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Pest categorisation of *Dendrolimus superans*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Dendrolimus superans* Butler (Lepidoptera: Lasiocampidae), the larch caterpillar, for the EU territory. *D. superans* is a major pest of conifer forests in Japan, northeast China and non-European Russia. However, reports of damage are to conifer species not grown in EU forestry. *Larix gmelinii* and *Pinus pumila* are regarded as major hosts. Eggs are laid on host needles and developing larvae feed on host foliage. Larvae overwinter in the soil. In its native range, *D. superans* usually takes one or two years to develop. In principle, host plants for planting and plant products, such as cut branches and wood with bark, could provide pathways into the EU. However, prohibitions on the import of *Abies, Cedrus, Larix*, *Picea, Pinus* and *Tsuga* from areas where *D. superans* occurs closes such pathways. Nevertheless, a derogation for specific dwarfed *Pinus* plants from Japan exists. Climates similar to those in some of its existing range occur in the EU. Norway spruce (*Picea abies*) is a known host in Japan although reports of any impact are lacking. Experiments on the related species *D. sibiricus* indicated that larvae were able to develop on forestry conifer species occurring in the EU, but which are found outside the native range of *D. sibiricus*. Were *D. superans* to be introduced into the EU, impacts on *P. abies* are possible and it is conceivable that *D. superans* could expand its host range, as seems possible with *D. sibiricus*. However, this remains uncertain. Other hosts are grown in the EU as ornamentals or amenity trees. *D. superans* satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest. Some uncertainty exists over the magnitude of potential environmental and economic impacts.

Keywords: Conifer, Larch caterpillar, pest risk, plant health, plant pest, quarantine

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1. Introduction

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

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the Open.EFSA portal). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the Open.EFSA portal). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Dendrolimus superans is one of a number of pests listed in Annex 1B to the Terms of Reference (ToRs) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest (QP) for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform EU decision making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/2072. If a pest fulfils the criteria to be potentially listed as a Union QP, risk reduction options will be identified.

1.3. Additional information

D. superans was identified as a pest of *Pinus thunbergii* in a commodity risk assessment of dwarfed Japanese black pine (*P. thunbergii*) from Japan (EFSA PLH Panel, 2019), and in a commodity risk assessment of dwarfed *P. parviflora* (Japanese white pine) grafted onto *P. thunbergii* from China (EFSA PLH Panel, 2022) (see Section 3.1.3).

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *D. superans* 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. Papers relevant for the pest categorisation 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 EPPO Global Database, the CABI databases and scientific literature databases as referred above in section 2.1.1.

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 and TRACES databases were 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 as a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. TRACES is the European Commission's multilingual online platform for sanitary and phytosanitary certification required for the importation of animals, animal products, food and feed of non-animal origin and plants into the European Union, and the intra-EU trade and EU exports of animals and certain animal products. Up until May 2020, the Europhyt database managed notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt to TRACES in May 2020.

GenBank was searched to determine whether it contained any nucleotide sequences for *D. superans* which could be used as reference material for molecular diagnosis. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

The Royal Horticultural Society (RHS) plant finder website (https://www.rhs.org.uk/) was searched to determine whether there were commercial suppliers of hosts. If there were suppliers listed it was assumed the trees could be used or ornamental or amenity plants in the EU (Appendix A).

The EC Joint Research Centre (JRC) European Atlas of Forest Trees species (https://forest.jrc.ec.europa.eu/en/european-atlas/) was checked to determine whether hosts were grown in EU forestry (Appendix A).

2.2. Methodologies

The Panel performed the pest categorisation for *D. superans*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018a,b), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013).

The criteria to be considered when categorising a pest as a potential Union QP is given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific

Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

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, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018a,b). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for QP status. Assessing social impact is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as derived from 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 (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, 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 in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
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 for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
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.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and/or to be transmissible?

Yes. The identity of the species is established and *Dendrolimus superans* Butler is the accepted name and authority.

Dendrolimus superans Butler is an insect within the order Lepidoptera and family Lasiocampidae. In the recent past the taxonomy and nomenclature of members within the genus *Dendrolimus* was debated, for example some researchers considered *D. superans* consisted of two subspecies, *Dendrolimus superans sibiricus* Tschetverikov[1] and *Dendrolimus superans albolineatus* Butler. However, examining molecular and morphological taxonomy Mikkola and Ståhls (2008) proposed *D. superans* Butler as a valid species (with *D. superans albolineatus* being a synonym) and *D. sibiricus* Tschetverikov as a valid species (with *D. superans sibiricus* being a synonym). Kononov et al. (2016) and other literature supports *D. sibiricus* and *D. superans* as distinct species.

[1] The authority Tschetverikov also appears in literature as Chetverikov.

Other synonyms of *D. superans* include *D. albolineatus* Matsumura, *D. jezoensis* Matsumura and *Odonestis superans* Butler. It has several common names; Japanese hemlock caterpillar, larch caterpillar, Sakhalin silk moth, Siberian conifer silk moth, Siberian lasiocampid, Siberian moth, Siberian silk moth and white-lined silk moth.

The EPPO code[2] (Griessinger and Roy, 2015; EPPO, 2019) for this species is: DENDSU (EPPO, online).

3.1.2. Biology of the pest

D. superans is a forestry pest of coniferous trees. In Hokkaido (Japan), the life cycle of *D. superans* usually takes one year (Kobayashi and Taketani, 1994). In the southern part of north-eastern China, development also takes one year, further north in China where the climate is colder, a single generation takes two years (EPPO, 2005; Fang et al., 2021). Adult *D. superans* emerge in the summer (June–July) and can be detected flying until August or September. Following emergence females emit a pheromone to attract males and to mate. Eggs are laid between June and September in clusters of 20–30 eggs on the needles towards the top of host trees and take 11–12 days to hatch (Kobayashi and Taketani, 1994). Dissected females of *D. superans* were found to contain an average of ~ 200 eggs (Maeto, 1991). As larvae feed and grow during the summer they skeletonize needles. In the autumn (September–October), second to fourth instar larvae descend to the ground and seek overwintering sites under moss, leaf litter or grass where they remain until the following spring (April) (Fang et al., 2021). Where *D. superans* occurs at high northern latitudes or in mountainous regions, winter snow covering the ground provides some insulation. In the spring, larvae then climb back up the host to continue to feed on needles. Larvae of the related *D. sibiricus* sometimes feed on the bark of young shoots and cones (EPPO, 2005), and it is assumed that larvae of *D. superans* can do the same. In Japan, larvae of *D. superans* feed on needles from May until October (Maeto, 1991). Larvae continue to feed and develop on needles during their second summer and then return to the ground to overwinter in the autumn as fifth to seventh instars (EPPO, 2005; Fang et al., 2021). The following spring, they emerge and again climb back up to feed on the foliage of hosts. Late instar larvae feed intensively and cause the most damage (Schmutzenhofer et al., 1996). In May–June, mature larvae of *D. superans* pupate in cocoons on the twigs and branches of host plants from which adults emerge after about 20–30 days (Kobayashi and Taketani, 1994; Fang et al., 2021).

3.1.3. Host range/Species affected

The larvae of *D. superans* feed and develop on a range of coniferous species. EPPO (2005) notes that *D. superans* prefers hosts within forests that are more than 50 years old. EPPO online reports the preferred hosts as *Abies sachalinensis, Larix gmelinii, Picea jezoensis* and *Pinus pumila*, with *L. gmelinii* and *P. pumila* being regarded as major hosts. Appendix A provides a more complete list of hosts.

Kobayashi and Taketani (1994) list 10 conifer species as *D. superans* hosts, including *Picea abies* (Norway spruce) which is planted along roadsides in northern Japan (Kayama et al., 2003). Kobayashi and Taketani (1994) also list *P. thunbergii* as a *D. superans* host, which supports the commodity risk assessment of *P. thunbergii* bonsai from Japan (EFSA PLH Panel, 2019). A commodity risk assessment for bonsai *P. parviflora* grafted onto *P. thunbergii* from China cites a Chinese dossier as evidence that *P. parviflora* is a host for *D. superans* (EFSA PLH Panel, 2022). The status of *P. parviflora* as a host was unconfirmed by the scientific literature available.

EPPO (2005) and a pest risk assessment by the Norwegian Scientific Committee for Food and Environment (VKM, 2018)[3] state that there are no specific reports of *D. superans* affecting species of conifers growing in Europe. However, many of the hosts listed in Appendix A are grown as ornamentals in Europe and Kobayashi and Taketani (1994) list *P. abies*, an important EU forestry species, as a host, although like VKM (2018) no specific reports of impact by *D. superans* on hosts that are grown in Europe were found whilst conducting this pest categorisation.

Of interest, in experiments by Kirichenko et al. (2008, 2009) on the closely related pest species *D. sibiricus*, larvae were able to develop on conifer species native to Europe which are found outside the

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[2] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger and Roy, 2015; EPPO, 2019).

[3] Kobayashi and Taketani (1994) is not cited by VKM (2018). The text by Kobayashi and Taketani (1994) is in Japanese and VKM (2018) may not have been aware of its content.

native range of *D. sibiricus*. European larch, *Larix decidua,* was reported to be the most suitable host for the larvae, European silver fir, *Abies alba*, Nordmann fir, *A. nordmanniana,* and Norway spruce, *Picea abies,* were intermediate hosts and European black pine, *Pinus nigra,* and Scots pine, *P. sylvestris,* were the poorest hosts. Douglas-fir *Pseudotsuga menziesii,* a North American species widely grown in Europe was also highly suitable for larval development. However, these studies did not check whether adults went on to be able to successfully reproduce. Were *D. superans* to be introduced into the EU, it is possible that *D. superans* could change its feeding habits and expand its host range, as seems possible with *D. sibiricus*, to feed and develop on more conifer species in the EU.

3.1.4. Intraspecific diversity

There is no intraspecific diversity. A previous taxonomy describing *D. superans* as consisting of two subspecies, *D. superans sibiricus* Tschetverikov and *D. superans albolineatus* Butler is no longer held valid (see Section 3.1.1).

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, adult males can be lured to pheromone traps. Eggs and larvae can be visually detected when searching branches of infested hosts. Morphological and molecular methods exist for the identification of the species.

Detection

Symptoms of infestation are needle loss and dieback. Defoliation over a long period leads to pine decline (Schmutzenhofer et al., 1996). During outbreaks, defoliation can occur over large areas and is described in EPPO (2005) as spectacular. Mature, late instar larvae are relatively large (up to 90 mm long) and can be easily seen. The compounds of the female sex-pheromone for *D. superans* have been identified and used as an attractant to trap males of the species (Kong et al., 2001).

Identification

Matsumura (1926) provides a detailed description of larvae and adults. Summary descriptions of life stages are provided below:

Egg: ~ 2.2 mm by 1.6 mm. A detailed description of the egg with SEM images can be seen in Dolinskaya and Pljushch (2000). Clusters of 20–30 eggs are laid on needles towards the top of a host tree (Kobayashi and Taketani, 1994).

Larva: Final instar larvae grow to between 60 and 90 mm long with a yellow-brown head and a grey-brown body with yellowish spots along it (Kobayashi and Taketani, 1994; Schmutzenhofer et al., 1996).

Pupa: Brown, between 33 and 39 mm long in females; male pupa smaller 28–34 mm long (EPPO, 2005).

Adult: Between 30 and 45 mm long with wingspan of 70–100 mm, typically grey, black or brown (Kobayashi and Taketani, 1994; Schmutzenhofer et al., 1996).

Molecular methods are available to identify *D. superans* with over 120 accessions held in Genbank. Mikkola and Ståhls (2008), Dai et al. (2012) and Kononov et al. (2016) describe molecular methods e. g. based on the nucleotide sequences of COI and COII mitochondrial genes and ITS2 spacer of nuclear ribosomal genes, used to differentiate between closely related species of *Dendrolimus,* including *D. superans*.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

D. superans occurs in non-European Russia (Siberia and Far East Russia), China, Mongolia and Japan often in mountainous coniferous forests ecosystems with continental climates with no dry or wet seasons. Figure 1 shows the global distribution of *D. superans*. Appendix B provides details of the global distribution based on scientific literature and the EPPO Global Database (EPPO, online).

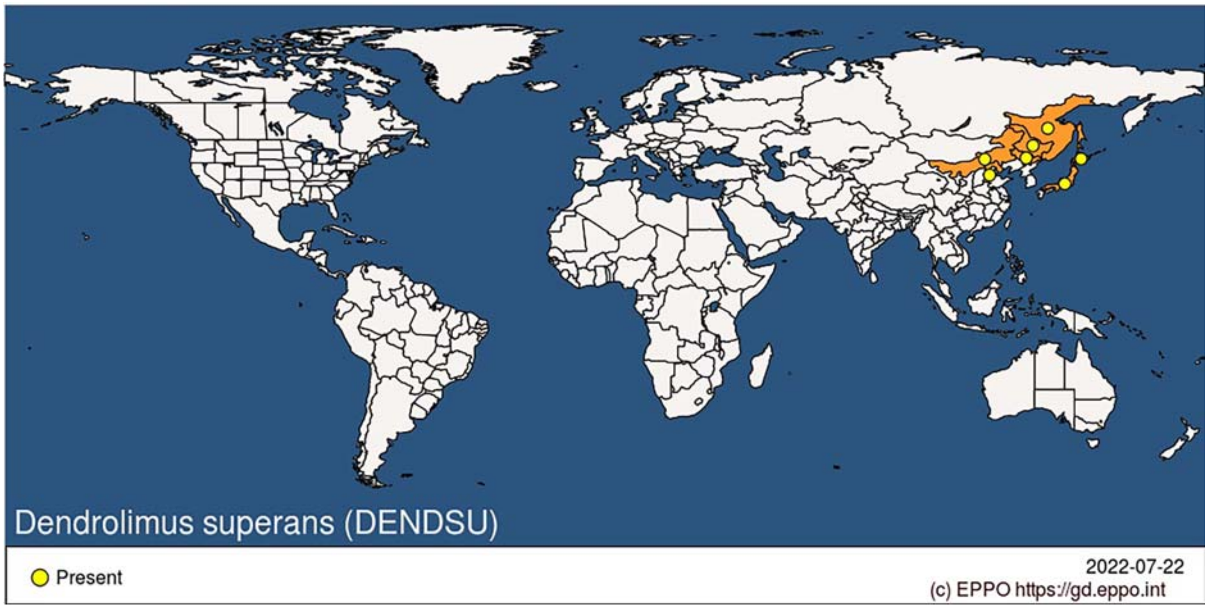

Figure 1: Global distribution of *Dendrolimus superans* (Source: EPPO, online accessed on 24/2/2022)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.

No. *D. superans* is not known to occur in the EU territory.

3.3. Regulatory status

D. superans is included in a list of pests of concern in relation to naturally or artificially dwarfed *Pinus parviflora* and *P. thunbergii* plants for planting from Japan in Commission Implementing Regulation (EU) 2020/1217. The regulation provides for a derogation from Article 7, point 1 of Annex VI of Implementing Regulation (EU) 2019/2072 if the plants comply with the conditions set out in Commission Implementing Regulation (EU) 2020/1217.

3.3.1. Commission Implementing Regulation 2019/2072

D. superans is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031.

3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries

Table 2: List of plants, plant products and other objects that are *Dendrolimus superans* hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN code**	**Third country, group of third countries or specific area of third country**
1.	Plants of *Abies* Mill., *Cedrus* Trew, *Chamaecyparis* Spach, *Juniperus* L., *Larix* Mill., *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* Carr. and *Tsuga* Carr., other than fruit and seeds	ex 0602 20 20 ex 0602 20 80 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 50 ex 0602 90 70 ex 0602 90 99 ex 0604 20 20 ex 0604 20 40	Third countries other than Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo- Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Turkey, Ukraine and the United Kingdom
19.	Soil as such consisting in part of solid organic substances	ex 2530 90 00 ex 3824 99 93	Third countries other than Switzerland

Note the derogation referred to above Section 3.3.1.

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

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

In principle, *D. superans* could enter the EU on host plants including plant products such as cut branches or wood with bark. However, prohibitions on host genera largely close such pathways although certain dwarfed *Pinus* spp. from Japan are provided a derogation by EU 2020/1217.

Comment on plants for planting as a pathway.

Plants for planting could, in principle, provide a pathway but the pathway is closed due to prohibition, with the exception of *P. parviflora* and *P. thunbergii* bonsai from Japan (EU 2020/1217) The status of *P. parviflora* as a host was unconfirmed by the scientific literature available.

Annex VI of EU 2019/2072 prohibits the introduction of *Abies, Cedrus, Larix, Picea, Pinus* and *Tsuga,* genera within which species of *D. superans* hosts occur, from countries and areas where *D. superans* occurs (Table 2). Certain dwarfed *Pinus* spp. from Japan are provided a derogation by EU 2020/1217.

Table 3 lists potential pathways into the EU. Whilst adults can fly there is no evidence that *D. superans* is spreading westwards towards the EU so natural spread as a means of entry is not considered possible (VKM et al., 2018).

Table 3: Potential pathways for *Dendrolimus superans* into the EU 27

Pathways (Description, e.g. host/intended use/source)	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Plants for planting of host trees	Eggs and larvae on needles and branches; larvae and pupae on bark and branches. Larvae in the litter of potted plants	2019/2072 Annex VI prohibition
Cut branches (including Christmas trees)	Eggs and larvae on needles and branches; larvae and pupae on bark and branches	2019/2072 Annex VI prohibition
Wood with bark of host plants	Larvae on bark	2019/2072 Annex VI prohibition
Isolated bark of host plants	Larvae on bark	2019/2072 Annex VI prohibition
Soil	Diapausing/hibernating larvae	2019/2072 Annex VI prohibition

Regarding the import of dwarfed *P. thunbergii* from Japan as a pathway for entry, the EFSA PLH Panel (2019) estimated that such dwarf plants were "extremely likely" to be free from *D. superans* given that the proposed risk mitigation measures were applied.

Regarding the import of dwarfed *P. parviflora* grafted onto *P. thunbergii* from China as a pathway for entry, the EFSA PLH Panel (2022) estimated that such dwarf plants were 'almost always pest free' given that the proposed risk mitigation measures were applied.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 31st May 2022 there were no records of interception of *D. superans* in the Europhyt and TRACES databases. (Note that because *D. superans* is not a QP, MS are not obliged to notify findings). There has been one interception of the related species, *D. spectabilis* (also not an EU QP) on dwarfed *Pinus* spp. from Japan between 1999 and 2018 (EFSA PLH Panel, 2019).

A pest risk assessment of *D. superans* by the Norwegian Scientific Committee for Food and Environment noted that there was no evidence that *D. superans* had been intercepted anywhere (VKM et al., 2018).

3.4.2. Establishment

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

Yes, there are climate zones in the EU that match those found where *D. superans* occurs and at least one host (*P. abies*) occurs as an important forestry tree in these zones. Should *D. superans* enter the EU it may also be possible for *D. superans* to adapt to feed on a wider range of conifer species occurring in the EU, facilitating its establishment.

Climatic mapping is the principal method for identifying areas that could provide suitable conditions for the establishment of a pest taking key abiotic factors into account (Baker, 2002). Availability of hosts is considered in Section 3.4.2.1. Climatic factors are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

D. superans is a polyphagous species and at least one host species (*P. abies*) is of major importance in both economic (forestry) and ecological terms in the EU (Caudullo et al., 2016). Were *D. superans* to be introduced into the EU, it is possible that it could change its feeding habits and expand its host range to feed and develop on other conifer species important to forestry, as seems possible with the closely related species *D. sibiricus* which was shown to develop successfully on several conifer species growing in the EU territory (Kirichenko et al., 2008, 2009; see Section 3.1.3).

Within Europe, the majority of the known hosts of *D. superans* are not grown for forestry purposes (Appendix A) but they are available in Europe from plant suppliers, garden centres or specialist conifer suppliers so can be grown as ornamental or amenity species. Such hosts are assumed to be relatively isolated and spread out from each other. Given that *D. superans* prefers hosts in forests that are over 50 years old (EPPO, 2005) whether *D. superans* could establish on isolated ornamentals is uncertain.

Figure 2 is a distribution map of *Picea abies* produced by the Joint Research Center (JRC) for EFSA. Appendix C provides details.

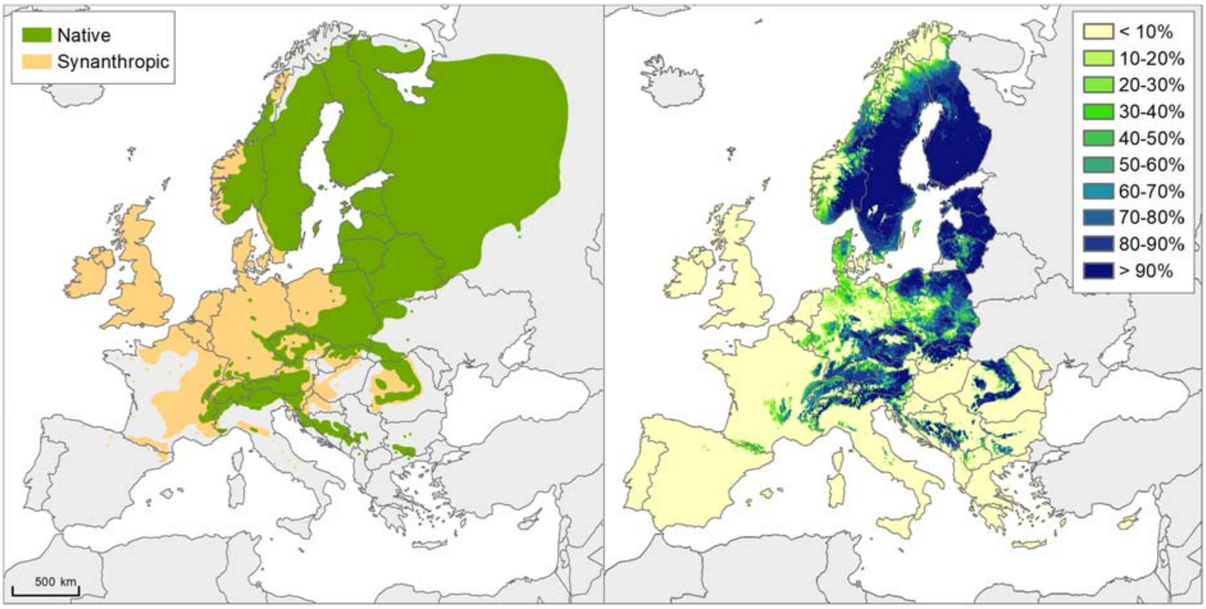

Figure 2: Left panel: chorological map of *Picea abies*, in green the areas where the species is native, in orange the area where the species has been introduced and actually naturalised (synanthropic) (Caudullo et al., 2017). Right panel: current habitat suitability for *P. abies* using the time period 1990–2020 as reference. Suitability values are higher where bio-climatic conditions are more similar to those observed where the species currently occurs natively (Mauri et al., 2022) (for details see Appendix C)

3.4.2.2. Climatic conditions affecting establishment

The global Köppen–Geiger climate zones (Kottek et al., 2006) describe terrestrial climate in terms of average minimum winter temperatures and summer maxima, amount of precipitation and seasonality (rainfall pattern). *D. superans* occurs in a range of climate zones in Asia. Some climatic zones in which *D. superans* occurs are also found in the EU (Figure 3). Collectively, climate types Bsk, Cfa, Cfb, Dfb and Dfc occupy ~ 84% of all EU 27 five arcmin grid cells (MacLeod and Korycinska, 2019). Zones Dfb (continental climate, no wet or dry seasons, warm summer) and Dfc (continental climate, no wet or dry seasons, cold summer) are found in the mountainous regions and in northern parts of the EU and are the regions perhaps most similar to those in Asia where *D. superans* is reported to be damaging most often. These colder areas occupy ~ 30% of EU 27 five arcmin grid cells (MacLeod and Korycinska, 2019). The host *P. abies* occurs in these areas (Figure 2).

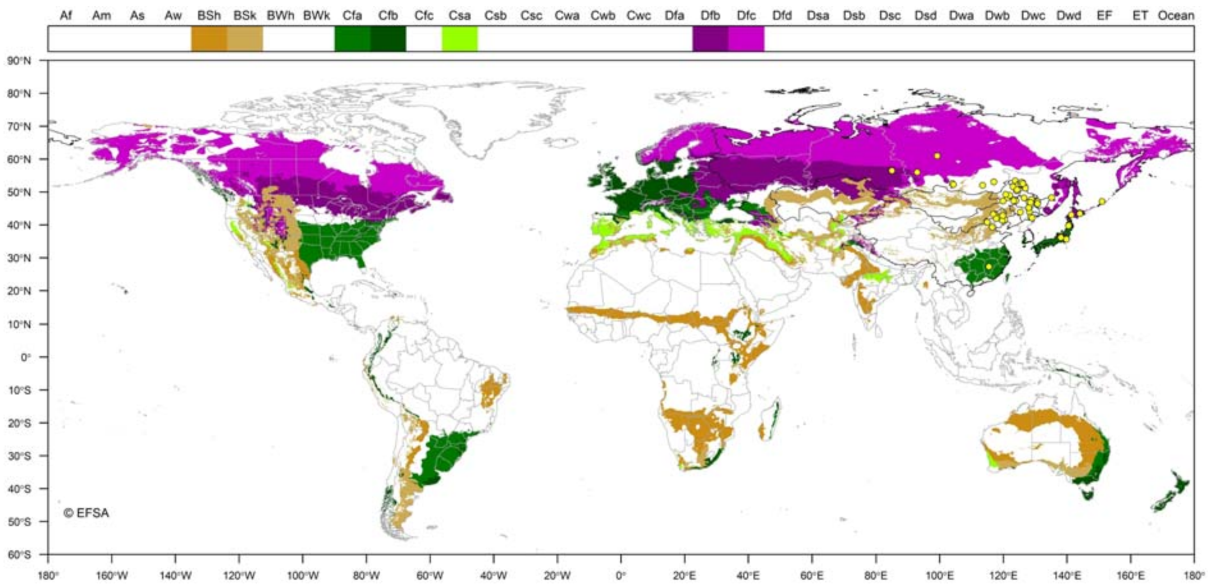

Figure 3: Distribution of Köppen–Geiger climate types that occur in the EU and in areas where *Dendrolimus superans* has been reported (yellow dots)

The southernmost record shown in China is from Yongfeng, a mountainous region in Jiangxi (Kuanya and Xuanji, 1994; Ma et al., 1998).

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?
Adult *D. superans* can fly and spread up to 100 km per year (EPPO, 2005).
Comment on plants for planting as a mechanism of spread.
All life stages could be transported on host plants for planting moved in trade (EPPO, 2005).

Whilst adults can fly, and *D. superans* is reported to be able to spread up to 100 km per year, a pest risk assessment of *D. superans* by the Norwegian Scientific Committee for Food and Environment noted that there was no evidence that *D. superans* was spreading westward from its area of origin (VKM et al., 2018).

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?
D. superans is a major pest of conifer forests in northeast China, Japan and non-European Russia. However, reports of damage are to conifer species not grown in EU forestry. *P. abies*, a species of major importance in EU forestry, is a recognised host but there were no reports of damage found in literature. Were *D. superans* to establish in EU forests of *P. abies*, impacts could nevertheless be expected. As a forest pest, the potential for consequences to hosts grown as ornamental or amenity trees in the EU is unknown.

D. superans is a major pest of *Larix* in Far East Russia and north-eastern Chinese forests. Mass outbreaks can cover thousands of ha with up to 15,000 larvae per tree and 3 million larvae per ha (Averensky et al., 2010; Fang et al., 2021). An extreme outbreak in China from 1989 to 1991 caused damage to over 1,000,000 ha of forest in the Great Xing'an Mountains (Fang et al., 2021). In Hokkaido (northern Japan) Higashiura (1991) reported outbreaks of *D. superans* in stands of *Abies sachalinensis* and *Picea jezoensis* approximately every 10–12 years (1941, 1952, 1962 and 1975). There may be a relationship between solar activity, the appearance of sunspots and outbreaks (Huang et al., 2010).

Larval feeding can result in total needle loss and death of the tree; smaller outbreaks with fewer larvae per tree results in lower wood productivity (smaller growth increments) and weakened trees. Ma et al. (1998) surveyed tree increment loss following an outbreak of *D. superans* in lightly to extremely heavily infested areas of larch in the Shibazhan Forest in the Daxing'an mountain region of China. Findings are summarised in Table 4.

Table 4: Impact of infestation of *Dendrolimus superans* on larch foliage and timber loss during an outbreak in China (Ma et al., 1998)

Infestation level	# *D. superans* per tree	Mean timber loss per tree (cm^3)	Foliage loss	Infested area (ha)
Extremely heavy	> 100	2,265	Complete defoliation	71,000
Heavy	60–99	1,947	10% needles remain	207,000
Moderate	40–59	1,553	60–90% needles remain	166,000
Light	20–39	1,183	> 90% needles remain	121,000
Control area	0–19	0	Few needles eaten	585,000

Defoliation over a long period leads to pine decline and mortality may occur if defoliation is over 75% (Fang et al., 2021). Larval feeding of *D. superans* threatens all age classes of pines (Schmutzenhofer et al., 1996).

Investigating the relationship between climatic factors, pest development and defoliation, Fang et al. (2021) found that increased rainfall whilst early instar larvae are developing can lead to reduced defoliation whilst increased temperatures during late larval development can increase defoliation. Maeto (1991) also noted that temperatures in late summer were generally higher in years preceding an outbreak and all outbreaks occurred after periods when temperatures in August and September were about 1°C higher than normal.

Modelling population dynamics and outbreaks over a 300-year simulation period, Chen et al. (2011) concluded that simulated outbreaks of *D. superans* could reduce frequency of forest fires due to less larch trees being available as fuel, and increase the proportion of white birch trees (*Betula papyrifera*) in the forest environment.

3.6. Available measures and their limitations

Are there measures available to prevent pest entry, establishment, spread or impacts such that the risk becomes mitigated?

Yes, Annex VI of 2019/2072 prohibits the introduction of plants and plant products of *Abies, Cedrus, Larix, Picea, Pinus* and *Tsuga* from many third countries, including countries and areas where *D. superans* occurs (see Section 3.3.2).

EPPO (2018) suggests commodity specific phytosanitary measures for Coniferae.

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are applied to the host genera (see Section 3.3.2). If these prohibitions stay in place, additional measures would not increase protection. Therefore, no additional measures have been identified.

A derogation for dwarfed *P. thunbergii* from Japan details the necessary requirements for the introduction of the plants into the EU (EU 2020/1217) and we do not suggest further measures are necessary.

3.6.1.1. Additional potential risk reduction options

Given the existing prohibition and requirements for the derogation from Japan no additional risk reduction options have been identified.

3.6.1.2. Additional supporting measures

Given the existing prohibition and requirements for the derogation from Japan no additional supporting measures have been identified.

3.7. Uncertainty

There is lack of information regarding impacts by *D. superans* on conifer species that are also grown in the EU either as forestry trees, i.e. *P. abies*, or as amenity or ornamental species. Available literature refers to conifer species used in forestry in China, Siberia, Far East Russia and Japan and these species are not grown in EU forestry. Nevertheless, as noted in Section 3.1.3, it may be possible for *D. superans* to adapt to EU conifers in forestry, as seems possible for the related species *D. sibiricus*.

4. Conclusions

D. superans satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union QP. Some uncertainty exists over the magnitude of potential impacts.

Table 5 provides a summary of the PLH Panel conclusions.

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

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the species is established and *Dendrolimus superans* Butler is the accepted name and authority.	None
Absence/presence of the pest in the EU (Section 3.2)	*D. superans* is not known to occur in the EU territory	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	In principle *D. superans* could enter the EU on host plants for planting and plant products such as cut branches or wood with bark. However, Annex VI of 2019/2072 prohibits the introduction of *D. superans* host genera (*Abies, Cedrus, Larix, Picea, Pinus* and *Tsuga*) from countries and areas where *D. superans* occurs, although a derogation exists for dwarfed *Pinus* from Japan. There are climate zones in the EU that match those found where *D. superans* occurs and at least one host species, *P. abies*, occurs in such zones.	None
Potential for consequences in the EU (Section 3.5)	*D. superans* is a major pest of conifer forests in northeast China, Japan and non-European Russia. Impacts may be expected on *P. abies* and potentially on other forestry species were *D. superans* to expand its known host range to more EU forestry species.	Within forestry, there is uncertainty over the magnitude of potential environmental and economic impacts. As a forest pest the potential for consequences to hosts grown as ornamental or amenity trees in the EU is uncertain
Available measures (Section 3.6)	Annex VI of 2019/2072 prohibits the introduction of plants and plant products of *D. superans* host genera from many third countries, including countries and areas where *D. superans* occurs.	None
Conclusion (Section 4)	*D. superans* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	Some uncertainty exists over the magnitude of potential economic and environmental impacts.
Aspects of assessment to focus on/scenarios to address in future if appropriate:	It would be useful to find out whether *D. superans* could feed and reproduce on more conifer species commonly used in EU forestry, and to quantify impacts to better inform any future risk assessment. However, such additional information would not alter the conclusion of this categorisation.	

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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, 2018)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018)
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, 2018)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
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, 2018)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018)
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, 2018)
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, 2018)
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, 2018)

Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
SEM	Scanning electron microscopy
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Appendix A – *Dendrolimus superans* host plants/species affected

Source: EPPO Global Database (EPPO, online) and literature.
All *D. superans* hosts are in the plant family Pinaceae.

Host name	Common name	Reference	Grown in EU as an amenity or ornamental plant?	Listed by JRC as a species used in European forestry?
Abies sachalinensis	Hokkaido pine/ Sakhalin fir	Higashiura (1991), Kobayashi and Taketani (1994), Kamata (2002)	Yes	No
Abies firma	Japanese fir	Kobayashi and Taketani (1994)	Yes	No
Cedrus deodara	Himalayan cedar	Kobayashi and Taketani (1994), Kamata (2002)	Yes	No
Larix gmelinii*	Dahurian larch	Huang et al. (2010)	Yes	No
Larix kaempferi	Japanese larch	Kobayashi and Taketani (1994)	Yes	No
*Larix kamtschatica***	Japanese larch	EPPO (2005)	Yes	No
Larix olgensis	Korean larch	Meng et al. (2011)	Yes	No
Picea abies	Norway spruce	Kobayashi and Taketani (1994)	Yes	**Yes**
Picea jezoensis	Yeddo spruce	Higashiura (1991), Kobayashi and Taketani (1994), Kamata (2002)	Yes	No
Picea asperata	Dragon spruce	Huang et al. (2010)	Yes	No
Pinus densiflora	Japanese red pine	Kobayashi and Taketani (1994)	Yes	No
Pinus koraiensis	Korean pine	Huang et al. (2010)	Yes	No
Pinus pumila*	Japanese stone pine	EPPO (online)	Yes	No
Pinus thunbergii	Japanese black pine	Kobayashi and Taketani (1994), "Chinese dossier section 4" within EFSA Panel on Plant Health (2022)	Yes	No
Tsuga sieboldii	Southern Japanese hemlock	Kobayashi and Taketani (1994)	Yes	No

*: Regarded as a major host in EPPO GD.
**: *Larix kamtschatica* is a synonym of *L. gmelinii* var. *gmelinii* (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:262434-1).

In experiments by Kirichenko et al. (2008, 2009) on the closely related species *Dolichoderus sibiricus*, larvae were able to develop on European conifer species which are found outside the native range of the pest. European larch *Larix decidua* was reported to be the most suitable host for the larvae, European silver fir *Abies alba*, Nordmann fir *A. nordmanniana* and Norway spruce *P. abies* were intermediate hosts and European black pine *Pinus nigra* and Scots pine *Pinus sylvestris* were the poorest hosts. Douglas-fir *Pseudotsuga menziesii,* a North American species widely grown in Europe was also highly suitable for larval development. Were *D. superans* to be introduced into the EU, it is possible that *D. superans* could expand its host range to feed and develop on conifer species used in forestry in the EU. However, there have been no formal experiments, such as feeding choice studies, or oviposition choice experiments to categorically confirm that *D. superans* could or could not, develop on European species of Pinanceae used in forestry.

Mistakenly reported as a host:

Host name	Common name	Reference suggesting a host for *Dendrolimus superans*
Populus spp.	Poplar	CABI (online)

A summary datasheet on *D. superans* in the CABI Invasive Species Compendium (CABI, online) includes *Populus* (poplar) (Salicaceae) as a host, citing Schmutzenhofer et al. (1996). However, a mistake has been made in interpreting the reference. The title of the work by Schmutzenhofer et al. refers to forest insect pests with an emphasis on poplars, which is probably why poplar is included as a host in the CABI datasheet. However, the text referring explicitly to *D. superans* within Schmutzenhofer et al. (1996) clearly states that *D. superans* is a pest of pines and larch; there is no mention of poplars as a host for *D. superans*. Further *D. superans* is not included in the list of poplar pests elsewhere in the text by Schmutzenhofer et al. (1996).

Appendix B – Distribution of *Dendrolimus superans*

Distribution records based on EPPO Global Database (EPPO, online) and scientific literature.

Region	Country	Sub-national (e.g. State)	Status	References
Asia	Russia (non-European)		Present, restricted distribution	
		Western Siberia		Nikiforov (1970)
		Eastern Siberia		Isaev and Ryapolov (1979), Orlov and Gorshkov (1966), Rusetskaya and Baldanova (2020), Soldatov et al. (2001)
		Far East (inc. Sakhalin island, Kurile islands)	Present, restricted distribution	Kononov et al. (2016), EPPO (2005), Maeto (1991)
	China			
		Hebei		Nangong (2008)
		Heilongjiang		Huang et al. (2010)
		Inner Mongolia		Chen et al. (2011), Fang et al. (2021)
		Jilin		Guo et al. (2007), Huang et al. (2010)
		Liaoning		Huang et al. (2010)
		Shangzhi		Kuanyu and Xuanji (1994)
	Japan		Present, restricted distribution	Higashiura (1991)
		Hokkaido	Present, widespread	Higashiura (1991)
		Honshu	Present, restricted distribution	Jeong et al. (2018), Kamiya (1933), Maeto (1991), Matsumura (1926), Zhang et al. (2017)
	Mongolia			Guo et al. (2007)
	Republic of South Korea		Absent, unreliable record	EPPO (online), Jeong et al. (2018)

Appendix C – Methodological notes on Figure 2

The single species map of *P. abies* is a two-panel figure showing the following maps:

1) The chorological map providing a synoptic overview of the species. These maps are based on historical and recent sources providing information about the specie range at continental scales. The distribution areas are defined by comparing multiple and heterogeneous sources and show a synthetic overview of all available information, so the boundaries cannot be considered precise limits where the species is present or absent, particularly at local level.
2) The EU-Tree4F habitat suitability map provided the species' suitable areas of occupancy. These distribution maps are part of the EU-Tree4F dataset, a collection of numerical maps modelled for 67 European tree species using a set of nine environmental parameters describing key features of climate and soil. The species distribution maps are developed for the current period (centred in the year 2005) and for three future scenarios (centred in the years 2035, 2065, and 2095). They were modelled using the BIOMOD platform with EURO-CORDEX regional climate model simulations.