Pest categorisation of *Arceuthobium* spp. (non-EU)

EFSA Panel on Plant Health (EFSA PLH Panel),
Claude Bragard, 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 Lucien Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent,
Jonathan Yuen, Lucia Zappalà, Johanna Boberg, Marco Pautasso and
Katharina Dehnen-Schmutz

Abstract

Following a request from the European Commission, the EFSA Panel on Plant Health performed a pest categorisation of *Arceuthobium* spp. (non-EU), a well-defined and distinguishable group of parasitic plant species of the family Viscaceae, also known as dwarf mistletoes. These are flowering plants parasitising a wide range of conifers of the families Pinaceae and Cupressaceae. *Arceuthobium* species (non-EU) are regulated in Council Directive 2000/29/EC (Annex IAI) as harmful organisms whose introduction into the EU is banned. Many *Arceuthobium* species are recognised, with most dwarf mistletoes native in the New World, and north-western Mexico and the western USA as the centre of diversity for the genus. Only two *Arceuthobium* species are native (and reported to be present) in the EU (*Arceuthobium azoricum* and *Arceuthobium oxycedrum*), which are thus not part of this pest categorisation. Hosts of non-EU dwarf mistletoes include species of the genera *Abies*, *Cupressus*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga* and *Tsuga*. Most *Arceuthobium* spp. can parasitise more than one species of conifer host. Dwarf mistletoes could enter the EU via host plants for planting and cut branches, but these pathways are closed. They could establish in the EU, as hosts are widespread and climatic conditions are favourable. They would be able to spread following establishment by human movement of host plants for planting and cut branches, as well as natural spread. Should non-EU dwarf mistletoes be introduced in the EU, impacts can be expected on coniferous woodlands, plantations, ornamental trees and nurseries. The main uncertainties concern (i) the precise distribution and host range of the individual *Arceuthobium* spp. and (ii) the level of susceptibility of conifers native to Europe. For *Arceuthobium* spp. (non-EU) as a group of organisms, the criteria assessed by the Panel for consideration as a potential quarantine pest are met, while, for regulated non-quarantine pests, the criterion on the pest presence in the EU is not met.

© 2018 European Food Safety Authority. *EFSA Journal* published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

Keywords: European Union, forest pathology, mistletoe, parasitism, plant pest, quarantine, tree health

Requestor: European Commission

Question number: EFSA-Q-2018-00035

Correspondence: alpha@efs.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 Lucien Reignault, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent, Jonathan Yuen and Lucia Zappala.

Acknowledgements: The Panel wishes to thank the following for the support provided to this scientific output: Ciro Gardi (EFSA Alpha Unit).

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Di Serio F, Gonthier P, Jacques M-A, Jaques Miret JA, Justesen AF, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, Van der Werf W, Vicent A, Yuen J, Zappala L, Boberg J, Pautasso M and Dehnen-Schmutz K, 2018. Scientific Opinion on the pest categorisation of Arceuthobium spp. (non-EU). EFSA Journal 2018;16(7):5384, 23 pp. https://doi.org/10.2903/j.efsa.2018.5384

ISSN: 1831-4732

© 2018 European Food Safety Authority. EFSA Journal published by John Wiley and Sons Ltd on behalf of European Food Safety Authority.

This is an open access article under the terms of the Creative Commons Attribution-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited and no modifications or adaptations are made.

Reproduction of the images listed below is prohibited and permission must be sought directly from the copyright holder:

Figure 2: © European Environment Agency; Figure 3: © Bugwood.org

The EFSA Journal is a publication of the European Food Safety Authority, an agency of the European Union.
Table of contents

Abstract ................................................................................................................................................... 1

1. Introduction ................................................................................................................................ 4

1.1. Background and Terms of Reference as provided by the requestor ............................................... 4

1.1.1. Background ................................................................................................................................4

1.1.2. Terms of Reference ..................................................................................................................... 4

1.1.2.1. Terms of Reference: Appendix 1 ........................................................................................... 5

1.1.2.2. Terms of Reference: Appendix 2 ........................................................................................... 6

1.1.2.3. Terms of Reference: Appendix 3 ........................................................................................... 7

1.2. Interpretation of the Terms of Reference ....................................................................................... 8

2. Data and methodologies ................................................................................................................... 8

2.1. Data ........................................................................................................................................... 8

2.1.1. Literature search ......................................................................................................................... 8

2.1.2. Database search .......................................................................................................................... 8

2.2. Methodologies ............................................................................................................................. 9

3. Pest categorisation .......................................................................................................................... 11

3.1. Identity and biology of the pest .................................................................................................... 11

3.1.1. Identity and taxonomy ................................................................................................................. 11

3.1.2. Biology of dwarf mistletoes ....................................................................................................... 11

3.1.3. Intraspecific diversity .................................................................................................................. 12

3.1.4. Detection and identification of the pest ....................................................................................... 12

3.2. Distribution of dwarf mistletoes ................................................................................................... 14

3.2.1. Distribution of dwarf mistletoes outside the EU ......................................................................... 14

3.2.2. Distribution of dwarf mistletoes in the EU ............................................................................... 14

3.3. Regulatory status ......................................................................................................................... 14

3.3.1. Council Directive 2000/29/EC .................................................................................................... 14

3.3.2. Legislation addressing the hosts of Arceuthobium spp. (non-EU) .............................................. 15

3.4. Entry, establishment and spread in the EU ................................................................................... 15

3.4.1. Host range .................................................................................................................................. 15

3.4.2. Entry .......................................................................................................................................... 16

3.4.3. Establishment ............................................................................................................................ 16

3.4.3.1. EU distribution of main host plants ......................................................................................... 16

3.4.3.2. Climatic conditions affecting establishment ........................................................................... 16

3.4.4. Spread .................................................................................................................................... 17

3.5. Impacts ........................................................................................................................................ 18

3.6. Availability and limits of mitigation measures ................................................................................ 18

3.6.1. Phytosanitary measures .............................................................................................................. 18

3.6.1.1. Biological or technical factors limiting the feasibility and effectiveness of measures to prevent the entry, establishment and spread of the pest ........................................................................ 18

3.6.1.2. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting .................................................................................................................. 19

3.6.1.3. Biological or technical factors limiting the effectiveness of measures to prevent the entry, establishment and spread of the pest ........................................................................ 19

3.6.1.4. Biological or technical factors limiting the ability to prevent the presence of the pest on plants for planting .................................................................................................................. 19

3.7. Uncertainty .................................................................................................................................. 19

4. Conclusions ................................................................................................................................... 20

References .......................................................................................................................................... 21

Abbreviations ..................................................................................................................................... 23
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
- *Grapholitha inopinata* Heinrich
- *Hishomonus phycitis*
- *Leucaspis japonica* Ckll.
- *Listronotus bonariensis* (Kuschel)
- *Scirtothrips aurantii* Faure
- *Scirtothrips citri* (Moultex)
- *Scolytidae spp.* (non-EU)
- *Tachypterellus quadrigibbus* Say
- *Toxoptera citricida* Kirk.
- *Unaspis citri* Comstock

(b) Bacteria

- *Citrus variegated chlorosis*
- *Erwinia stewardii* (Smith) Dye

(c) Fungi

- *Alternaria alternata* (Fr.) Keissler (non-EU pathogenic isolates)
- *Anisogramma anomala* (Peck) E. Müller
- *Apiosporina morbosa* (Schwein.) v. Arx
- *Ceratoxystis virescens* (Davidson) Moreau
- *Deighton*
- *Cercospora pini-densiflorae* (Hori and Nambu)
- *Cercospora angolensis* Carv. and Mendes

(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*

**Annex IIB**

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

- *Anthonomus grandis* (Boh.)
- *Cephalcia laricifila* (Klug)
- *Dendroctonus micans* Kugelan
- *Gilphinia hercyniae* (Hartig)
- *Goniiperus scutellatus* Gyll.
- *Ips amitinus* Eichhof
- *Ips cembrae* Heer
- *Ips duplicatus* Sahlberg
- *Ips sexdentatus* Börner
- *Ips typographus* Heer
- *Sternochetus mangiferae* Fabricius
- *Stegophora ulmea* (Schweinitz: Fries) Sydow & Sydow
- *Venturia nashicola* Tanaka and Yamamoto

- Little cherry pathogen (non-EU isolates)
- Naturally spreading psorosis
- Palm lethal yellowing mycoplasma
- Satsum dwarf virus
- Tatter leaf virus
- Witches’ broom (MLO)
(b) Bacteria

*Curtobacterium flaccumfaciens pv. flaccumfaciens* (Hedges) Collins and Jones

(c) Fungi

*Glomerella gossypii* Edgerton  
*Hypoxylon mammatum* (Wahl.) J. Miller  
*Gremmeniella abietina* (Lag.) Morelet

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  
3) *Graphocephala atropunctata* (Signoret)

2) *Draeculacephala minerva* Ball

Group of Tephritidae (non-EU) such as:

1) *Anastrepha fraterculus* (Wiedemann)  
12) *Pardalaspis cyanescens* Bezzi

2) *Anastrepha ludens* (Loew)  
13) *Pardalaspis quinaria* Bezzi

3) *Anastrepha obliqua* Macquart  
14) *Pterandrus rosa* (Karsch)

4) *Anastrepha suspensa* (Loew)  
15) *Rhacochaena japonica* Ito

5) *Dacus ciliatus* Loew  
16) *Rhagoletis completa* Cresson

8) *Dacus adsitius* Hendel  
17) *Rhagoletis fausta* (Osten-Sacken)

9) *Dacus rosaceus* Miyake  
18) *Rhagoletis indifferens* Curran

10) *Dacus zonatus* Saund.  
19) *Rhagoletis mendax* Curran

11) *Epochra canadensis* (Loew)  
20) *Rhagoletis pomonella* Walsh

12) *Rhagoletis suavis* (Loew)

(c) Viruses and virus-like organisms

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

1) Andean potato latent virus  
4) Potato black ringspot virus

2) Andean potato mottle virus  
5) Potato virus T

3) Arracacha virus B, oca strain  
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  
8) Peach yellows mycoplasm

2) Cherry rasp leaf virus (American)  
9) Plum line pattern virus (American)

3) Peach mosaic virus (American)  
10) Raspberry leaf curl virus (American)

4) Peach phony rickettsia  
11) Strawberry witches’ broom mycoplasm

5) Peach rosette mosaic virus  
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 IIAI

(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)  
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  

(b) Fungi

Ceratocystis fagacearum (Bretz) Hunt  
Chrysomyxa arctostaphyli Dietel  
Crornartium 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  

(c) Viruses and virus-like organisms

Tobacco ringspot virus  
Tomato ringspot virus  
Bean golden mosaic virus  
Cowpea mild mottle virus  
Lettuce infectious yellows virus  

Longidorus diadecturus Eveleigh and Allen  
Monochamus spp. (non-EU)  
Myndus crudus Van Duze  
Nacobbus aberrans (Thorne) Thorne and Allen  
Naupactus leucoloma Boheman  
Premnotrypes spp. (non-EU)  
Pseudopityophthorus minutissimus (Zimmermann)  
Pseudopityophthorus pruinatus (Eichhoff)  
Scaphoideus luteolus (Van Duze)  
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  

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  
Thechphora solani Barrus  
Trechispora brinkmannii (Bresad.) Rogers  

Pepper mild tigré virus  
Squash leaf curl virus  
Euphorbia mosaic virus  
Florida tomato virus
(d) Parasitic plants

*Arceuthobium* spp. (non-EU)

**Annex I AII**

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

*Arceuthobium* spp. (non-EU), also known as dwarf mistletoes, are 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 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 term ‘non-EU’ is interpreted to refer to those *Arceuthobium* spp. native only outside of the EU and, if introduced in the EU, with restricted distribution and under official control. Therefore, *Arceuthobium oxycedri*, which is native both in the EU and outside of the EU, is not considered to be non-EU. *Arceuthobium azoricum*, which is native in the Azores (part of the risk assessment area), is also not considered to be non-EU and thus not considered in this pest categorisation.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *Arceuthobium* spp. 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 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 MS and the phytosanitary measures taken to eradicate or avoid their spread.

2.2. Methodologies

The Panel performed the pest categorisation for *Arceuthobium* spp. (non-EU), following guiding principles and steps presented in the EFSA guidance on the harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standard for Phytosanitary Measures No 11 (FAO, 2013) and No 21 (FAO, 2004).

In accordance with the guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work was started following an evaluation of the EU 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 a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

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

| Criterion of pest categorisation | Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest | Criterion in Regulation (EU) 2016/2031 regarding protected zone quarantine pest (articles 32–35) | Criterion in Regulation (EU) 2016/2031 regarding Union regulated non-quarantine pest |
|---------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Identity of the pest (Section 3.1) | Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? | Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? | Is the identity of the pest established, or has it been shown to produce consistent symptoms and to be transmissible? |
| Absence/presence of the pest in the EU territory (Section 3.2) | Is the pest present in the EU territory? If present, is the pest widely distributed within the EU? 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 RNQP. (A RNQP must be present in the risk assessment area). |
| 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 |
|----------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| **Regulatory status**            | 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 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? | 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 RNQP 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

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 non-EU Arceuthobium spp. as a group of species is clear.

Arceuthobium spp. are parasitic plants of the family Viscaceae. They are also known as dwarf mistletoes.

A detailed discussion of the taxonomy of the genus Arceuthobium is provided by Hawksworth and Wiens (1996). There is a phylogeny of the known species of Arceuthobium differentiating them based on molecular data (Nickrent et al., 2004).

3.1.2. Biology of dwarf mistletoes

The genus Arceuthobium is a clearly defined group of small (generally less than 20 cm high), variously coloured (yellow to brown, black or red) flowering plants that are aerial parasites on conifers of the families Pinaceae and Cupressaceae (Nickrent et al., 1994; Hawksworth and Wiens, 1996). Arceuthobium spp. are obligate parasites with an endophytic root system ramifying within host branches (Anon, 2017). Dwarf mistletoes rely on their host for support, water and nutrients, including a portion of their required carbon compounds (Shamoun et al., 2003).

A generalised life cycle of Arceuthobium spp. starts with explosive seed ejection (up to 14–16 m distance; animals may be involved in long-distance dispersal) from mature dwarf mistletoe fruits (Robinson and Geils, 2006; Hill et al., 2017). Dwarf mistletoes reproduce only from seeds (Hawksworth and Wiens, 1996). After rainfall, the seed coat stickiness makes dwarf mistletoe seeds adhere to host needles, which makes it more likely for germination on host twigs to occur. Once infection is established (twig penetration), the mistletoe develops a system of haustoria. After a period of 2–5 years from infection, initial shoots develop (Hawksworth and Wiens, 1996). Flowering occurs 1–2 years after shoot development (EPPO, 1997).

Most Arceuthobium spp. are dioecious and both female and male plants can be produced on the same host tree (Linhart et al., 2003; Hoffman, 2010). Pollination is mediated by insects, but (early in the spring when few insect pollinators are active) dwarf mistletoes can also be wind pollinated (Hill et al., 2017). The time required from pollination to fruit maturity varies considerably (4–19 months) depending on the species (Hawksworth and Wiens, 1996). On the whole, the minimum time from infection to initial seed production averages 6–8 years depending on the Arceuthobium species (Hawksworth and Wiens, 1996).

Many different Arceuthobium species are recognised (Table 2). The Plantlist (an online working list of all plant species, accessed April 2018) lists 39 accepted species names for the genus Arceuthobium (http://www.theplantlist.org/browse/A/Santalaceae/Arceuthobium/), one of which (Arceuthobium chinensis) is likely to be a misspelling. Most dwarf mistletoes are native in the New World, with northwestern Mexico and the western USA as the centre of diversity for the genus (Shamoun et al., 2003). Arceuthobium is the most widespread and species-rich mistletoe in North America (Dwarka et al., 2011). Only two Arceuthobium species are native in the EU (Arceuthobium azoricum and Arceuthobium oxycedrum) (Hawksworth and Wiens, 1976) (Table 2), which are thus not part of this pest categorisation (see Section 1.2).
Table 2: List of currently recognised *Arceuthobium* species (compiled from EPPO (2018), the PlantList (http://www.theplantlist.org/) and the Plants of the World online database, http://powo.science.kew.org/). ‘X’ in ‘EPPO Global Database’ column implies presence in that database. ‘-’ in ‘Presence in the EU’ column implies not known to occur in the EU. ‘-’ in the ‘Distribution according to EPPO’ column implies no information available.

| Accepted species name in the PlantList | EPPO GD | Presence in the EU | Distribution according to EPPO | Distribution according to Plants of the World Online (Kew) |
|---------------------------------------|---------|--------------------|--------------------------------|---------------------------------------------------------|
| *Arceuthobium abietinum* (Engelm.) Abrams | X       | -                  | Mexico, USA                    | Mexico, USA                                             |
| *Arceuthobium abietis-religiosae* Heil | -       | -                  | Mexico                         |                                                         |
| *Arceuthobium americanum* Nutt. ex A.Gray | X       | -                  | Canada, USA                    | Canada, USA                                             |
| *Arceuthobium apacheum* Hawksw. & Wiens | X       | -                  | Mexico, USA                    |                                                         |
| *Arceuthobium azoricum* Wiens & Hawksw. | X       | Yes                | -                              | Azores                                                  |
| *Arceuthobium bicarinatum* Urb. | -       | -                  | Dominican Republic, Haiti       |                                                         |
| *Arceuthobium blumeri* A.Nelson | X       | -                  | Mexico                         |                                                         |
| *Arceuthobium californicum* Hawksw. & Wiens | X       | -                  | USA                            |                                                         |
| *Arceuthobium campylopodum* Engelm. | X       | -                  | Canada, USA, Mexico            | Mexico, USA                                             |
| *Arceuthobium chinense* Lecomte | -       | -                  | China                          |                                                         |
| *Arceuthobium cubense* Leiva & Bisse (synonym of *Dendrophthora cupressoides* (Griseb.) Eichler) | -       | -                  | Cuba, Haiti                                    |                                                         |
| *Arceuthobium cyanocarpum* (A.Nelson) Abrams | X       | -                  | Mexico, USA                    |                                                         |
| *Arceuthobium dacrydi* Ridl. (synonym of *Korthalsella dacrydi* (Ridl.) Danser) | -       | -                  | Indonesia                       |                                                         |
| *Arceuthobium divaricatum* Engelm. | X       | -                  | Mexico, USA                    |                                                         |
| *Arceuthobium douglasii* Engelm. | X       | -                  | Canada, USA, Mexico            | Mexico, USA                                             |
| *Arceuthobium gillii* Hawksw. & Wiens | X       | -                  | Mexico, USA                    |                                                         |
| *Arceuthobium globosum* Hawksw. & Wiens | -       | -                  | Mexico                         |                                                         |
| *Arceuthobium guatemalense* Hawksw. & Wiens | -       | -                  | Guatemala, Mexico              |                                                         |
| *Arceuthobium hondurensense* Hawksw. & Wiens | -       | -                  | Honduras                        |                                                         |
| *Arceuthobium juniperi-procerae* Chiov. | X       | -                  | Eritrea, Ethiopia, Kenya        |                                                         |
| *Arceuthobium laricis* (Piper) H.St.John (synonym of *Arceuthobium campylopodum* subsp. laricis (M.E.Jones) Nickrent) | X       | -                  | Canada, USA                    | USA                                                     |
| *Arceuthobium littorum* Hawksw., Wiens & Nickrent | -       | -                  | USA                            |                                                         |
| *Arceuthobium minutissimum* Hook.f. | X       | -                  | Bhutan, India, Pakistan, Nepal  | West Himalaya                                           |
| *Arceuthobium monticola* Hawksw., Wiens & Nickrent | -       | -                  | USA                            |                                                         |
### Intraspecific diversity

A study of the isozymes of 19 North American taxa of *Arceuthobium* showed that the genus has remarkably high levels of genetic diversity, despite the relative morphological homogeneity of dwarf mistletoes (Nickrent, 1986). Subsequent studies have documented the intraspecific genetic diversity (and distinguished races, formae speciales and subspecies) within some individual *Arceuthobium* species, often in association with their different hosts (Jerome and Ford, 2002; Linhart et al., 2003; Nickrent, 2012; Reif et al., 2015; Mathiasen and Kenaley, 2017). An overview of the accepted infraspecific nomenclature of *Arceuthobium* species is available on the Plants of the World online database of the Kew Gardens (http://powo.science.kew.org/).

### Detection and identification

| Accepted species name in the Plantlist | EPPO GD | Presence in the EU | Distribution according to EPPO | Distribution according to Plants of the World Online (Kew) |
|--------------------------------------|---------|--------------------|--------------------------------|----------------------------------------------------------|
| *Arceuthobium occidentale* Engelm. ex S.Watson | X | - | USA | California |
| *Arceuthobium oxycedri* (DC.) M.Bieb. | X | Yes | Western Mediterranean, Balkans, Black Sea, Caucasus, Central Asia | Europe, Asia-Tropical, Africa and Asia-Temperate |
| *Arceuthobium pendens* Hawksw. & Wiens | - | - | - | Mexico |
| *Arceuthobium pini* Hawksw. & Wiens | X | - | - | China, Tibet |
| *Arceuthobium pusillum* M.Peck | X | - | Canada, USA | USA |
| *Arceuthobium rubrum* Hawksw. & Wiens | - | - | - | Mexico |
| *Arceuthobium sichuanense* (H.S.Kiu) Hawksw. & Wiens | X | - | - | East Himalaya, Tibet, China South-Central and Qinghai |
| *Arceuthobium siskiyounense* Hawksw., Wiens & Nickrent | - | - | - | USA |
| *Arceuthobium strictum* Hawksw. & Wiens | - | - | - | Mexico |
| *Arceuthobium tibetense* H.X.Kiu & W.Ren | - | - | - | Tibet |
| *Arceuthobium tsugense* (Rosend.) G.N.Jones | X | - | Canada, USA | Canada, USA |
| *Arceuthobium vaginatum* (Humb. & Bonpl. ex Willd.) J.Presl | X | - | Mexico, USA | Mexico, Honduras |
| *Arceuthobium verticilliflora* Engelm. | - | - | - | Mexico |
| *Arceuthobium yecorense* Hawksw. & Wiens | - | - | - | Mexico |

#### Are detection and identification methods available for the pest?

Yes

Early detection of *Arceuthobium* spp. is limited by the difficulty to detect infection during the 2- to 5-year endophyte phase of the parasite. The endophytic root system within the host branch may or may not (depending upon the species) induce host deformations called witches’ brooms, which have diagnostic value (Nickrent and García, 2009). However, polymerase chain reaction (PCR) techniques for detecting some *Arceuthobium* spp. in tissues of their hosts have been developed (Marler et al., 1999). Identification keys to distinguish the different *Arceuthobium* species are available (e.g. Hawksworth and Wiens, 1972, 1996), thus making it possible to separate *Arceuthobium* species native to the EU.
(Arceuthobium azoricum and Arceuthobium oxycedri) from those native only outside of the EU (Hawksworth and Wiens, 1976).

3.2. Distribution of dwarf mistletoes

3.2.1. Distribution of dwarf mistletoes outside the EU

Arceuthobium spp. (non-EU) are present in North and Central America, Africa and Asia (Figure 1; Table 2; EPPO, 2018).

According to the Plants of the World online database, 17 Arceuthobium spp. (non-EU) are native in Mexico and 16 spp. in the USA (two of which also in Canada), with 7 of these species reported as native from both countries. Six further Arceuthobium spp. (non-EU) are reported as native in Asia, three from Central America and one from Eastern Africa (Table 2). On the whole, 36 Arceuthobium spp. (non-EU) are thus currently recognised according to this database (accessed April 2018).

![Global distribution map for Arceuthobium spp. (non-EU) (based on Table 2)](image)

**Figure 1:** Global distribution map for Arceuthobium spp. (non-EU) (based on Table 2)

3.2.2. Distribution of dwarf mistletoes in the EU

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

No, Arceuthobium spp. (non-EU) are not reported to be present in the EU.

3.3. Regulatory status

3.3.1. Council Directive 2000/29/EC

Arceuthobium is listed in Council Directive 2000/29/EC. Details are presented in Tables 3 and 4.
3.3.2. Legislation addressing the hosts of *Arceuthobium* spp. (non-EU)

3.4. Entry, establishment and spread in the EU

3.4.1. Host range

Most *Arceuthobium* spp. can parasitise more than one species of conifer host (Linhart et al., 2003). Host species of *Arceuthobium* spp. (non-EU) include: *Abies grandis*, *Abies magnifica*, *Larix occidentalis*, *Picea engelmannii*, *Picea mariana*, *Pinus attenuata*, *Pinus banksiana*, *Pinus contorta*, *Pinus jeffreyi*, *Pinus ponderosa*, *Pinus radiata*, *Pinus sylvestris*, *Pinus wallichiana*, *Pseudotsuga menziesii*, *Tsuga heterophylla* and *Tsuga mertensiana* (EPPO, 2018).

This list of *Arceuthobium* spp. (non-EU) hosts extracted from the EPPO Global Database is likely not complete, as no host species are listed for several *Arceuthobium* species (EPPO, 2018). Among the additional hosts, there are several Central American pine species reported to be hosts of *Arceuthobium aureum*: *Pinus caribaea*, *Pinus michoacana*, *Pinus montezumae*, *Pinus oaxacana*, *Pinus oocarpa*, *Pinus patula* and *Pinus pseudostrobus* (Hawksworth and Wiens, 1977). Similarly, *Arceuthobium rubrum* was reported on *Pinus cooperi*, *Pinus durangensis*, *Pinus engelmannii*, *Pinus herrerai*, *Pinus lawsonii*, *P. michoacana*, *P. oaxacana*, *P. pseudostrobus* and *Pinus teocote* (Hawksworth and Wiens, 1977).

Further North American host species can be found in Hawksworth and Wiens (1972, 1996) and include: *Abies concolor*, *Juniperus* spp., *Picea pungens*, *Pinus albicaulis*, *Pinus aristata*, *Pinus coulteri*, *Pinus edulis*, *Pinus flexilis*, *Pinus hartwegii*, *Pinus lambertiana* and *Pinus muricata*. Queijeiro-Bolaños et al. (2014) report *Cupressus* spp. as a possible host of *Arceuthobium globosum*.

Additional hosts of *Arceuthobium* spp. native to Asia include *Picea crassifolia*, *Picea purpurea* and *Pinus gerardiana* (Chaudhry and Badshah, 1984; Xia et al., 2017).

The introduction into the EU of *Arceuthobium minutissimum* (one dwarf mistletoe from the Himalaya, which affects *Pinus wallichiana*) was assessed to threaten five-needled pines found in Europe (the European *Pinus cembra* and the introduced *Pinus strobus*) (Vannini et al., 1995).

Artificial inoculation of *Arceuthobium* spp. has proven successful for conifers native to Europe such as *Larix decidua*, *Picea abies* and *Pinus pinea* (Hawksworth and Wiens, 1972). Moreover, *P. abies* was found to be parasitised naturally by *Arceuthobium campylopodum* in the USA (Mathiasen et al., 1998).

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, dwarf mistletoes could enter the EU on host plants for planting and cut branches.

The main pathways of entry (EPPO, 2018) are coniferous:
- plants for planting (including artificially dwarfed plants)
- and cut branches.

These pathways are closed due to Council Directive 2000/29/EC banning the import from non-European countries of plants, other than fruit and seeds, of Abies, Juniperus, Larix, Picea, Pinus, Pseudotsuga and Tsuga (see Section 3.3.2).

Up to March 2018, there were no interceptions of Arceuthobium spp. (non-EU) 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, as hosts are present and favourable climatic conditions are common.

3.4.3.1. EU distribution of main host plants

Conifer species hosts of Arceuthobium spp. (non-EU) (see Section 3.4.1) are common and widespread throughout the EU, from the Mediterranean to Scandinavia and from the Balkans to Scotland (Figure 2). Maps of the European distribution of Abies spp., Larix spp., Pinus spp., Picea spp. and Pseudotsuga menziesii have been provided in previous pest categorisations of forest fungi (EFSA PLH Panel, 2017, 2018a,b).

![Coniferous forest coverage map](source: Corine Land Cover, year 2012, version 18.5, by European Environment Agency)

Figure 2: Cover percentage of coniferous forests in Europe (0–100%) at 1 km resolution (source: Corine Land Cover, year 2012, version 18.5, by European Environment Agency)

3.4.3.2. Climatic conditions affecting establishment

The distribution of Arceuthobium spp. (non-EU) in their native range covers a wide variety of climates, including those found throughout the EU regions with presence of hosts. Climate is thus assumed not to be a limiting factor for the establishment of dwarf mistletoes in the EU.
3.4.4. Spread

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

Yes, by movement of host plants for planting and cut branches, as well as dispersal of seeds by animals.

RNQP: Is spread mainly via specific plants for planting, rather than via natural spread or via movement of plant products or other objects?

No, spread is not mainly via plants for planting, as it can also occur by movement of cut branches and by dispersal of seeds by animals.

Arceuthobium spp. disperse by explosive discharge of seeds followed by ballistic flight to a maximum distance of about 14–16 m (Robinson and Geils, 2006; Hill et al., 2017). Dwarf mistletoe seeds, however, normally only travel 2–4 m before sticking to a host twig due to the mucilaginous seed coating (Hawksworth and Wiens, 1996). Dwarf mistletoe seed dispersal has been modelled in a probabilistic and spatially explicit way for each host tree of two simulated open-canopy, treated against the parasite vs. untreated, Pinus ponderosa stands (Robinson and Geils, 2006).

Although seeds of Arceuthobium spp. are short-lived and are thus not likely to be important as long distance means of spread of dwarf mistletoes (EPPO, 1997), they can be carried externally by animals over medium distances and thus contribute to spread (Hill et al., 2017). Infected host plants have been assessed as the only likely means of international spread of dwarf mistletoes (EPPO, 1997).

3.5. Impacts

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

Yes, the introduction of dwarf mistletoes would have economic and environmental impacts in conifer woodlands, plantations and nurseries.

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

Yes, the presence of dwarf mistletoes on plants for planting would have an economic impact on their intended use.

Prevalence values of dwarf mistletoes are variable not only among systems, places, and species but also within species in a given area (Queijeiro-Bolarios et al., 2014). Nonetheless, on the whole timber volume losses due to dwarf mistletoe are estimated at 3.8 million m³ annually in western Canada and 11.3 million m³ in the western USA (Shamoun et al., 2003). Because of their wide distribution and broad host range, dwarf mistletoes have been claimed to cause more losses to timber production in western North America than any other group of pathogens (Mehl et al., 2013). Dwarf mistletoes have also been reported from nurseries (Hawksworth and Wiens, 1977).

Seedlings and saplings are severely damaged by dwarf mistletoes (Geils and Hawksworth, 2002). Infection of young trees by Arceuthobium spp. results in high mortality, while infection of mature trees leads to decreased (i) needle length, (ii) length of needle-bearing branches, (iii) needle surface area, and (iv) total number of needles. This reduction in photosynthetic area, in turn, translates into (i) lower tree growth and fitness, (ii) branch and stem deformations and (iii), in some host-parasite combinations, to increased tree mortality rates (Hawksworth and Wiens, 1996). Moreover, stem infections (Figure 3) also provide entrance points for decay fungi (Hoffman, 2010).

In addition to the provision of deadwood, an important habitat for many forest species, dwarf mistletoes can enhance forest biodiversity by providing food and shelter for animal species (Watson, 2001; Shaw et al., 2004; Hoffman, 2010; Hill et al., 2017). Notwithstanding, witches’ brooms caused by dwarf mistletoes are more flammable than normal conifer branches and thus increase fire severity, especially in Douglas fir stands (Hoffman, 2010). Hence, dwarf mistletoes can increase forest ecosystem diversity by indirectly increasing understory light and plant productivity (Hill et al., 2017). Dwarf mistletoes are now recognised as important forest disturbance agents with distinct ecological functions (Geils and Hawksworth, 2002).

---

4 See Section 2.1 on what falls outside EFSA’s remit.
Should non-EU dwarf mistletoes be introduced into the EU, impacts can be expected to coniferous woodland, plantations, ornamental trees and nurseries.

Figure 3: American dwarf mistletoe (*Arceuthobium americanum*) on lodgepole pine (*Pinus contorta*), Wyoming, USA. Photo by Brytten Steed, USDA Forest Service, Bugwood.org. Available online: https://www.forestryimages.org/browse/detail.cfm?imgnum=2141085

3.6. Availability and limits of mitigation measures

| Question                                                                 | Answer |
|-------------------------------------------------------------------------|--------|
| 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, see Section 3.6.1. |
| RNQPs: Are there measures available to prevent pest presence on plants for planting such that the risk becomes mitigated? | Yes, 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 plants of the various conifer genera hosting dwarf mistletoes (see Section 3.3.2).

3.6.1.1. Control measures

Potential additional control measures are listed in Table 5 (those already included in Council Directive 2000/29/EC are not repeated here).
3.6.1.2. Supporting measures

Potential supporting measures are listed in Table 6.

Table 6: Selected supporting measures. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance.

| Nr  | Information sheet title | Supporting measure summary | Risk component (entry/establishment/spread/impact) | Link to the document |
|-----|-------------------------|----------------------------|--------------------------------------------------|---------------------|
| 1.02 | Timing of planting and harvesting | Replacing affected stands with regeneration free of dwarf mistletoes has been suggested as control measure (Hoffman, 2010) | Impact | Work in progress, not yet available |
| 1.16 | Biological control and behavioural manipulation | The use of hyperparasitic fungi as potential biological control agents of dwarf mistletoes has been investigated (Shamoun et al., 2003) | Impact | Work in progress, not yet available |

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

- The abundance of dwarf mistletoes tends to increase more rapidly in low-density stands, and increased incidence following thinning has been reported for several host-mistletoe combinations (Mehl et al., 2013).

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

- Visible shoots of dwarf mistletoes develop only 2 to 5 years after infection (see Section 3.1.2).

3.7. Uncertainty

There is uncertainty on the precise distribution and host range of several non-EU Arceuthobium spp. However, no reports of the presence in the EU for Arceuthobium spp. that are only native outside of the EU are available and all hosts of dwarf mistletoes are coniferous trees of the families Pinaceae and Cupressaceae.

There is less information on the Asian Arceuthobium spp. and their impacts compared to dwarf mistletoes from North America.

Some conifer species native to the EU have been shown to be hosts of dwarf mistletoes based on artificial inoculation, but there is uncertainty about their susceptibility level in the field. However, P. abies has been found to be naturally infected by dwarf mistletoes in the USA (see Section 3.4.1).
4. Conclusions

Arceuthobium species (non-EU) meet the criteria assessed by EFSA for consideration as potential quarantine pests (Table 7).

Table 7: 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 non-EU Arceuthobium spp. as a group of species is clear                         | The identity of non-EU Arceuthobium spp. as a group of species is clear | None |
| Absence/presence of the pest in the EU territory (Section 3.2) | Arceuthobium spp. (non-EU) are not reported to be present in the EU | Arceuthobium spp. (non-EU) are not reported to be present in the EU | None |
| Regulatory status (Section 3.3) | Arceuthobium spp. (non-EU) are regulated by Council Directive 2000/29/EC (Annex IAI) as harmful organisms whose introduction into, and spread within, all Member States shall be banned | Arceuthobium spp. (non-EU) are regulated by Council Directive 2000/29/EC (Annex IAI) as harmful organisms 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: dwarf mistletoes could enter the EU via plants for planting and cut branches of Cupressaceae and Pinaceae Establishment: hosts and favourable climatic conditions are widespread in the risk assessment area Spread: dwarf mistletoes would be able to spread following establishment by movement of plants for planting and cut branches of Cupressaceae and Pinaceae, 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 | There is uncertainty on the precise distribution and host range of several non-EU Arceuthobium spp. |
| Potential for consequences in the EU territory (Section 3.5) | The introduction of non-EU dwarf mistletoes would have economic and environmental impacts in coniferous woodlands, plantations, ornamental trees and nurseries | The introduction of non-EU dwarf mistletoes could have an impact on the intended use of plants for planting | Some conifer species native to the EU have been shown to be hosts of non-EU dwarf mistletoes based on artificial inoculation, but there is uncertainty about their susceptibility level in the field |
| 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 | 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 *Arceuthobium* spp. (non-EU) 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 knowledge gap is the precise distribution and host range of several non-EU *Arceuthobium* spp. However, this uncertainty does not affect the conclusion of the pest categorisation on non-EU *Arceuthobium* spp. as a group of organisms | |

**References**

Anon, 2017. *Arceuthobium americanum* (lodgepole pine dwarf mistletoe). CABI datasheet. Available online: [https://www.cabi.org/isc/datasheet/6824](https://www.cabi.org/isc/datasheet/6824)

Chaudhry Z and Badshah K, 1984. *Pinus gerardiana*—a new host of *Arceuthobium minutissimum*. European Journal of Forest Pathology, 14, 123–125.

Dwarka A, Ross Friedman CM, MacKay ME and Nelson D, 2011. Polymerase chain reaction identification of a female-specific genetic marker in *Arceuthobium americanum* (lodgepole pine dwarf mistletoe) and its implications for *Arceuthobium* sex determination. Botany-Botanique, 89, 369–377.

EFSA PLH Panel (EFSA Panel on Plant Health), 2010. PLH Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. EFSA Journal 2010;8(2):1495, 66 pp. [https://doi.org/10.2903/j.efsa.2010.1495](https://doi.org/10.2903/j.efsa.2010.1495)

EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Cafieri D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gregoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Urek G, Van Bruggen A, Van der Werf W, West J, Winter S, Boberg J, Gonthier P and Pautasso M, 2017. Scientific Opinion on the pest categorisation of *Gremmeniella abietina*. EFSA Journal 2017;15(11):5030, 30 pp. [https://doi.org/10.2903/j.efsa.2017.5030](https://doi.org/10.2903/j.efsa.2017.5030)

EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Cafieri D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gregoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Urek G, Van Bruggen A, Van der Werf W, West J, Winter S, Boberg J, Gonthier P and Pautasso M, 2018a. Scientific opinion on the pest categorisation of *Coniferiportia weirii* and *C. sulphurascens*. EFSA Journal 2018;16(6):5302, 22 pp. [https://doi.org/10.2903/j.efsa.2018.5302](https://doi.org/10.2903/j.efsa.2018.5302)

EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Cafieri D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gregoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Urek G, Van Bruggen A, Van der Werf W, West J, Winter S, Boberg J, Gonthier P and Pautasso M, 2018b. Scientific opinion on the pest categorisation of *Mycodiella laricis-leptolepidis*. EFSA Journal 2018;16(4):5246, 27 pp. [https://doi.org/10.2903/j.efsa.2018.5246](https://doi.org/10.2903/j.efsa.2018.5246)

EPPO (European and Mediterranean Plant Protection Organization), 1997. Data sheets on quarantine pests: *Arceuthobium* spp. (non-European). In: Smith IM, McNamara DG, Scott PR, Holderness M (eds.). Quarantine Pests for Europe. 2nd Edition. CABI/EPOPO, Wallingford. 1425 pp.

EPPO (European and Mediterranean Plant Protection Organization), 2018. EPPO Global Database. Accessed April 2018. Available online: [https://gd.eppo.int](https://gd.eppo.int)
FAO (Food and Agriculture Organization of the United Nations), 2004. ISPM (International Standards for Phytosanitary Measures) 21—Pest risk analysis of regulated non-quarantine pests. FAQ, Rome, 30 pp. Available online: https://www.ippc.int/sites/default/files/documents/1323945746_ISPM_21_2004_En_2011-11-29_Refor.pdf

FAO (Food and Agriculture Organization of the United Nations), 2013. ISPM (International Standards for Phytosanitary Measures) 11—Pest risk analysis for quarantine pests. FAQ, Rome, 36 pp. Available online: https://www.ippc.int/sites/default/files/documents/20140512/ispm_11_2013_en_2014-04-30_201405121523-494.65%20KB.pdf

Geils BW and Hawksworth FG, 2002. Damage, effects, and importance of dwarf mistletoes. In: Geils BW, Cibrian-Tovar J and Moody B (eds.). Mistletoes of North American Conifers. USDA Forest Service, Rocky Mountain Research Station, GTR-98, pp. 57-65. Available online: https://www.fs.fed.us/rm/pubs/rmrs_gtr098/rmrs_gtr098_057_065.pdf

Hawksworth FG and Wiens D, 1972. Biology and classifications of dwarf mistletoes (Arceuthobium). USDA Forest Service, Washington D.C., USA. Agriculture Handbook No. 401, 242 pp. Available online: https://na ldic.nal.usda.gov/download/CAT87208731/PDF

Hawksworth FG and Wiens D, 1976. Arceuthobium oxycedri and its segregates A. juniperi-procerae and A. azoricum (Viscaceae). Kew Bulletin, 31, 71–80.

Hawksworth FG and Wiens D, 1977. Arceuthobium (Viscaceae) in Mexico and Guatemala: additions and range extensions. Britania, 29, 411–418.

Hawksworth FG and Wiens D, 1996. Dwarf Mistletoes: Biology, Pathology, and Systematics. USDA Forest Service, Washington DC, USA Agriculture Handbook No. 709.

Hill R, Loxterman JL and Aho K, 2017. Insular biogeography and population genetics of dwarf mistletoe (Arceuthobium americanum) in the Central Rocky Mountains. Ecosphere, 8, e01810.

Hoffman J, 2010. Management guide for dwarf mistletoe. USDA Forest Service, 14 pp. Available online: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187427.pdf

Jerome CA and Ford BA, 2002. The discovery of three genetic races of the dwarf mistletoe Arceuthobium americanum (Viscaceae) provides insight into the evolution of parasitic angiosperms. Molecular Ecology, 11, 387–405.

Linhart YB, Ellwood LM, Karron JD and Gehring JL, 2003. Genetic differentiation in the dwarf mistletoes Arceuthobium vaginatum and Arceuthobium americanum (Viscaceae) on their principal and secondary hosts. International Journal of Plant Sciences, 164, 61–69.

Marler M, Pedersen D, Mitchell-Olens T and Callaway RM, 1999. A polymerase chain reaction method for detecting dwarf mistletoe infection in Douglas-fir and western larch. Canadian Journal of Forest Research, 29, 1317–1321.

Mathiasen RL and Kenaley SC, 2017. Arceuthobium tsugense (Viscaceae): four subspecies with contrasting morphologies and host distributions. Journal of the Botanical Research Institute of Texas, 11, 363–390.

Mathiasen RL, Allison JR and Geils BW, 1998. Western dwarf mistletoe parasitizing Colorado blue spruce and Norway spruce in California. Plant Disease, 82, 351.

Mehl HK, Mori SR, Frankel SJ and Rizzo DM, 2013. Mortality and growth of dwarf mistletoe-infected red and white fir and the efficacy of thinning for reducing associated losses. Forest Pathology, 43, 193–203.

Muir JA and Geils BW, 2002. Management strategies for dwarf mistletoes: silviculture. In: Geils BW, Cibrian-Tovar J and Moody B (eds.). Mistletoes of North American Conifers. USDA Forest Service, Rocky Mountain Research Station, GTR-98, pp. 83-94. Available online: https://www.fs.fed.us/rm/pubs/rmrs_gtr098/rmrs_gtr098_083_094.pdf

Nickrent DL, 1986. Genetic polymorphism in the morphologically reduced dwarf mistletoes (Arceuthobium, Viscaceae): an electrophoretic study. American Journal of Botany, 73, 1492–1502.

Nickrent DL, 2012. Justification for subspecies in Arceuthobium camphylodum (Viscaceae). Phytoneuron, 51, 1–11.

Nickrent DL and Garcia MA, 2009. On the brink of holoparasitism: plastome evolution in dwarf mistletoes (Arceuthobium, Viscaceae). Journal of Molecular Evolution, 68, 603–615.

Nickrent DL, Schuette KP and Starr EM, 1994. A molecular phylogeny of Arceuthobium (Viscaceae) based on nuclear ribosomal DNA Internal Transcribed Spacer Sequences. American Journal of Botany, 81, 1149–1160.

Nickrent DL, Garcia MA, Martin MP and Mathiasen RL, 2004. A phylogeny of all species of Arceuthobium (Viscaceae) using nuclear and chloroplast DNA sequences. American Journal of Botany, 91, 125–138.

Queijeiro-Bolanos M, Cano-Santana Z and García-Guzmán G, 2014. Incidence, severity, and aggregation patterns of two sympatric dwarf mistletoe species (Arceuthobium spp.) in Central Mexico. European Journal of Forest Research, 133, 297–306.

Reif BP, Mathiasen RL, Kenaley SC and Allan GJ, 2015. Genetic structure and morphological differentiation of three Western North American dwarf Mistletoes (Arceuthobium: Viscaceae). Systematic Botany, 40, 191–207.

Robinson DC and Geils BW, 2006. Modelling dwarf mistletoe at three scales: life history, ballistics and contagion. Ecological Modelling, 199, 23–38.

Shamoun SF, Ramsfield TD and Van Der Kamp BJ, 2003. Biological control approach for management of dwarf mistletoes. New Zealand Journal of Fores Science, 33, 373–384.

Shaw DC, Watson DM and Mathiasen RL, 2004. Comparison of dwarf mistletoe (Arceuthobium spp., Viscaceae) in the western United States with mistletoes (Amyema spp., Loranthaceae) in Australia—ecological analogs and reciprocal models for ecosystem management. Australian Journal of Botany, 52, 481–498.
Vannini A, Cecca D, Monaci L and Anselmi N, 1995. Main tree pathogens of western Himalayan forests in Nepal: description and risk of introduction. EPPO Bulletin, 25, 455–461.

Watson DM, 2001. Mistletoe—a keystone resource in forests and woodlands worldwide. Annual Review of Ecology and Systematics, 32, 219–249.

Xia B, Liu L, Zhang QH, Han F, Luo Y and Tian C, 2017. Impact of *Arceuthobium sichuanense* infection on needles and current-year shoots of *Picea crassifolia* and *Picea purpurea* in Qinghai Province, China. European Journal of Plant Pathology, 147, 845–854.

**Abbreviations**

| Abbreviation | Description |
|--------------|-------------|
| DG SANTE     | Directorate General for Health and Food Safety |
| EPPO         | European and Mediterranean Plant Protection Organization |
| FAO          | Food and Agriculture Organization |
| IPPC         | International Plant Protection Convention |
| MS           | Member State |
| PCR          | polymerase chain reaction |
| PLH          | EFSA Panel on Plant Health |
| RNQP         | Regulated Non-Quarantine Pest |
| TFEU         | Treaty on the Functioning of the European Union |
| ToR          | Terms of Reference |