wilt disease that causes significant damage to oak trees.

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?[5]

Yes, the presence of the pests on plants for planting is likely to have an adverse impact.

The two *Pseudopityophthorus* species, *P. minutissimus* and *P. pruinosus*, attack mainly dying or dead trees. Therefore, they have minimal impact on their host plants due to direct damage. However, they are both known vectors of the oak wilt disease, caused by the fungus *B. fagacearum* (Haack et al., 1983; Juzwik et al., 2011; EFSA PLH Panel, 2018b). Oak wilt is a severe disease of oak trees. In the USA where the disease is known to occur, it causes significant losses of oak trees. Associated economic losses in the USA have been attributed to loss of timber, decreased property value, costs of tree removal and replacement. Considerable environmental impact has also been recorded in the USA. For instance, the endangered bird species *Setophaga chrysoparia* is facing habitat losses due to oak wilt in mixed juniper-oak woodland (Juzwik et al., 2011).

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, measures to prevent entry are shown in Sections 3.3 and 3.6.1. In summary, main host plants for planting are prohibited; their wood must be appropriately treated.

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

Yes, the risk would be mitigated if the plants for planting are produced in pest free areas or places of production.

3.6.1. Identification of additional measures

Phytosanitary measures are currently applied to some of the hosts of *P. minutissimus* and *P. pruinosus* (see Section 3.3 addressing legislation on the main host genera *Quercus*). Phytosanitary measures applicable to the vectored pathogen *B. fagacearum* (EFSA PLH Panel, 2018b) may also be considered.

3.6.1.1. Additional control measures

For the plants for planting, cut branches and wood from host species/genera that are not regulated (*Carpinus caroliniana*, *Fagus grandifolia*, *Hamamelis* spp., *Alnus* spp.) potential additional control measures may be required (Table 6).

[5] See Section 2.1 on what falls outside EFSA's remit.

Table 6: Selected control measures (a full list is available in EFSA PLH Panel, 2018a,b) 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)
Growing plants in isolation	Growing of host plants for planting in isolated conditions would prevent the infestation by both *P. minutissimus* and *P. pruinosus*	Entry
Chemical treatments on consignments or during processing	Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage. The treatments addressed in this information sheet are: a) fumigation; b) spraying/dipping pesticides; c) surface disinfectants; d) process additives; e) protective compounds	Entry
Physical treatments on consignments or during processing	This information sheet deals with the following categories of physical treatments: irradiation/ionisation; mechanical cleaning (brushing, washing); sorting and grading, and; removal of plant parts (e.g. debarking wood)	Entry
Roguing and pruning	Roguing is defined as the removal of infested plants and/or uninfested host plants in a delimited area, whereas pruning is defined as the removal of infested plant parts only, without affecting the viability of the plant	Entry/establishment/spread
Heat and cold treatments	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to the treated material itself. The measures addressed in this information sheet are: autoclaving; steam; hot water; hot air; cold treatment	Entry

3.6.1.2. Additional supporting measures

For the plants for planting, cut branches and wood from host species/genera that are not regulated (*Carpinus caroliniana*, *Fagus grandifolia*, *Hamamelis* spp., *Alnus* spp.) potential additional supporting measures may be required (Table 7).

Table 7: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018a,b) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques.	Entry
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests	Entry

Information sheet title (with hyperlink to information sheet if available)	Supporting measure summary	Risk component (entry/ establishment/ spread/impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing. For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology	Entry
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5): export certificate (import)	Entry

3.7. Uncertainty

- Host plants: the present list of host plants is possibly incomplete. Atkinson (2018) writes that there is no host information for many records.
- Spread: the flight capacity of *P. minutissimus* and *P. pruinosus* has not been analysed to date.
- Vector role: *P. minutissimus* and *P. pruinosus* do not seem to be the principal vectors of *Bretziella fagacearum*: '...the role as vectors of the two *Pseudopityophthorus* species has also been debated. It is argued that these species are not well adapted to vector the disease and are thus considered to be of lesser importance (Sinclair and Lyon 2005; Harrington 2009, Harrington 2013)' (EFSA PLH Panel, 2018b).

4. Conclusions

P. minutissimus and *P. pruinosus* meet all the criteria assessed by EFSA for consideration as potential Union quarantine pest (Table 7). The criteria for considering *P. minutissimus* and *P. pruinosus* as potential Union regulated non-quarantine pests are not met since both species are not known to be present in the EU.

Table 8: 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 *P. minutissimus* and *P. pruinosus* is clearly defined	The identity of *P. minutissimus* and *P. pruinosus* is clearly defined	None
Absence/ presence of the pest in the EU territory (Section 3.2)	*P. minutissimus* and *P. pruinosus* are not known to occur in the EU. Both are American species	*P. minutissimus* and *P. pruinosus* are not known to occur in the EU. Both are American species	None
Regulatory status (Section 3.3)	*P. minutissimus* and *P. pruinosus* are listed on Annex IAI of Council Directive 2000/29/EC	*P. minutissimus* and *P. pruinosus* are listed on Annex IAI of Council Directive 2000/29/EC	None

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
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	*P. minutissimus* and *P. pruinosus* have the potential to enter in wood, bark, plants for planting, cut branches, chips and wood waste; and become established and spread within the EU	Plants for planting are not the main source of spread	The present list of host plants is possibly incomplete. The flight capacity of *P. minutissimus* and *P. pruinosus* has not been analysed to date
Potential for consequences in the EU territory (Section 3.5)	The introduction of either *P. minutissimus* or *P. pruinosus* will have an economic and environmental impact especially for oak forests	*P. minutissimus* or *P. pruinosus* are associated with plants for planting and are expected to have an impact on the use of those plants for planting	*P. minutissimus* and *P. pruinosus* do not seem to be the principal vectors of *Bretziella fagacearum*
Available measures (Section 3.6)	There are measures available to prevent the entry of *P. minutissimus* and *P. pruinosus* in the EU, which are described in Council Directive 2000/29/EC and in Section 3.6	Growing of plants in isolation or in pest free area or place of production	None
Conclusion on pest categorisation (Section 4)	*P. minutissimus* and *P. pruinosus* meet all criteria assessed by EFSA above for consideration as a potential quarantine pest	*P. minutissimus* and *P. pruinosus* do not meet all criteria assessed by EFSA above for consideration as a potential regulated non-quarantine pest as they are not present in EU	None
Aspects of assessment to focus on/ scenarios to address in future if appropriate	None		

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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

CLC	Corine Land Cover
C-SMFA	constrained spatial multi-scale frequency analysis
DG SANTÉ	Directorate General for Health and Food Safety
EPPO	European and Mediterranean Plant Protection Organization
EUFGIS	European Information System on Forest Genetic Resources
FAO	Food and Agriculture Organization
GD^2	Georeferenced Data on Genetic Diversity
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
RNQP	Regulated Non-Quarantine Pest
RPP	relative probability of presence
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Appendix A – Methodological notes on Figure 3

The relative probability of presence (RPP) reported here for *Quercus* spp. in Figure 3 and in the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of that genus to occur in a given spatial unit (de Rigo et al., 2017). In forestry, such a probability for a single taxon is called 'relative'. The maps of RPP are produced by means of the constrained spatial multi-scale frequency analysis (C-SMFA) (de Rigo et al., 2014, 2017) of species presence data reported in geo-located plots by different forest inventories.

A.1. Geolocated plot databases

The RPP models rely on five geodatabases that provide presence/absence data for tree species and genera: four European-wide forest monitoring data sets and a harmonised collection of records from national forest inventories (de Rigo et al., 2014, 2016, 2017). The databases report observations made inside geolocalised sample plots positioned in a forested area, but do not provide information about the plot size or consistent quantitative information about the recorded species beyond presence/absence.

The harmonisation of these data sets was performed within the research project at the origin of the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz, 2016; San-Miguel-Ayanz et al., 2016). Given the heterogeneity of strategies of field sampling design and establishment of sampling plots in the various national forest inventories (Chirici et al., 2011a,b), and also given legal constraints, the information from the original data sources was harmonised to refer to an INSPIRE compliant geospatial grid, with a spatial resolution of 1 km^2 pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, http://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

A.1.1. European National Forestry Inventories database

This data set was derived from National Forest Inventory data and provides information on the presence/absence of forest tree species in approximately 375,000 sample points with a spatial resolution of 1 km^2/pixel, covering 21 European countries (de Rigo et al., 2014, 2016).

A.1.2. Forest Focus/Monitoring data set

This project is a Community scheme for harmonised long-term monitoring of air pollution effects in European forest ecosystems, normed by EC Regulation No. 2152/2003[6]. Under this scheme, the monitoring is carried out by participating countries on the basis of a systematic network of observation points (Level I) and a network of observation plots for intensive and continuous monitoring (Level II). For managing the data, the JRC implemented a Forest Focus Monitoring Database System, from which the data used in this project were taken (Hiederer et al., 2007; Houston Durrant and Hiederer, 2009). The complete Forest Focus data set covers 30 European Countries with more than 8,600 sample points.

A.1.3. BioSoil data set

This data set was produced by one of a number of demonstration studies performed in response to the 'Forest Focus' Regulation (EC) No. 2152/2003 mentioned above. The aim of the BioSoil project was to provide harmonised soil and forest biodiversity data. It comprised two modules: a Soil Module (Hiederer et al., 2011) and a Biodiversity Module (Houston Durrant et al., 2011). The data set used in the C-SMFA RPP model came from the Biodiversity module, in which plant species from both the tree layer and the ground vegetation layer were recorded for more than 3,300 sample points in 19 European Countries.

[6] Council of the European Union, 2003. Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus). Official Journal of the European Union 46 (L 324), 1–8.

A.1.4. European Information System on Forest Genetic Resources (EUFGIS)

EUFGIS (http://portal.eufgis.org) is a smaller geodatabase providing information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of forest stands managed for the genetic conservation of one or more target tree species. Hence, the plots represent the natural environment to which the target tree species are adapted.

A.1.5. Georeferenced Data on Genetic Diversity (GD^2)

GD^2 (http://gd2.pierroton.inra.fr) provides information about 63 species of interest for genetic conservation. The database covers 6,254 forest plots located in stands of natural populations that are traditionally analysed in genetic surveys. While this database covers fewer species than the others, it covers 66 countries in Europe, North Africa and the Middle East, making it the data set with the largest geographic extent.

A.2. Modelling methodology

For modelling, the data were harmonised in order to have the same spatial resolution (1 km^2) and filtered to a study area comprising 36 countries in the European continent. The density of field observations varies greatly throughout the study area and large areas are poorly covered by the plot databases. A low density of field plots is particularly problematic in heterogeneous landscapes, such as mountainous regions and areas with many different land use and cover types, where a plot in one location is not representative of many nearby locations (de Rigo et al., 2014). To account for the spatial variation in plot density, the model used here (C-SMFA) considers multiple spatial scales when estimating RPP. Furthermore, statistical resampling is systematically applied to mitigate the cumulated data-driven uncertainty.

The presence or absence of a given forest tree species then refers to an idealised standard field sample of negligible size compared with the 1 km^2 pixel size of the harmonised grid. The modelling methodology considered these presence/absence measures as if they were random samples of a binary quantity (the punctual presence/absence, not the pixel one). This binary quantity is a random variable having its own probability distribution which is a function of the unknown average probability of finding the given tree species within a plot of negligible area belonging to the considered 1 km^2 pixel (de Rigo et al., 2014). This unknown statistic is denoted hereinafter with the name of 'probability of presence'.

C-SMFA performs spatial frequency analysis of the geo-located plot data to create preliminary RPP maps (de Rigo et al., 2014). For each 1 km^2 grid cell, the model estimates kernel densities over a range of kernel sizes to estimate the probability that a given species is present in that cell. The entire array of multi-scale spatial kernels is aggregated with adaptive weights based on the local pattern of data density. Thus, in areas where plot data are scarce or inconsistent, the method tends to put weight on larger kernels. Wherever denser local data are available, they are privileged ensuring a more detailed local RPP estimation. Therefore, a smooth multi-scale aggregation of the entire arrays of kernels and data sets is applied instead of selecting a local 'best performing' one and discarding the remaining information. This array-based processing, and the entire data harmonisation procedure, are made possible thanks to the semantic modularisation which defines the Semantic Array Programming modelling paradigm (de Rigo, 2012).

The probability to find a single species (e.g. a particular coniferous tree species) in a 1 km^2 grid cell cannot be higher than the probability of presence of all the coniferous species combined. The same logical constraints applied to the case of single broadleaved species with respect to the probability of presence of all the broadleaved species combined. Thus, to improve the accuracy of the maps, the preliminary RPP values were constrained so as not to exceed the local forest-type cover fraction with an iterative refinement (de Rigo et al., 2014). The forest-type cover fraction was estimated from the classes of the Corine Land Cover (CLC) maps which contain a component of forest trees (Bossard et al., 2000; Büttner et al., 2012).

The resulting probability of presence is relative to the specific tree taxon, irrespective of the potential co-occurrence of other tree taxa with the measured plots, and should not be confused with the absolute abundance or proportion of each taxon in the plots. RPP represents the probability of finding at least one individual of the taxon in a plot placed randomly within the grid cell, assuming that the plot has negligible area compared with the cell. As a consequence, the sum of the RPP associated with different taxa in the same area is not constrained to be 100%. For example, in a forest with two co-dominant tree species which are homogeneously mixed, the RPP of both may be 100% (see e.g. the Glossary in San-Miguel-Ayanz et al. (2016), http://forest.jrc.ec.europa.eu/media/atlas/Glossary.pdf).

The robustness of RPP maps depends strongly on sample plot density, as areas with few field observations are mapped with greater uncertainty. This uncertainty is shown qualitatively in maps of 'RPP trustability'. RPP trustability is computed on the basis of the aggregated equivalent number of sample plots in each grid cell (equivalent local density of plot data). The trustability map scale is relative, ranging from 0 to 1, as it is based on the quantiles of the local plot density map obtained using all field observations for the species. Thus, trustability maps may vary among species based on the number of databases that report a particular species (de Rigo et al., 2014, 2016).

The RPP and relative trustability range from 0 to 1 and are mapped at a 1 km spatial resolution. To improve visualisation, these maps can be aggregated to coarser scales (i.e. 10 $\times$ 10 pixels or 25 $\times$ 25 pixels, respectively summarising the information for aggregated spatial cells of 100 km^2 and 625 km^2) by averaging the values in larger grid cells.