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Pest categorisation of *Malacosoma disstria*

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Abstract

The European Commission requested the EFSA Panel on Plant Health to conduct a pest categorisation of *Malacosoma disstria* Hübner (Lepidoptera: Lasiocampidae), commonly known as the forest tent caterpillar, for the territory of the EU. *M. disstria* is a North American polyphagous leaf-eating pest primarily feeding on deciduous trees belonging to the genera *Acer, Malus, Populus, Prunus, Quercus* and *Tilia*. It is a univoltine species. Eggs are laid on twigs and branches. Larvae emerge in the spring to feed on buds and fresh leaves. Host plants can be completely defoliated although they often refoliate and recover within a few weeks. Nevertheless, three consecutive years of heavy defoliation or repeated periods of defoliation combined with drought can cause extensive tree mortality. As such, *M. disstria* is regarded as one of the most serious hardwood forestry insect pests in North America. Population upsurges leading to outbreaks are cyclical, generally nine to 13 years apart and can last 2–3 years. Outbreaks have been reported in eastern North America since the late 18th century. Outbreaks in western Canada have spanned up to 200,000 km^2. Plants for planting, cut branches and isolated bark provide pathways for entry. Host availability and climate suitability suggest that large parts of the EU would be suitable for establishment. The pest could spread naturally by flight within the EU. Eggs on plants for planting could also facilitate spread. The introduction of *M. disstria* into the EU could lead to serious outbreaks causing significant damage to forest, orchard and amenity trees and shrubs. Phytosanitary measures are available to inhibit the entry and spread of this species. *M. disstria* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: forest tent 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

Malacosoma disstria is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest 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 quarantine pest, risk reduction options will be identified.

1.3. Additional information

This pest categorisation was initiated as a result of media monitoring, PeMoScoring and subsequent discussion in PAFF, resulting in it being included in the current mandate within the list of pests identified by horizon scanning and selected for pest categorisation.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *M. disstria* 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 European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), 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 *Malacosoma disstria* 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).

2.2. Methodologies

The Panel performed the pest categorisation for *M. disstria*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel et al., 2018), 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 quarantine pest (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, 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest 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 *Malacosoma disstria* Hübner is the accepted name.

M. disstria is an insect within the order Lepidoptera and family Lasiocampidae. It is commonly known as the forest tent caterpillar (Figure 1).

The EPPO code[1] (Griessinger and Roy, 2015; EPPO, 2019) for this species is: MALADI (EPPO, online).

[1] 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 & Roy, 2015; EPPO, 2019).

Figure 1: *Malacosoma disstria* larva (Photograph by James R. Meeker, FDACS, Division of Forestry.- *image is from* https://entnemdept.ufl.edu/creatures/trees/forest_tent_caterpillar.htm)

3.1.2. Biology of the pest

M. disstria is a highly studied forestry and amenity tree pest with thousands of published papers on its biology. The following summary of the life cycle and some aspects of its behaviour is based on reports by Hodson (1941), Stehr and Cook (1968), Cooke and Roland (2003), Colasurdo and Despland (2005), Cook et al. (2008), Babin-Fenske and Anand (2011), Uelmen Junior et al. (2016), Schowalter (2017) and Stephens et al. (2018). For some important features of the life history strategy of *M. disstria,* see also Table 2.

M. disstria is a univoltine species. Adults emerge in spring in the southern USA and in midsummer, between late June and early July, in cooler northern regions of the USA and Canada. Males emerge before females. Before emergence, females emit a sex pheromone from within the cocoon, which attracts males (Miller, 2006). A few seconds after female emergence mating begins. Following mating, females fly to seek a suitable site for egg laying, which occurs a day after mating. Females oviposit all their eggs as an egg mass either in a single band encircling a host twig or as a flat mass on a larger branch or stem of a host. Females cover the egg mass with a foamy substance (spumaline) that hardens. This is thought to protect the eggs from freezing, dehydration, predation and parasitism. Egg masses consist of approximately 100 to 350 eggs. The number of eggs laid is influenced by the quality of the host the female fed on as a larva. Unmated females can oviposit a few eggs, but these are always infertile. Adults of both sexes are nocturnal fliers (see 3.4.3). Adults have no functional mouthparts so cannot feed and die after 5–10 days (Fitzgerald, 1995, cited in Evenden et al., 2015a, p. 2).

Eggs persist during the summer and autumn and overwinter before they hatch the following spring. Eggs are cold tolerant, but extreme (unspecified) cold temperatures cause egg mortality. Egg hatching coincides with budburst and the first flush of new leaves on host trees, typically during early April or May, depending on location. There are five larval instars, each lasts 7–10 days. Early instar larvae feed on buds and expanding leaves.

Although commonly named a 'tent caterpillar', larvae do not produce a silken 'tent', but create trails of silk from the mouthparts on which they secrete a non-volatile sterol lipid trail pheromone from anterior glands. The silk helps larvae attach to hosts and the pheromone induces younger larvae to stay together, either at rest or when foraging. The larvae are gregarious and the first three larval instars from an egg mass move together in chains following the trail of silken threads and feed and rest together on such webbing. After feeding on buds or leaves, larvae move together to resting sites, often on the lower trunk of the tree they feed on. A new resting site is chosen after each feeding session. Fourth and fifth instar larvae do not aggregate as much when feeding but disperse and feed separately on mature leaves although they can aggregate on tree trunks to rest after feeding. Mature larvae spin protective silken cocoons in host foliage in which they form pupae. Cocoons can also be fixed to non-host material, including buildings. After 7–10 days, adults emerge, and the cycle begins again.

Population explosions and outbreaks appear with a cycle of 6–13 years, depending on location, and are most likely linked to host–parasitoid interactions. The pupal parasitoid *Arachnidomyia aldrichi* (Parker) (Diptera, Sarcophagidae) is considered the primary cause of mortality influencing outbreaks.

Table 2: Important features of the life history strategy of *Malacosoma disstria*

Life stage	Phenology and relation to host	Other relevant information
Egg	Eggs are laid in a mass on host twigs, branches or stems in the spring and summer. They overwinter and hatch the following spring.	The longest lasting life stage; overwintering survival can be affected by severe winter temperatures; Eggs are protected with a foamy substance.
Larva	Larvae develop in the spring over 35–50 days; instars 1–3 feed gregariously on buds and new leaves. Instars 4 and 5 are more solitary and feed on older leaves.	Each instar takes 7–10 days to develop.
Pupa	Pupae are formed within cocoons usually attached to leaves but can also attach to other surfaces, including buildings.	Development of pupae takes 7–10 days. There can be a high rate of pupal parasitism (70–80%), (Witter and Kulman, 1979).
Adult	Adults emerge in spring and summer, quickly mate and lay eggs. They do not feed and die after 5–10 days.	After mating, eggs are laid within a day or so. Adults are active fliers and can spread a few kilometres (see Section 3.4.3).

3.1.3. Host range/Species affected

M. disstria is a polyphagous leaf-feeding pest with a relatively broad host range. Approximately one hundred hosts from 15 different families are reported. Most reports are from hardwood trees in Canada and USA. In the northern and western USA and in southern Canada trembling aspen (*Populus tremuloides*) is preferred; in the Plains region, aspen (*Populus*), apple (*Malus*), basswood (*Tilia americana*), cherry (*Prunus*) and maple (*Acer*) are favoured hosts (Fauske, 2002). In the southern US, gum trees (*Nyssa* spp. and *Liquidambar styraciflua*) and oaks (*Quercus*) are common hosts (USDA, 1989). Although deciduous hardwood species are preferred, larvae will resort to feeding on less preferred species, including conifers, when outbreaks deplete leaves of favoured hosts (Meeker, 2013). Appendix A provides an extensive host list.

3.1.4. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, populations of *M. disstria* can be found during visual inspections of infested trees showing symptoms and adult males can be detected using pheromone traps. Morphological keys and molecular methods are available for species identification.

Symptoms

Symptoms of infestation include dieback of the growing tips of hosts, external feeding damage on host leaves and extensive webbing (CABI, 2020). Single trees or complete stands may be completely defoliated during the spring and early summer (USDA, 1989).

Detection

Egg masses can be detected by visual inspection. Eggs occur in a mass encircling small twigs on host trees or as a flat mass on the stem or larger branches (Stehr and Cook, 1968). Larvae can be detected by visual inspection. They can aggregate on leaves or buds when feeding and on the lower portion of the trunk when resting. The sight of the silk webbing is a symptom of infestation (USDA, 1989).

Adult males can be detected using female sex pheromone baited traps (Evenden et al., 2015a).

Identification and description

Eggs: Between 100 and 350 eggs are laid in a mass either around twigs or as a flat mass on larger branches and stems, covered with frothy, dark brown gluey substance (spumaline) which prevents them from desiccating and freezing (Darling and Johnson, 1982).

Larvae: up to 50 mm, with a brownish body and pale bluish lines along the sides, a row of white spots down the middle of the back; sparsely covered with whitish setae (USDA, 1989).

Adults: wingspan approximately 30 mm, buff-brown, with dark oblique bands on the wings (USDA, 1989).

Stehr and Cook (1968) provide a morphological key to identify species within the genus *Malacosoma*; the key includes *M. disstria*.

Molecular diagnostic methods, based on the cytochrome c oxidase I (COI) sequence (Wilson, 2012), are available to identify *M. disstria* (Lait and Hebert, 2018), with a number of accessions in Genbank e.g. MT791627.1 and MT791626.1 (see also Section 2.1.2).

In Europe, the related species *Malacosoma neustria* (lackey moth) is widespread and common. The eggs and early-instar larvae of the two species are similar in appearance and could be confused by non-experts.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

M. disstria occurs in Canada and USA extending north to south from the Northwest Territories to California and Texas, and east to west from Newfoundland to British Columbia (Figure 2).

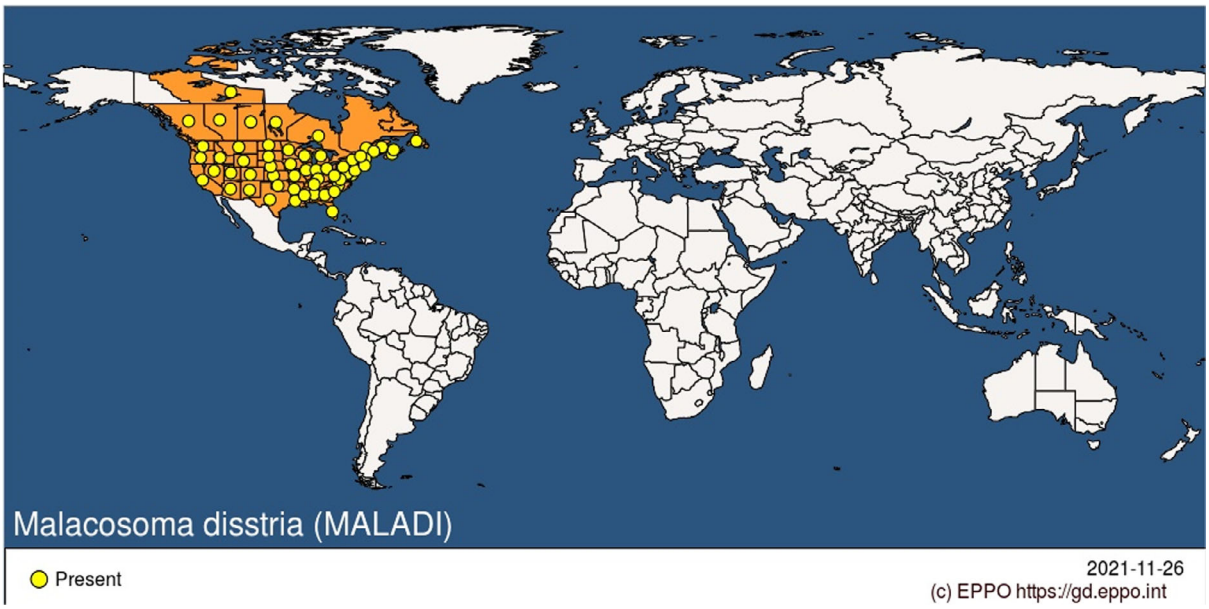

Figure 2: Global distribution of *Malacosoma disstria* (Source: EPPO Global Database accessed on 26 November 2021)

There is uncertainty regarding the occurrence of *M. disstria* in Mexico. Steher and Cook (1968) suggest that while no specimens of *M. disstria* have been found in Mexico, the presence of the pest in New Mexico and southern Texas suggests that the pest could occur in Mexico.

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, *M. disstria* is not known to occur in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

M. disstria is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031. It is not known to be in any emergency EU plant health legislation either.

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

A number of *M. disstria* hosts are prohibited from entering the EU (Table 3).

Table 3: List of plants, plant products and other objects that are *Malacosoma disstria* 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., … *Larix* Mill., *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* 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: […]
2.	Plants of […] and *Quercus* L., with leaves, other than fruit and seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	Third countries other than: […]
3.	Plants of *Populus* L., with leaves, other than fruit and seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	Canada, Mexico, United States
5.	Isolated bark of *Quercus* L., other than *Quercus* suber L.	ex 1404 90 00 ex 4401 40 90	Canada, Mexico, United States
6.	Isolated bark of *Acer saccharum* Marsh.	ex 1404 90 00 ex 4401 40 90	Canada, Mexico, United States

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**
7.	Isolated bark of *Populus* L.	ex 1404 90 00 ex 4401 40 90	The Americas
8.	Plants for planting of [...], *Crateagus* L., *Cydonia* Mill., *Malus* Mill., *Prunus* L., *Pyrus* L. and *Rosa* L., other than dormant plants free from leaves, flowers and fruits	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 40 00 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: [...]
9.	Plants for planting of *Cydonia* Mill., *Malus* Mill., *Prunus* L. and *Pyrus* L. and their hybrids, and [...] other than seeds	ex 0602 10 90 ex 0602 20 20 ex 0602 90 30 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: [...] USA other than Hawaii
11.	Plants of *Citrus* L., [...] and their hybrids, other than fruits and seed	ex 0602 10 90 ex 0602 20 20 0602 20 30 ex 0602 20 80 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	All third countries

The following *M. disstria* host genera are listed in Commission implementing regulation (EU) 2018/2019 as high risk plants for planting, whose introduction into the Union is prohibited pending risk assessment other than as seeds, *in vitro* material, or naturally or artificially dwarfed woody plants:

- *Acer*
- *Alnus*
- *Cornus*
- *Corylus*
- *Crataegus*
- *Fagus*
- *Fraxinus*
- *Hamamelis*
- *Juglans*
- *Malus*
- *Populus*
- *Prunus*
- *Quercus*
- *Robinia*
- *Salix*
- Sorbus
- *Tilia*
- *Ulmus*

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

Yes, *M. disstria* could enter the EU via the import of host plants for planting (excluding seed), on cut branches and on bark.

Comment on plants for planting as a pathway

Plants for planting provide a potential pathway for entry and spread within the EU.

Table 4 provides broad descriptions of potential pathways for the entry of *M. disstria* into the EU.

Table 4: Potential pathways for *Malacosoma disstria* 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]**
Host plants for planting (dormant/ without leaves) (excluding seed)	Eggs	Annex VI prohibitions apply. Prohibitions on high risk plants (EU 2018/2019) apply.
Host plants for planting (with buds or leaves)	Larvae, Pupae	Annex VI prohibitions apply. Prohibitions on high risk plants (EU 2018/2019) apply.
Host cut branches	Eggs, Larvae, Pupae	Annex VI prohibitions apply.
Host isolated bark	Eggs	Some Annex VI prohibitions apply to the bark of some hosts (*Quercus* (Table 3, point 5), *Acer* (point 6) and *Populus* (point 7)) from countries where *M. disstria* occurs.

Appendix A lists the hosts of *M. disstria*. Some hosts are prohibited from entering the EU.

Betula, Liquidambar and *Nyssa* are major hosts not included in Annex VI of 2019/2072 or within 2018/2019 and could therefore provide possible pathways as plants for planting.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 7 February 2022, there were no records of interceptions of *M. disstria* in the Europhyt and TRACES databases.

3.4.2. Establishment

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

Yes, biotic factors (host availability) and abiotic factors (climate suitability) suggest that large parts of the EU would be suitable for 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 et al., 2000; 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

Many genera of *M. disstria* hosts are present or are grown widely across the EU (e.g. *Acer, Betula, Malus, Populus, Prunus, Quercus* and *Ulmus*). Stehr and Cook (1968) noted that *M. disstria* 'oviposits and feeds on practically all species of deciduous trees'. Given the polyphagous nature of the pest, European species related to American hosts may be susceptible. Appendix C provides maps from the European Atlas of Forest Tree Species showing the distribution of European species related to some of the major host species in North America.

3.4.2.2. Climatic conditions affecting establishment

M. disstria is distributed across a wide range of Köppen–Geiger climate types (Kottek et al., 2006) in the USA and Canada, including climate types which occur over wide areas of the EU (Figure 3). For example, climate type Cfb (temperate oceanic) which is found widely in central and northern EU countries and is represented in approximately 46% of EU 27 five arcmin grid cells, and climate type Dfb (continental, warm summer) which occurs in central eastern Europe in approximately 9% of grid cells (MacLeod and Korycinska, 2019).

The EPPO datasheet on *M. disstria* suggests that *M. disstria* 'could certainly establish in European forests'.

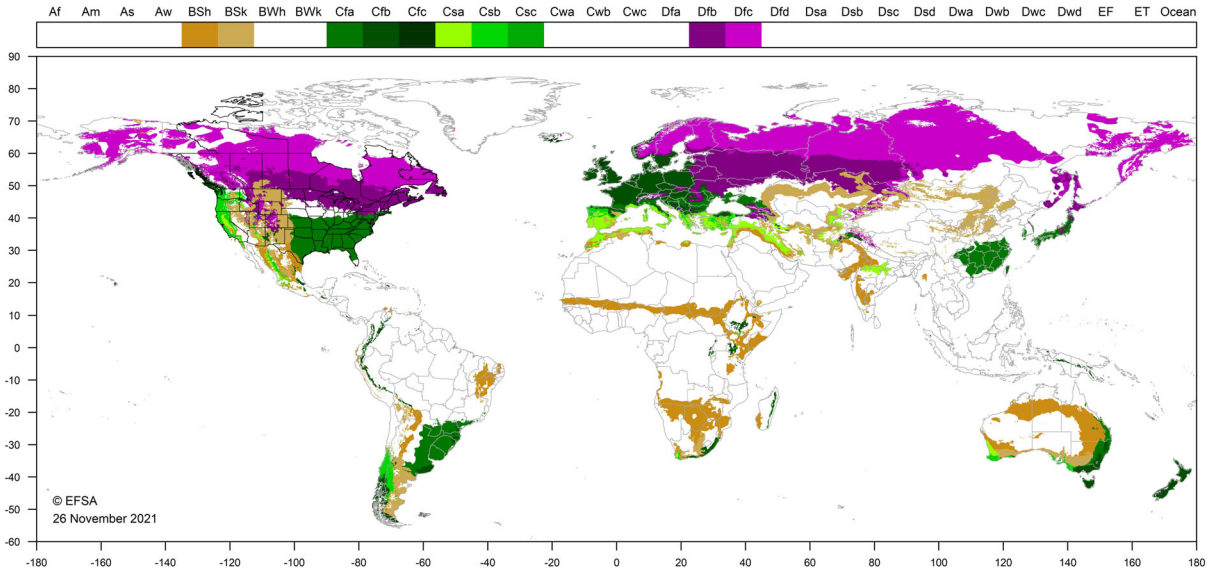

Figure 3: World distribution of 10 Köppen–Geiger climate types that occur in the EU and in countries where *Malacosoma disstria* occurs

Recalling that *M. disstria* is a North American species that has been known for over 200 years, the PLH Panel found no evidence that it had spread outside of North America or had ever been intercepted anywhere. This gave rise to a number of uncertainties regarding the introduction (entry and establishment) of the pest. Larvae are gregarious and conspicuous, creating silken threads and forming webbing whilst moving between feeding on foliage and resting on the trunks of hosts. The PLH Panel considered such factors likely to mean that hosts infested with larvae would be detected prior to export. Nevertheless, eggs could be carried on plants for planting and cut branches. However, the pests' ability to transfer to a suitable host following arrival in the EU on cut branches is uncertain.

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?

M. disstria is a free-living organism that would spread naturally within the EU. Adults are good fliers and in controlled flight could spread several km each generation. If carried on weather fronts they can be spread hundreds of km.

Comment on plants for planting as a mechanism of spread

Juvenile stages (eggs, larvae, pupae) could be carried with plants for planting. Eggs on dormant plants are the most likely life stage to be transported.

Adults of both sexes are nocturnal fliers (Fullard & Napoleone, 2001); in flight mill experiments lasting 8.5 h Evenden et al. (2015b) measured males flying up to 3.3 km. Females make shorter flights between mating and laying eggs (Miller, 2006). When assisted by turbulent cold air masses, adults have been shown to disperse in excess of 480 km (Brown, 1965).

3.5. Impacts

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

Yes, the introduction of *M. disstria* into the EU could lead to serious outbreaks causing significant damage to forest, orchard and amenity trees and shrubs.

M. disstria has been known as a serious forest pest in USA for over 230 years, with outbreaks reported in eastern areas since the late 18th Century (Hodson, 1941; Stehr and Cook, 1968), and as a pest in Canada for at least approximately 100 years with outbreaks in British Columbia reported from 1923 (Condrashoff, 1957). Today *M. disstria* is still regarded as one of the most serious hardwood forestry insect pests (Kosiba et al., 2018) and is the most destructive pest of trembling aspen (*Populus tremuloides*) and balsam poplar (*P. balsamifera*) in Canada (Peterson and Peterson, 1992; Battersby, 1999). Infestations can cause almost complete defoliation of the canopy (Stephens et al., 2018). Trees will often recover and refoliate a few weeks after defoliation although the leaves will be smaller than before (Stephens et al., 2018). Outbreaks in eastern Canada and the eastern US are cyclical, generally 9 to 13 years apart and can last 2 to 3 years (Cooke and Lorenzetti, 2006) over large areas. For example, in 2006, approximately 485,000 ha were defoliated by *M. disstria* in New York state (Wood et al., 2009). Outbreaks in western Canada have spanned up to 200,000 km^2 (Schowalter, 2017). Three consecutive years of heavy defoliation or repeated periods of defoliation combined with periods of drought can cause extensive tree mortality (Cooke and Lorenzetti, 2006; Man and Rice, 2010).

Brandt (1995) calculated losses caused by major forest pests in Canada over the years 1988–1992 and reported *M. disstria* caused timber losses of 1.625 million $m^3 year^{-1}$ due to growth reduction and 2.44 million $m^3 year^{-1}$ timber losses due to tree mortality.

In the north-eastern US and in Canada defoliation of sugar maple (*Acer saccharum*) stands lowers maple syrup yields and quality (Wood et al., 2009). As well as being a forestry pest, larvae damage ornamental trees and shrubs; defoliated trees are regarded as unsightly, and the large amounts of frass produced and dropped by larvae make *M. disstria* a nuisance pest for homeowners (Schowalter, 2017).

Should *M. disstria* establish in the EU and if natural enemies were not able to reduce populations, serious outbreaks could lead to significant damage to forest, orchard and amenity trees and shrubs.

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, some hosts are already prohibited from entering the EU (see Section 3.3.2). Hosts permitted entry require a phytosanitary certificate and a proportion of consignments are inspected. Additional options are available to reduce the likelihood of pest entry into the EU.

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants whilst other hosts such as *Betula, Liquidambar* and *Nyssa* (see Section 3.3.2).

Additional potential risk reduction options and supporting measures are shown in Sections 3.6.1.1 and 3.6.1.2.

3.6.1.1. Additional potential risk reduction options

Potential additional risk reduction and control measures are listed in Table 5.

Table 5: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Control measure/Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	**RRO summary**	**Risk element targeted (entry/establishment/spread/impact)**
Require pest freedom	Pest-free area for *Malacosoma disstria* (EPPO, 2017)	Entry/ Spread
Roguing and pruning	During nursery inspections, any egg masses on twigs or branches of plants detected could be pruned. However, whether such a measure would be practical on larger hosts is uncertain.	Entry/Spread
Biological control and behavioural manipulation	Pheromone dispensers can disrupt mating (Palaniswamy et al., 1983; Schowalter, 2017) and could be considered as part of a systems approach. Some natural enemies are considered key in influencing timing of outbreaks, conservation or classical biological control could be considered, should *M. disstria* establish in the EU.	Entry/Spread/Impact
Chemical treatments on crops including reproductive material	Widespread use of insecticides in forestry is prohibitively expensive but could be considered if eradicating a small outbreak in the EU. Insecticides (e.g. systemic, biopesticides) could be used in nurseries.	Establishment/Spread
Chemical treatments on consignments or during processing	Fumigation (EPPO, 2017)	Entry/Spread
Heat and cold treatments	Controlled temperature treatments aimed to kill or inactivate pests without causing any unacceptable prejudice to isolated bark could be applied.	Entry/Spread
Conditions of transport	Transported outside of *M. disstria* flight periods or not transported through areas infested with *M. disstria* or transported closed, to prevent infestation of harvested material (EPPO, 2017)	Entry/Spread
Post-entry quarantine and other restrictions of movement in the importing country	Could be used for dormant plants for planting potentially infested with egg masses although other measures would probably be more practical.	Entry/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 6.

Table 6: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	**Summary**	**Risk element targeted (entry/establishment/spread/impact)**
Inspection and trapping	Egg masses, larvae and pupae are visible and could be detected during visual inspections. Pheromone baited traps could be used at sites of production.	Entry/Spread
Laboratory testing	Required to confirm diagnosis and identification of the pest.	Entry/Spread

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	Summary	Risk element targeted (entry/establishment/ spread/impact)
Sampling	According to ISPM 31, it is usually not feasible to inspect entire consignments, so phytosanitary inspection is performed mainly on samples obtained from a consignment. It is noted that the sampling concepts presented in this standard may also apply to other phytosanitary procedures, notably selection of units for testing. For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology.	Entry/Spread
Phytosanitary certificate and plant passport	Required to attest that a consignment meets phytosanitary import requirements a) phytosanitary certificate (imports) b) plant passport (EU internal trade)	Entry/Spread
Delimitation of Buffer zones	ISPM 5 defines a buffer zone as 'an area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimize the probability of spread of the target pest into or out of the delimited area, and subject to phytosanitary or other control measures, if appropriate' (ISPM 5). The objectives for delimiting a buffer zone can be to prevent spread from the outbreak area and to maintain a pest free production place (PFPP), site (PFPS) or area (PFA).	Spread
Surveillance	Necessary to inform phytosanitary decision making	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- Egg masses may be difficult to detect on large trees.
- Adults can fly and disperse, up to a few hundred km when carried on weather fronts.
- Wide range of plant hosts (making the inspection very difficult).

3.7. Uncertainty

Uncertainties are mentioned previously (e.g. occurrence in Mexico (Section 3.2.1) and likelihood of introduction (Section 3.4)) but none are key such that they cast doubt over the conclusions.

4. Conclusions

M. disstria is a North American polyphagous pest, primarily affecting deciduous forestry although orchard and amenity trees and shrubs can also be hosts. *M. disstria* satisfies all of the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest (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	Key uncertainties (casting doubt on the conclusion)
Identity of the pest (Section 3.1)	The identity of the species is established and *Malacosoma disstria* Hübner is the accepted name and authority.	None
Absence/ presence of the pest in the EU (Section 3.2)	*M. disstria* is not known to be present in the EU.	None

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties (casting doubt on the conclusion)
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*M. disstria* could enter the EU via the import of host plants for planting that are not prohibited such as *Betula*, *Liquidambar*, and *Nyssa* (excluding seed) and on cut branches and isolated bark. Biotic factors (host availability) and abiotic factors (climate suitability) suggest that large parts of the EU would be suitable for establishment. Adults are good fliers, and the pest could spread naturally within the EU. Eggs on plants for planting could also facilitate spread.	None
Potential for consequences in the EU (Section 3.5)	The introduction of *M. disstria* into the EU could lead to serious outbreaks causing significant damage to forests, orchards and amenity trees and shrubs.	None
Available measures (Section 3.6)	Some hosts are already prohibited from entering the EU. Additional options are available to reduce the likelihood of pest entry and/ or spread.	None
Conclusion (Section 4)	*M. disstria* satisfies all the criteria assessed by EFSA for consideration as a potential Union quarantine pest.	None
Aspects of assessment to focus on / scenarios to address in future if appropriate:		

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Abbreviations

DG SANTÉ	Directorate General for Health and Food Safety
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
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

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)

Appendix A – *Malacosoma disstria* host plants/species affected

Source: EPPO Global Database (EPPO online) unless stated otherwise.

Major hosts	Plant family	Common name	Reference
Acer saccharum	Sapindaceae	Sugar maple	
Betula papyrifera	Betulaceae	Paper birch	
Liquidambar styraciflua	Altingiaceae	American sweet gum	
Nyssa aquatic	Cornaceae	Cotton gum/water tupelo	
Nyssa sylvatica	Cornaceae	Black tupelo/pepperidge	
Populus tremuloides	Salicaceae	American aspen	
Quercus macrocarpa	Fagaceae	Bur oak	
Quercus nigra	Fagaceae	Water oak	
Quercus phellos	Fagaceae	Willow oak	
Other hosts/species affected			
Abies	Pinaceae		
Abies balsamea	Pinaceae		Robinson et al. (2010)
Acer	Sapindaceae		
Acer negundo	Sapindaceae	Box elder	Robinson et al. (2010)
Acer spicatum	Sapindaceae	Mountain maple	Robinson et al. (2010)
Alnus	Betulaceae		
Alnus incana	Betulaceae		Robinson et al. (2010)
Alnus rubra	Betulaceae	Oregon/red alder	CABI (2020)
Amelanchier	Rosaceae		
Amelanchier alnifolia	Rosaceae		Robinson et al. (2010)
Arctostaphylos patula	Ericaceae		Robinson et al. (2010)
Betula	Betulaceae		
Betula alleghaniensis	Betulaceae		Robinson et al. (2010)
Carpinus caroliniana	Corylaceae		Robinson et al. (2010)
Carya	Juglandaceae		Robinson et al. (2010)
Citrus	Rutaceae		Meeker (2013)
Cornus	Cornaceae		
Cornus florida	Cornaceae	Flowering cornel	CABI (2020)
Corylus	Corylaceae		
Crataegus	Rosaceae		Robinson et al. (2010)
Cydonia oblonga	Rosaceae		Robinson et al. (2010)
Eriobotrya japonica	Rosaceae	loquat	Meeker (2013)
Fagus grandifolia	Fagaceae	American beech	CABI (2020)
Fraxinus	Oleaceae		
Fraxinus americana	Oleaceae	Cane/white ash	CABI (2020)
Fraxinus nigra	Oleaceae	Black ash	Robinson et al. (2010)
Fraxinus pennsylvanica	Oleaceae	Green/red ash	CABI (2020)
Hamamelis virginiana	Hamamelidaceae		Robinson et al. (2010)
Ilex	Aquifoliaceae		Robinson et al. (2010)
Juglans nigra	Juglandaceae	Black walnut	Robinson et al. (2010)
Juglans regia	Juglandaceae	Common walnut	Robinson et al. (2010)
Larix	Pinaceae		
Larix laricina	Pinaceae		Robinson et al. (2010)
Malus	Rosaceae		
Malus pumila	Rosaceae	Paradise apple	Robinson et al. (2010)
Nyssa	Cornaceae		
Ostrya	Betulaceae		

Major hosts	Plant family	Common name	Reference
Ostrya virginiana	Corylaceae		Robinson et al. (2010)
Picea	Pinaceae		
Picea glauca	Pinaceae	Canadian spruce	Robinson et al. (2010)
Picea sitchensis	Pinaceae		Robinson et al. (2010)
Pinus	Pinaceae		
Pinus banksiana	Pinaceae		Robinson et al. (2010)
Populus	Salicaceae		
Populus alba	Salicaceae	White poplar	Robinson et al. (2010)
Populus balsamifera	Salicaceae		Robinson et al. (2010)
Populus grandidentata	Salicaceae	Canadian aspen	CABI (2020)
Prunus	Rosaceae		
Prunus cerasus	Rosaceae	Sour cherry	Robinson et al. (2010)
Prunus demissa	Rosaceae	Western chokecherry	Robinson et al. (2010)
Prunus domestica	Rosaceae	European plum	Robinson et al. (2010)
Prunus pensylvanica	Rosaceae	Pin cherry	CABI (2020)
Prunus persica	Rosaceae	Peach	Robinson et al. (2010)
Prunus serotina	Rosaceae	Black/rum cherry	CABI (2020)
Prunus virginiana	Rosaceae		Robinson et al. (2010)
Pseudotsuga menziesii	Pinaceae	British Columbian pine	
Pyrus	Rosaceae		
Pyrus communis	Rosaceae	Common pear	Robinson et al. (2010)
Quercus	Fagaceae		
Quercus alba	Fagaceae	White oak	Robinson et al. (2010)
Quercus aquatica	Fagaceae		Robinson et al. (2010)
Quercus garryana	Fagaceae		Robinson et al. (2010)
Quercus laurifolia	Fagaceae	Swamp laurel oak	CABI (2020)
Quercus marilandica	Fagaceae		Robinson et al. (2010)
Quercus michauxii	Fagaceae	Swamp chestnut oak	CABI (2020)
Quercus palustris	Fagaceae	Pin oak	CABI (2020)
Quercus rubra	Fagaceae	American red oak	CABI (2020)
Quercus stellata	Fagaceae		Robinson et al. (2010)
Quercus velutina	Fagaceae		Robinson et al. (2010)
Quercus virginiana	Fagaceae	Southern live oak	CABI (2020)
Rhododendron	Ericaceae	Azalea	Meeker (2013)
Robinia pseudoacacia	Leguminosae		Robinson et al. (2010)
Rosa blanda	Rosaceae		Robinson et al. (2010)
Rosa carolina	Rosaceae		Robinson et al. (2010)
Rubus ideaus	Rosaceae	raspberry	Robinson et al. (2010)
Salix	Salicaceae		CABI (2020)
Salix exigua	Salicaceae		Robinson et al. (2010)
Sorbus	Rosaceae		Robinson et al. (2010)
Tilia americana	Malvaceae	American basswood	CABI (2020)
Ulmus	Ulmaceae		CABI (2020)
Ulmus americana	Ulmaceae	American elm	Robinson et al. (2010)
Vaccinium angustifolium	Ericaceae	Late sweet blueberry	Robinson et al. (2010)
Vaccinium pallidum	Ericaceae	Hillside blueberry	Robinson et al. (2010)

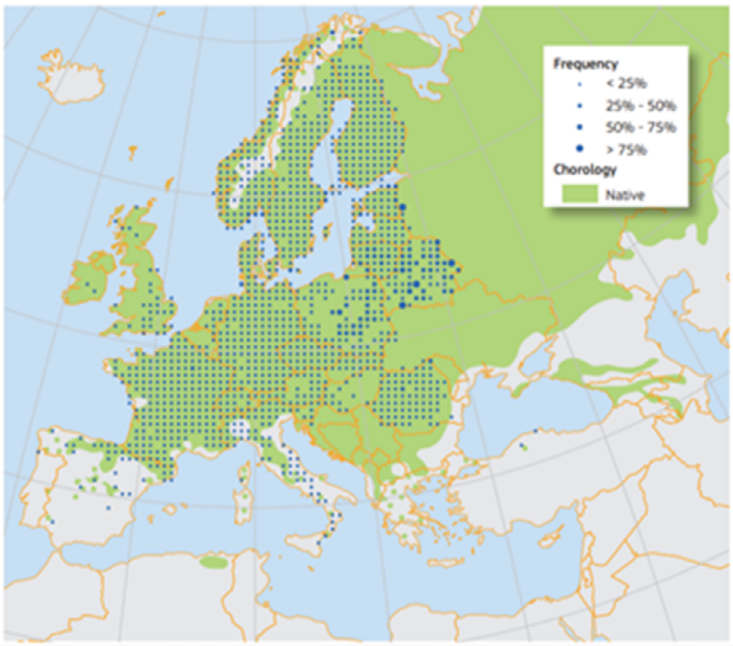
Appendix B – Distribution of *Malacosoma disstria*

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

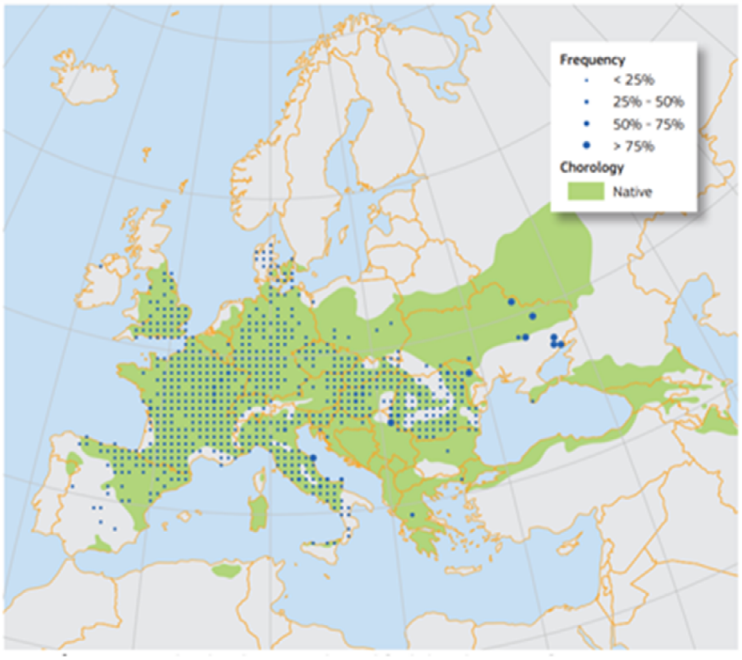
Region	Country	Sub-national (e.g. State)	Status
North America	Canada		Present, widespread
		Alberta	Present, restricted distribution
		British Columbia	Present, restricted distribution
		Manitoba	Present, restricted distribution
		New Brunswick	Present, restricted distribution
		Newfoundland	Present, no details
		Northwest Territories	Present, few occurrences
		Nova Scotia	Present, restricted distribution
		Ontario	Present, restricted distribution
		Prince Edward Island	Present, no details
		Québec	Present, restricted distribution
	USA		Present, widespread
		Alabama	Present, widespread
		Arizona	Present, restricted distribution
		Arkansas	Present, widespread
		California	Present, widespread
		Colorado	Present, restricted distribution
		Connecticut	Present, widespread
		Delaware	Present, widespread
		District of Columbia	Present, widespread
		Florida	Present, restricted distribution
		Georgia	Present, widespread
		Idaho	Present, widespread
		Illinois	Present, widespread
		Indiana	Present, widespread
		Iowa	Present, widespread
		Kansas	Present, restricted distribution
		Kentucky	Present, widespread
		Louisiana	Present, no details
		Maine	Present, widespread
		Maryland	Present, widespread
		Massachusetts	Present, widespread
		Michigan	Present, widespread
		Minnesota	Present, widespread
		Mississippi	Present, widespread
		Missouri	Present, widespread
		Montana	Present, restricted distribution
		Nebraska	Present, restricted distribution
		Nevada	Present, widespread
		New Hampshire	Present, widespread
		New Jersey	Present, widespread
		New Mexico	Present, restricted distribution
		New York	Present, widespread
		North Carolina	Present, widespread
		North Dakota	Present, restricted distribution
		Ohio	Present, widespread
		Oklahoma	Present, restricted distribution

Region	Country	Sub-national (e.g. State)	Status
		Oregon	Present, restricted distribution
		Pennsylvania	Present, widespread
		Rhode Island	Present, widespread
		South Carolina	Present, widespread
		South Dakota	Present, restricted distribution
		Tennessee	Present, widespread
		Texas	Present, widespread
		Utah	Present, widespread
		Vermont	Present, widespread
		Virginia	Present, widespread
		Washington	Present, widespread
		West Virginia	Present, widespread
		Wisconsin	Present, widespread
		Wyoming	Present, widespread
EU (27)		Netherlands	Absent, confirmed by survey

Appendix C – The distribution of European species related to some of the major host of *Malacosoma disstria* in North America



Plot distribution and simplified chorology map for *Populus tremula*. Frequency of *Populus tremula* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *P. tremula* is derived from several sources (Caudullo and de Rigo, 2016)



Plot distribution and simplified chorology map for *Acer campestre*. Frequency of *Acer campestre* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *A. campestre* is derived from several sources (Zecchin et al., 2016)