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Pest categorisation of *Coleosporium eupatorii*

EFSA Panel on Plant Health (PLH),
Claude Bragard, Paula Baptista, Elisavet Chatzivassiliou, Francesco Di Serio, Paolo Gonthier,
Josep Anton Jaques Miret, Annemarie Fejer Justesen, Alan MacLeod,
Christer Sven Magnusson, Panagiotis Milonas, Juan A Navas-Cortes, Stephen Parnell,
Roel Potting, Emilio Stefani, Hans-Hermann Thulke, Wopke Van der Werf,
Antonio Vicent Civera, Jonathan Yuen, Lucia Zappalà, Quirico Migheli, Irene Vloutoglou,
Andrea Maiorano, Marco Pautasso and Philippe Lucien Reignault

Abstract

The EFSA Plant Health Panel performed a pest categorisation of *Coleosporium eupatorii* Arthur ex Cummins, a clearly defined heteroecious fungus of the family Coleosporiaceae, causing rust diseases on five-needle *Pinus* spp. (aecial hosts) and on several genera of the Asteraceae family (telial hosts), such as *Eupatorium* spp. and *Stevia* spp. *C. eupatorii* is reported from Asia as well as North, Central and South America. It is not known to occur in the EU. The pathogen is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072 and has not been intercepted in the EU. The pathogen can be detected on its host plants by DNA sequencing. The main pathway for the entry of *C. eupatorii* into the EU is host plants for planting, other than seeds. In the EU, there is availability of aecial host plants, with *Pinus peuce*, *P. strobus* and *P. cembra* being the most important ones. There is a key uncertainty about whether European *Eupatorium* species (specifically *E. cannabinum*) are hosts of *C. eupatorii* and thus the ability of the pathogen to complete its life cycle, establish and spread in the EU. *C. eupatorii* could potentially spread within the EU by both natural and human-assisted means. The introduction of *C. eupatorii* into the EU is expected to have an economic and environmental impact. Phytosanitary measures are available to prevent the introduction and spread of the pathogen in the EU. *C. eupatorii* satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as potential Union quarantine pest.

Keywords: forest pathology, pest risk, pine rust, plant health, plant pest, quarantine, eupatorium rust

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Correspondence: plants@efsa.europa.eu

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

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1. Introduction

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

1.1.1. Background

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

Coleosporium eupatorii is one of a number of pests listed in Annex 1C 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 (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

This pest categorisation was initiated following the commodity risk assessment of bonsai plants (*Pinus parviflora* grafted on *Pinus thunbergii*) from China performed by EFSA (EFSA PLH Panel, 2022), in which *C. eupatorii* was identified as a relevant non-regulated EU pest, which could potentially enter the EU on bonsai plants.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *C. eupatorii* 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 *C. eupatorii* 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 *C. eupatorii*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 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 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 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 *C. eupatorii* is well established and the pathogen has been shown to produce consistent rust symptoms and to be transmissible.

C. eupatorii Arthur ex Cummins is a plant pathogenic fungus of the order Pucciniales and the family Coleosporiaceae, described for the first time in 1906 by Arthur (1906). Arthur, however, had only described the uredinia of the fungus. Cummins (1956) provided a description of the telia, and specified a new type specimen. The EPPO Global Database (EPPO, online) provides the following taxonomic identification for *C. eupatorii*:

Scientific name: *Coleosporium eupatorii* Arthur ex Cummins
Order: Pucciniales
Family: Coleosporiaceae
Genus: *Coleosporium*
Species: *Coleosporium eupatorii*

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

3.1.2. Biology of the pest

There is no specific information about *C. eupatorii* biology. Therefore, most of the information provided on *C. eupatorii* biology was based on other species of the genus *Coleosporium*, particularly on *C. asterum, C. montanum, C. solidaginis* and *C. phellodendri*, since they share common characteristics. Most *Coleosporium* species have heteromacrocyclic life cycles, with five spore stages, namely pycniospores (also called spermogonia or spermatia), aeciospores, urediniospores, teliospores and basidiospores (Cummins and Hiratsuka, 2003). Along with various spore types, most *Coleosporium* spp. require alternation between two specific and unrelated host plant taxa to complete their life cycle (heteroecious rust) (Beenken et al., 2017). The pycnidial and the aecial stages develop on aecial hosts, with *Pinus* being the only known aecial host genus (primary host). The uredinial, telial and basidial stages develop on telial hosts, that include various woody and herbaceous angiosperms that often grow beneath *Pinus* spp. (Kaneko, 1981; Suzuki et al., 2018). These telial hosts are usually different for every *Coleosporium* species and are considered as alternate hosts (Suzuki et al., 2018).

As with other rust fungi, *C. eupatorii* spores are disseminated by wind and by water-splash (Saho, 1963; Zinno et al., 1965). Aeciospores are reported to travel shorter distances than urediniospores, with the latter being able to cause infection at a distance of 100–500 m from the primary source (Zinno et al., 1965). On the final stages of the disease cycle (i.e. late summer), *C. eupatorii* infection was found even at a distance of 1,000 m and its frequency was higher in downwind than in upwind areas (Zinno et al., 1965). Even longer distances are possible, as rust fungal spores can travel long distances in air currents (Kakishima et al., 2017; Casamayor et al., 2023; Hovmøller et al., 2023). Larvae of some *Mycodiplosis* species (Insecta, Diptera) are known to feed on spores of rust fungi, thus it is possible that adult flies may also disperse spores of *C. eupatorii* as suggested previously for other *Coleosporium* species (Henk et al., 2011). However, despite their apparent ubiquity on rusts (Henk et al., 2011), the real role of *Mycodiplosis* adult flies in spore dispersal has not been so far demonstrated.

The most important features of the disease cycle of *Coleosporium* species, including *C. eupatorii*, are depicted in Table 2.

Table 2: Important features of the life cycle of *Coleosporium* spp.

Disease cycle	Infection process and relation to host	Other relevant information
Overwintering phase of the pathogen	The pathogen overwinters within the pine needles (aecial host).	Symptoms on pines are not detectable during this period (from late summer to early spring).
Production of aeciospores	In the early spring, infected needles exhibit yellow spots and develop initially pycnia on the upper side, followed by white aecia on the underside. Aeciospores are released from aecia and infect the telial host during the summer.	Aeciospores are spread by wind or by water-splash.
Infection of telial host plant(s)	The aeciospores germinate on the leaves and stems of the telial host, leading to infection and the appearance of orange pustules (uredinia) beneath the epidermis of the host plant.	Infection may occur within 24 h, at optimal temperature of 20°C and high humidity (Sinclair et al., 1989). The time between infection and the appearance of uredinia varies with the telial host and local climatic conditions, being in general 10–15 days for the *Coleosporium* genus (Sinclair and Lyon, 2005).

[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 and Roy, 2015; EPPO, 2019).

Disease cycle	Infection process and relation to host	Other relevant information
Secondary inoculum (urediniospores)	Urediniospores produced in uredinia cause multiple infection cycles on the telial host (up to 15 disease cycles for most *Coleosporium* species) during the summer season (Chapell and Rausher, 2016). Urediniospores germinate in moisture on plant surfaces prior to infection.	Urediniospores are spread by wind or by water-splash. Urediniospores of the same *Coleosporium* species infect different host genera in the same family (Farr and Rossman, 2023), and probably from different families (Beenken et al., 2017). Some *Coleosporium* species (e.g. *C. solidaginis*) may overwinter in the uredial stage on the perennial telial host (Baranyay et al., 1979).
Primary inoculum (basidiospores)	In the late summer/early autumn, telia develop in the place of uredinia, producing teliospores. Upon germination, the teliospore produces a basidium, which in turn produces basidiospores.	It is generically recognised that teliospores can overwinter in host plant tissues, under favourable climatic conditions (i.e. humid and not frosty; Jones, 2005). Basidiospores are spread by wind and are generally unable to survive extreme temperatures or drought, even for a short period (Lowe, 1972).
Infection of aecial host plant(s)	Upon landing on susceptible pine (aecial host), the basidiospores germinate and develop germ tubes infecting current-year needles, where this pathogen overwinters (Suzuki et al., 2018), completing the life cycle. Infection of pine hosts would most occur if they are growing in close proximity to diseased telial hosts (Mihail et al., 2002).	The basidiospores of some *Coleosporium* species (e.g. *C. phellodendri*) can germinate at temperatures ranging from 5 to 25°C, with an optimum of 15–25°C (Hama, 1972; Wei et al., 2013). A few species of *Coleosporium* (e.g. *C. asterum*) can survive for more than 1 year as mycelium in the living tissue of the pine host, where they may produce aecia for 2–3 subsequent summers (Lowe, 1972).

3.1.3. Host range/species affected

As the majority of Pucciniales, *C. eupatorii* requires two specific and unrelated plant hosts in order to complete its life cycle: the aecial host and the telial host (see Section 3.1.2 - Biology of the pest). There is limited information on *C. eupatorii* hosts. The reported aecial hosts include eight species of five-needle pines (*Pinus* genus, Pinaceae family). Among these, *P. koraiensis*, *P. strobus* and *P. parviflora* were the most frequently reported in the literature (Zinno and Endo, 1964; Hiratsuka et al., 1992; Farr and Rossman, 2023). The telial hosts include up to 20 species belonging to five genera in the family Asteraceae. Both *Eupatorium* and *Stevia* are the most species-rich genera reported as hosts of *C. eupatorii*. There is a key uncertainty about whether European *Eupatorium* species (specifically *E. cannabinum*) are hosts of *C. eupatorii*. It is also uncertain whether *Stevia* species grown in the EU are hosts.

In comparison to other *Coleosporium* species, the host plant range of *C. eupatorii* is less known. The type specimen specified by Arthur (1906) is on *Eupatorium macrophyllum* L., whereas the one specified by Cummins (1956) was on *Eupatorium lindleyanum* DC. Moreover, there is growing evidence that host jumps (a process by which pathogens settle in new related or unrelated taxonomically host plants; Thines, 2019) and not coevolution *per se*, have contributed to the host range of rust fungi (Pucciniales), including of *Coleosporium* spp., more than it has been generally accepted (McTaggart et al., 2016). There is thus a high uncertainty on the host range of *C. eupatorii*.

The complete list of the host plants reported so far for *C. eupatorii* is included in Appendix A (last updated: 12 March 2023).

3.1.4. Intraspecific diversity

No intraspecific diversity has been reported so far in *C. eupatorii*. Nevertheless, the ability of the pathogen to differentiate sexual reproductive stages may enhance its genomic plasticity and adaptation to various adverse environmental conditions, including fungicide exposure.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, there are methods available for the detection and identification of *C. eupatorii*.

The information provided in the literature concerning detection and identification of *C. eupatorii* is very scarce when compared to other rust fungi of the genus *Coleosporium*.

Symptomatology

There is no specific information about symptoms caused by *C. eupatorii*.

The symptoms on *Pinus* spp. (aecial host) caused by *Coleosporium* spp. include leaf spotting, chlorosis on leaves and defoliation. The first symptoms appear during the following spring (after the incubation period) and only on the youngest needles, as yellow-to-orange spots. From late spring to early summer, fruiting bodies, called pycnia or pycnidia, develop beneath these spots, followed by white, 'tongue-like' fruiting bodies (aecia), that discharge orange spores (aeciospores) (Lowe, 1972). The aecia disappear by the end of the summer, leaving tiny scars on yellow-brown spots/bands on partly yellowed infected needles (Lowe, 1972). Both discolouration and needle cast are also reported in severe *Coleosporium* infections, the lower branches of young *Pinus* trees being in general the most affected (Baxter, 1931; Sansford, 2015).

The main symptoms caused by *Coleosporium* rust fungi on the telial host are orange-yellow uredinia on the lower side of the leaves and on the stems all summer long. In late summer/early autumn, reddish brown and crusty telia are formed on the lower side of the leaves (Back et al., 2014). No symptoms have been reported on flowers. Severe infections may result in leaf distortion, drying and premature fall (Zakharova, 1958; Back et al., 2014).

Thus, it is difficult to distinguish *C. eupatorii* from other *Coleosporium* rust fungi occurring on the same host species based only on visual inspection of symptoms.

Morphology

The description of the morphological characteristics of *C. eupatorii* in the literature is very scarce.

The morphological characteristics of uredinia and urediniospores of *C. eupatorii* were described for the first time by Arthur (1906) as follows: '*Uredinia chiefly hypophyllous, scattered, round, small, 0.25 mm across, early naked, pulverulent, yellow fading to white, ruptured epidermis somewhat noticeable; Urediniospores short ellipsoid, or globoid, 15–20 by 22–27 μm; wall colorless, medium thick, 2–2.5 μm, half formed by the rather large, irregular, deciduous tubercles*'.

The description of the morphological characteristics of telia and teliospores of *C. eupatorii* is provided by Cummins (1956), in Latin: '*Teliis hypophyllis, aggregatis, 0.35–0.5 mm diam., pulvinatis, ceraceis, ochraceo-brunneis; teliosporis cylindraceis vel plus-minusve clavatis, 11–18 × 54–74 μm, membrane hyalina, ca 1 μm cr., ad apicem 6–14 μm*'.

Some morphological characteristics of pycnial and aecial stages of *C. eupatorii* are provided in Lee et al. (2008): Spermagonia are 0.6–0.8 mm in length while aecia are 0.5–2 mm in width; Peridial cells ellipsoid or ovoid, 35–62 × 25–32 μm, outer and inner walls closely verrucose; Aeciospores ellipsoid, 18–26 × 12–22 μm, with verrucose surface (35–40 verrucae/100 μm^2 and each verrucae with size of 0.5–2 × 0.5–2 μm).

However, as pointed out by Beenken et al. (2017), *Coleosporium* species are difficult to identify when based only on morphology, because closely related species exhibit similar microscopic morphological characteristics. For example, the urediniospores of different *Coleosporium* species often have similar morphological features (Kaneko, 1981). Because of the poor knowledge about *C. eupatorii*, there is uncertainty about whether the morphological features described above actually refer to the same taxon.

DNA-based identification

The molecular techniques available for the identification of *Coleosporium* species are mostly based on the sequencing of different regions of the ribosomal DNA (rDNA). These include, the D1/D2 domains of the large subunit of the 28S rRNA gene and the internal transcribed spacer (ITS) region, in particular the ITS2 region. Phylogenetic studies of rust fungi targeting the D1/D2 domains of the 28S rRNA gene, showed that this region provides variability within and between genera, supporting *Coleosporium* as monophyletic (Maier et al., 2003). Nevertheless, McTaggart and Aime et al. (2018), in their phylogenetic studies of *Coleosporium* infecting species of Asteraceae emphasise the use of ITS2 region to separate closely related species that were not distinguished by the 28S region. The same authors suggested that, in taxonomically challenging groups such as *Coleosporium*, a secondary locus would be required when accurate identification and confirmation through morphology or host range is not feasible.

In GenBank (accessed on 13 March 2023), only five accessions referred to *C. eupatorii* are currently available, including partial sequences of the 18S (accession MG907199), 28S rRNA (accession MG907208, MF769673 and MF769674) and cytochrome c oxidase subunit 3 (COIII) gene (accession MG907256) regions (Aime et al., 2018; McTaggart and Aime, 2018). Some of these specimens are available on the Arthur Fungarium (PUR), at Purdue University, with the collection n° PUR N6728 and PUR N6727 (McTaggart and Aime, 2018). *C. eupatorii* specific primers are not available to amplify the pathogen directly from diseased host plant tissue or from fungal tissue.

No EPPO Standard is available for the detection and identification of *C. eupatorii*.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

C. eupatorii has been reported to be present in Asia (China, Japan, Korea, Russia and Taiwan), North America (Mexico and USA), Central America (Belize, Costa Rica, Guatemala and Nicaragua), including the Caribbean (Cuba, Dominican Republic, Puerto Rico and Virgin Islands) and South America (Colombia and Venezuela). A complete list of the countries and states/provinces from where *C. eupatorii* has been reported is included in Appendix B. These records are based on CABI Invasive Species Compendium (accessed on 23 February 2023), Farr and Rossman (2023) (Fungal Databases, U.S. National Fungus Collections, ARS, USDA) and other sources as indicated in Appendix B. The current geographical distribution of *C. eupatorii* is shown in Figure 1.

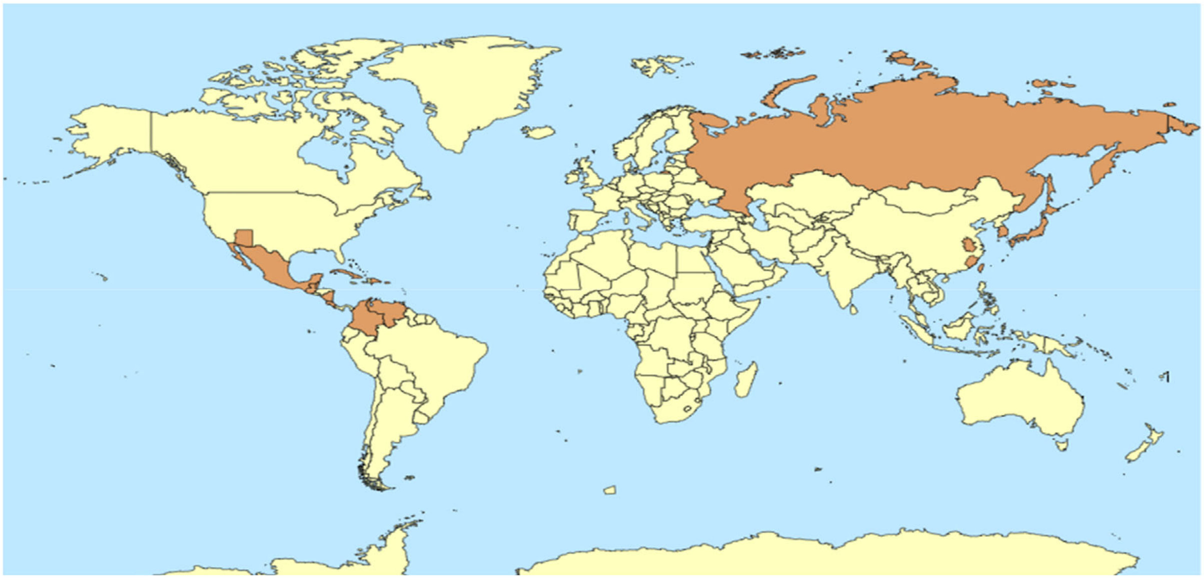

Figure 1: Global distribution of *Coleosporium eupatorii* (Source: Farr, D.F., & Rossman, A.Y. Fungal Databases, U.S. National Fungus Collections, ARS, USDA. accessed on 23 February 2023)

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, *C. eupatorii* is not known to occur in the EU territory.

3.3. Regulatory status

C. eupatorii is not regulated in the EU.

3.3.1. Commission Implementing Regulation 2019/2072

C eupatorii is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031, or in any emergency plant health legislation. The pathogen is mentioned in commodity risk assessments for bonsai *Pinus* spp. imported from China (EFSA PLH Panel, 2022).

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

A list of hosts included in Annex VI of Commission Implementing Regulation (EU) 2019/2072 is provided in Table 3. According to this Regulation, the introduction of *Pinus* plants into the Union is prohibited from third countries (see Table 3).

Table 3: List of plants, plant products and other objects that are *Coleosporium eupatorii* 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 [. . .] *Pinus* L., [. . .] 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, Türkiye, Ukraine and the United Kingdom

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, the pest is able to enter the EU territory via the host plants for planting, other than seeds, and parts of host plants (e.g. cut flowers, foliage, branches), other than fruits.

Comment on plants for planting as a pathway.

Host plants for planting, other than seeds, is a main pathway for the entry of the pathogen into the EU.

The Panel identified the following main pathways for the entry of *C. eupatorii* into the EU territory:

1) Plants for planting of Asteraceae, other than seeds.
2) Plants for planting of *Pinus* spp., other than seeds.

The needles of the host pines as well as the leaves/stems of Asteraceae host plants can be infected both symptomatically and asymptomatically (see Section 3.1.2 – Biology of the pest). Therefore, plants of *Pinus*/Asteraceae host species, including plant parts, other than seeds, are possible pathways for the entry of *C. eupatorii* into the EU territory.

C. eupatorii could potentially enter into the EU territory on cut flowers of Asteraceae host plants with latent infections (see Section 3.1.2 – Biology of the pest). However, this is considered a minor pathway for the entry of the pathogen into the EU, since *C. eupatorii* is not reported in the main exporting countries of cut flowers to EU (e.g. Africa continent). However, Colombia is a major exporter of cut flowers too.

Primary method of propagation of *Pinus* species is via seed. Seed transmission has never been reported for *Coleosporium* spp. Therefore, entry of *C. eupatorii* through this pathway is unlikely.

The maximum dispersal distance of *C. eupatorii* infection is reported as 1,000 m (see Section 3.1.2 – Biology of the pest). Thus, it is unlikely for the pathogen to enter the EU by natural means (wind, water-splash, insects, etc.) because of the long distance between the infested third countries and the EU Member States. However, some infested third countries (e.g. Russia) are neighbouring EU Member States, therefore this possibility cannot be excluded.

Although there is no information available, *C. eupatorii* spores may also be present as contaminants on other substrates or objects (e.g. non-host plants, second-hand agricultural machinery and equipment, crates, etc.) imported into the EU. Soil and water are not known to be pathways of entry for *C. eupatorii*, but soil and growing media containing infected plant debris could represent a pathway of entry. Nevertheless, these are considered minor pathways for the entry of the pathogen into the EU territory.

An overview on potential pathways is provided in Table 4.

Table 4: Potential pathways for *C. eupatorii* into the EU

Pathways (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 other than seeds	Mycelium, basidiospores, aeciospores, urediniospores, teliospores	Annex VI (1) bans the introduction of plants for planting of *Pinus* L. other than fruit and seed from certain third countries (including countries where the pest occurs: China, Republic of Korea, Japan and the Siberian Federal district of Russia). There is a derogation for artificially dwarfed pines from Japan (Regulation 2020/1217); Annex VII (10 & 11) requires official statement of special requirements for the introduction into the Union from certain third countries of trees and shrubs, intended for planting, other than seeds and plants in tissue culture (Table 4). These requirements are not specifically targeted against *C. eupatorii*.
Parts of host plants (e.g. foliage, branches) other than fruits	Mycelium, basidiospores, aeciospores, urediniospores, teliospores	Annex XI (A.3) requires a phytosanitary certificate for foliage, branches and other parts of conifer (Pinales) plants, without flowers or flower buds, being goods of a kind suitable for bouquets or for ornamental purposes, fresh, from third countries other than Switzerland.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As of 29 March 2023, there were no records of interception of *C. eupatorii* in the Europhyt and TRACES databases. However, since *C. eupatorii* is not a quarantine pest, the EU Member States have no formal obligation to notify interceptions of the pathogen.

Table 5 and Appendix D provide the annual imports of main hosts from countries where *C. eupatorii* is present.

Table 5: EU annual imports of commodities of main hosts from countries where *Coleosporium eupatorii* is present, 2016–2020 (in 100 kg). Source: Eurostat, accessed on 21 March 2023

Potential commodity pathway	HS code	2016	2017	2018	2019	2020
Live forest trees	0602 90 41	133.06	135.68	0.45	0.05	0.63
Fresh conifer branches, suitable for bouquets or ornamental purposes	0604 20 40	0	0	21.65	87.01	0.23
Fresh cut flowers and buds, of a kind suitable for bouquets or for ornamental purposes*	0603 19 70	23,751.00	30,930.80	39,727.23	38,243.95	38,349.75

*: (Excl. roses, carnations, orchids, gladioli, ranunculi, chrysanthemums and lilies).

3.4.2. Establishment

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

Yes, *C. eupatorii* could potentially become established in the EU territory. There is a key uncertainty about the host status of *Eupatorium cannabinum* (other *Eupatorium* species are reported as hosts, but no information is available about the host status of *E. cannabinum*).

C eupatorii is very likely to establish in the EU territory both outdoors and under protected plant growth conditions (e.g. greenhouses). All EU areas where host plants in the Asteraceae and Pinaceae families are growing in very close proximity and where the climatic conditions are similar to those of *C. eupatorii* native range, would be the most suitable areas for its establishment.

C. eupatorii could potentially be transferred from the pathways of entry (host plants for planting and host plant parts) to the host plants (*Pinus* spp. and wild or ornamental Asteraceae) grown in the EU, via airborne spores (basidiospores or urediniospores). The frequency of this transfer will depend on the volume and frequency of the imported commodities, their destination (*e.g*. nurseries, retailers), the distance between the aecial or telial hosts growing in the EU, as well as on the management of plant residues.

The availability of the main plant hosts of *C. eupatorii* in the EU is considered in Section 3.4.2.1, while climatic factors suitable for its establishment in the EU are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

The area of the EU where the establishment of *C. eupatorii* would be possible is determined by the co-occurrence of host plants of the genera *Pinus* (aecial host) and of Asteraceae species, such as *Eupatorium* and *Stevia* (telial hosts). Some of the *Pinus* hosts of *C. eupatorii* listed in Appendix A are widely distributed in the EU territory, in forests and in parks or large gardens. For example, *Pinus strobus* is currently widely distributed in Central Europe since its introduction in the 19th century (Mandák et al., 2013), while *Pinus peuce* is a highly valuable timber tree native to the Balkan peninsula (Alexandrov and Andonovski, 2011). Finally, *Pinus cembra* is another common host species in the mountain regions of Central Europe and planted in parks and arboreta, especially in northern EU MSs (Caudullo and de Rigo, 2016). An overview on the probability of presence of the genus *Pinus* in Europe is provided in Figure 2.

There is uncertainty on the actual presence and distribution of *Eupatorium* spp. hosts as well as of other telial hosts in the EU and their proximity to *Pinus* species. *E. cannabinum* is a common native species in Europe and it is widely distributed in the EU (GBIF, 2022). Some other *Eupatorium* species are cultivated as ornamentals in Europe (Galloway, 2000). However, there is no information on their susceptibility to *C. eupatorii*. This is a key uncertainty for the ability of *C. eupatorii* to complete its life cycle following entry.

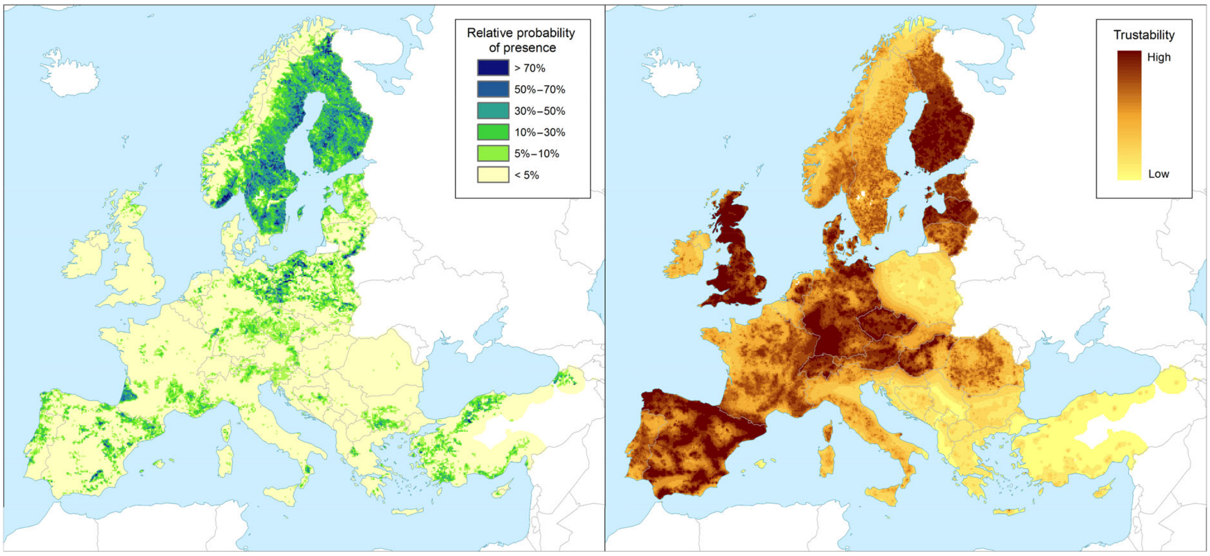

Figure 2: Left panel: Relative probability of presence (RPP) of the genus *Pinus* in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring datasets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix C (courtesy of JRC). Right panel: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in forestry inventories. The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details see Appendix C.)

3.4.2.2. Climatic conditions affecting establishment

Based on the few data available, the Köppen–Geiger climatic zones (Cfa, Cfb, Dfb and Dfc) where *C. eupatorii* has been reported, also occur in the EU territory, where susceptible *Pinus* hosts are also grown (Figure 3). Southern regions in southern EU countries where *Pinus* species are also present according to Figure 2 (e.g. most of the Iberian Peninsula) appear unsuitable to establishment due to climatic conditions, but most central, northern and eastern Europe is suitable.

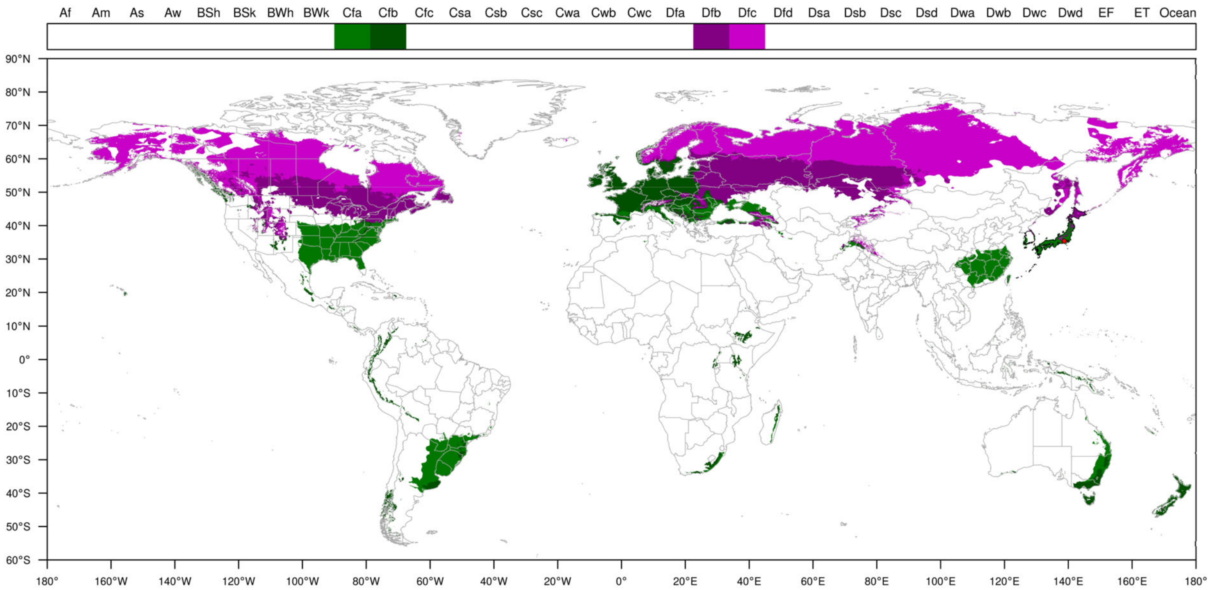

Figure 3: Distribution of Köppen–Geiger climate types temperate (Cfa and Cfb,) and continental (Dfb and Dfc) that occur in the EU and in third countries where *Coleosporium eupatorii* has been reported. The legend shows the list of Köppen–Geiger climates

3.4.3. Spread

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

C eupatorii could potentially spread within the EU by both natural and human-assisted means.

Comment on plants for planting as a mechanism of spread.

Host plants for planting is a main means of spread of the pathogen in the EU territory.

C. eupatorii could potentially spread via natural and human-assisted means.

Spread by natural means. Aeciospores produced on susceptible *Pinus* spp. as well as urediniospores produced on Asteraceae hosts during the summer may spread by wind, up to 500 m from the primary source, or by water-splash (Zinno et al., 1965). In late summer/early autumn, basidiospores are produced on the Asteraceae hosts and may infect pine needles, thereby completing the life cycle. At this stage, the distance of *C. eupatorii* infection spread was reported to be up to 1,000 m (Zinno et al., 1965). Even longer distances are possible, as rust fungal spores can travel long distances in air currents (see Section 3.1.2).

Insects may also have the potential to act as carriers of propagules of *C. eupatorii*. Although it has not been documented specifically in the case of *C. eupatorii*, *Mycodiplosis* spp. adult flies (Insecta, Diptera) have the potential to disperse spores of rust fungi (Henk et al., 2011) (see Section 3.1.2).

Spread by human-assisted means. The pathogen could potentially spread over long distances via the movement of infected host plants for planting (*Pinus* spp., Asteraceae hosts), other than seeds, and host plant parts (e.g. cut flowers, foliage, branches), other than fruits. The spread via the seeds of its host plants has not been documented.

3.5. Impacts

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

Yes, the introduction of *C. eupatorii* into the EU is expected to have an economic and environmental impact.

Nevertheless, the magnitude of the impacts is uncertain, given the lack of reports from the countries where the pest is present and the uncertainty about the host status of *Eupatorium* species present in the EU.

There is little information on the impact of *C. eupatorii* in the area of its current distribution. In Japan, the rust caused by *C. eupatorii* was reported to be a serious disease in young pine plantations (Saho, 1962a). On unspecified five-needle pine species, a growth reduction of 30–40% was reported in *C. eupatorii*-diseased trees when compared to healthy trees, in the forest of Tokyo University (Saho, 1962a). Similarly, in Japan, *C. eupatorii* heavily damaged heavily *P. strobus* trees, by affecting more than 30% of their needles (Saho, 1962b). The growth of these trees stopped earlier than those damaged slightly, and the water content of the diseased needles decreased gradually until they died (Saho, 1962b). Further reports of impacts due to *C. eupatorii* include a severely affected plantation of *Pinus koraiensis* and serious damage of a young *Pinus monticola* experimental forest, both in Hokkaido (Kaneko, 1981).

Despite the scarcity of data, young *Pinus* trees seem to be the most severely affected by *C. eupatorii,* resulting in growth reduction. Therefore, *C. eupatorii* is likely to have more of an impact on nursery pine trees (e.g. for afforestation and ornamental trees) than on mature pine forests, if eradication measures against susceptible telial hosts (Asteraceae) are not taken. Also, young pine trees in native forests are prone to infection and therefore regeneration processes may be impacted (Sansford, 2015).

Nevertheless, the co-existence of both *Pinus* spp. and telial host plants is needed for *C. eupatorii* to complete its life cycle. Due to the lack of information on the host status of *Eupatorium* spp. present in the EU, the magnitude of the impacts of *C. eupatorii* is highly uncertain.

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. Although not always specifically targeted against *C. eupatorii*, existing phytosanitary measures (see Sections 3.3.2 and 3.4.1) mitigate the likelihood of the pathogen's further entry on certain host plants and plant products into the EU territory. Potential additional measures are also available to further mitigate the risk of further entry, establishment and spread of the pathogen in the EU (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (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 control measures are listed in Table 6.

Table 6: 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	Plants, plant products and other objects come from a pest-free country or a pest-free area or a pest-free place of production.	Entry/Spread
Growing plants in isolation	Aecial (*Pinus* spp.) and telial (Asteraceae) susceptible host plant species should not be present/grown in the same area to avoid the completion of the life cycle of *C. eupatorii*.	Entry/Establishment/Spread
Managed growing conditions	Plants collected directly from natural habitats, have been grown for at least two consecutive years prior to dispatch in officially registered nurseries, which are subject to an officially supervised control regime.	Entry/Spread/Impact
Use of resistant and tolerant plant species/varieties	Resistant *Pinus* spp. plants towards *C. eupatorii* may be a sustainable tool to restrict the growth and development of the pathogen and/or its damage.	Entry/Establishment/Impact
Roguing and pruning	Removal of new symptomatic shoots on *Pinus* spp. through pruning may represent an effective means to reduce *C. eupatorii* inoculum sources.	Spread/Impact
Chemical treatments on crops including reproductive material	Although not specifically tested against *C. eupatorii*, several fungicides (mostly systemic) were reported to be effective against rust fungi on both *Pinus* spp. and telial host plants (EFSA PLH Panel, 2019).	Entry/Establishment/Spread/Impact
Chemical treatments on consignments or during processing	The application of fungicides to plants or plant products after harvest, during process or packaging operations and storage may contribute to mitigate the likelihood of entry or spread of *C. eupatorii*.	Entry/Spread

Control measure/Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Limits on soil	Although *Coleosporium* spp. entry with soil/ growing media is unlikely, there is a possibility of contamination of soil and growing media by infected plant debris. Thus, limits on soil can be an efficient measure to reduce *C. eupatorii* inoculum.	Entry/Spread
Waste management	Young *Pinus* trees are the most severely affected by *C. eupatorii*. Therefore, proper management of plant residues (e.g. incineration) in nurseries and greenhouses is recommended as an efficient measure to reduce the risk of pathogen dispersal.	Establishment/Spread
Post-entry quarantine and other restrictions of movement in the importing country	Some species of *Coleosporium* can survive for more than 1 year as mycelium in host pine tissues (Lowe, 1972). Therefore, imported plants for planting can be subject to post-entry quarantine to ensure they are free from *C. eupatorii*.	Establishment/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

Table 7: 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	The pathogen may remain latent within the host tissues (asymptomatic). Moreover, visual signs and symptoms caused by *C. eupatorii* are poorly described. Therefore, it is unlikely that *C. eupatorii* could be detected based on visual inspection only.	Entry/Establishment/Spread
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests. Multilocus gene sequencing analysis combined with macroscopic examination of the fungal signs and symptoms as well as microscopic analysis for characteristic fungal structures (fruiting bodies and spores) is required for the reliable detection and identification of *C. eupatorii* (see Section 3.1.5).	Entry/Spread
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.	Entry/Spread

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	Summary	Risk element targeted (entry/establishment/ spread/impact)
	For inspection, testing and/or surveillance purposes the sample may be taken according to a statistically based or a non-statistical sampling methodology. Necessary as part of other risk reduction options.	
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade) Recommended for host plants, including plant parts (e.g. cut flowers, foliage and branches).	Entry/Spread
Certified and approved premises	Mandatory/voluntary certification/approval of premises is a process including a set of procedures and of actions implemented by producers, conditioners and traders contributing to ensure the phytosanitary compliance of consignments. It can be a part of a larger system maintained by the NPPO in order to guarantee the fulfilment of plant health requirements of plants and plant products intended for trade. Key property of certified or approved premises is the traceability of activities and tasks (and their components) inherent the pursued phytosanitary objective. Traceability aims to provide access to all trustful pieces of information that may help to prove the compliance of consignments with phytosanitary requirements of importing countries. If plant material originates from an approved premise, e.g. from a pest-free area, the likelihood of the commodity being infected is assumed to be reduced.	Entry/Spread
Certification of reproductive material (voluntary/official)	Plants come from within an approved propagation scheme and are certified pest-free (level of infestation) following testing; used to mitigate against pests that are included in a certification scheme. The risk of entry and/or spread of *C. eupatorii* is reduced if host plants for planting are produced under an approved certification scheme and tested free of the pathogen.	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 minimise 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). Delimitation of a buffer zone around an outbreak area is an effective measure to prevent further spread of the pathogen and to maintain a pest free production place (PFPP), site (PFPS) or area (PFA).	Spread

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	**Summary**	**Risk element targeted (entry/establishment/spread/impact)**
	For the delimitation of the buffer zone, the distance between the aecial and telial hosts should be also taken into consideration. *C. eupatorii* infection is reported to spread over distances up to 1,000 m (Zinno et al., 1965).	
Surveillance	Surveillance to guarantee that plants and produce originate from a pest free area could be an option. Surveillance is an effective measure to define pest-free areas or pest-free places of production as well as to prevent further spread of the pathogen	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- Although not specifically reported for *C. eupatorii,* some *Coleosporium* species have a long incubation period (more than 1 year) on the aecial host (*Pinus* spp.) before appearance of symptoms. During this period, the asymptomatic plants might remain undetected.
- The similarity of symptoms and signs (e.g. pycnia and aecia) caused by *C. eupatorii* with those of other *Coleosporium* species affecting *Pinus* spp. hampers the detection and identification of the pathogen by visual inspection.
- Rapid diagnostic methods based on molecular approaches are unavailable to detect the pathogen in plant tissues at entry.
- The theoretical possibility of sexual recombination in *C. eupatorii* may limit the efficacy of chemical control approaches by favouring the selection of fungicide-resistant populations.

3.7. Uncertainty

Whether European *Eupatorium* species (specifically *E. cannabinum*) are hosts of *C. eupatorii* and thus the ability of *C. eupatorii* to complete its life cycle in the EU.

4. Conclusions

The Panel considers that *C. eupatorii* satisfies the criteria that are within the remit of EFSA to assess for this species to be regarded as potential Union quarantine pest, with uncertainty about the ability to establish (Table 8).

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	**Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest**	**Key uncertainties**
Identity of the pest (Section 3.1)	Yes, the identity of the pest is clearly defined, and the pathogen has been shown to produce consistent symptoms and to be transmissible.	None
Absence/presence of the pest in the EU (Section 3.2)	The pathogen is not known to be present in the EU territory.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	The pathogen is able to enter into, become established in, and spread within the EU territory via host plants for planting and host plant parts (e.g. cut flowers, foliage, branches), other than seeds and fruits.	Whether European *Eupatorium* species (specifically *E. cannabinum*) are hosts of *C. eupatorii* and thus the ability of *C. eupatorii* to complete its life cycle in the EU

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Potential for consequences in the EU (Section 3.5)	The introduction into and/or spread of *C. eupatorii* in the EU is expected to have yield and quality impacts in parts of the territory where susceptible hosts are grown.	None
Available measures (Section 3.6)	Yes, although not always specifically targeted against *C. eupatorii*, phytosanitary measures are available to mitigate the likelihood of the pathogen's entry into the EU territory. Potential additional measures also exist to mitigate the risk of introduction and spread of the pathogen in the EU.	None
Conclusion (Section 4)	*C. eupatorii* satisfies all the criteria that are within the remit of EFSA to assess for this species to be regarded as potential Union quarantine pest.	None
Aspects of assessment to focus on/scenarios to address in future if appropriate:	The information on the biology and host range of *C. eupatorii* is limited. Moreover, the host status of European *Eupatorium* spp. should be evaluated.	

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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
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, 2022)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2022)
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, 2022)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2022)

Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2022)
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, 2022)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2022)
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, 2022)
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, 2022)
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, 2022)

Appendix A – *Coleosporium eupatorii* host plants/species affected

Source: Farr DF and Rossman AY, Fungal Databases, U.S. National Fungus Collections, ARS, USDA.

Host status	Host name	Plant family	Common name	Reference[A]
Cultivated hosts				
	Ainsliaea	Asteraceae	–	Zhuang (1983)
	Brickellia californica	Asteraceae	California brickellbush	Gilbertson et al. (1979)
	Brickellia thrysiflora	Asteraceae	–	Gallegos and Cummins (1981)
	Chromolaena odorata	Asteraceae	Awolowo weed	Barreto and Evans (1994)
	Eupatorium spp.	Asteraceae		Hiratsuka (1927)
	Eupatorium bertholdii	Asteraceae	–	Gallegos and Cummins (1981)
	Eupatorium chinense var. sachalinense	Asteraceae	–	Saho (1960), Hiratsuka et al. (1992)
	Eupatorium chinense var. simplicifolium	Asteraceae	–	Hiratsuka et al. (1992)
	Eupatorium collinum	Asteraceae	–	Berndt (2004)
	Eupatorium formosanum	Asteraceae	–	Tai (1979)
	Eupatorium fortune	Asteraceae	–	Tai (1979)
	Eupatorium glehnii	Asteraceae	–	
	Eupatorium lindleyanum	Asteraceae	–	Cummins (1956)
	Eupatorium lindleyanum var. trifoliolatum	Asteraceae	–	Chen (2002)
	Eupatorium odoratum	Asteraceae	Archangel	Gallegos and Cummins (1981)
	Eupatorium macrophyllum	Asteraceae	Big-leaf eupatorium	Chardon and Toro (1930)
	Eupatorium oerstedianum	Asteraceae	–	Mains (1939)
	Eupatorium pulchellum	Asteraceae	–	Gallegos and Cummins (1981)
	Eupatorium tashiroi	Asteraceae	–	Tai (1979)
	Pinus cembra	Pinaceae	Swiss stone pine; Arolla pine	Hiratsuka et al. (1992)
	Pinus koraiensis	Pinaceae	Korean pine	Saho (1961), Hiratsuka et al. (1992)
	Pinus monticola	Pinaceae	Western white pine	Saho (1961), Hiratsuka et al. (1992)
	Pinus parviflora	Pinaceae	Japanese white pine	Zinno and Endo (1964), Hiratsuka et al. (1992), Farr and Rossman (2023)
	Pinus parviflora var. pentaphylla	Pinaceae	–	Zinno and Endo (1964), Zinno et al. (1965)
	Pinus peuce	Pinaceae	Balkan pine	Hiratsuka et al. (1992)
	Pinus strobus	Pinaceae	Eastern white pine	Saho (1960, 1961, 1962b)), Zinno et al. (1965), Hiratsuka et al. (1992)
	Pinus × *griffithii-strobus*	Pinaceae		Hiratsuka et al. (1992)
	Pinus wallichiana (syn. *Pinus griffithii*)	Pinaceae	Blue pine; Himalayan white pine	Hiratsuka et al. (1992)
	Stevia clinopodioides	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia lemmonii	Asteraceae	–	Gallegos and Cummins (1981)

Host status	Host name	Plant family	Common name	Reference[A]
	Stevia lucida	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia monardaefolia	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia origanoides	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia palmeri	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia purpurea	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia pyrolaefolia	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia reglensis	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia rhombifolia	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia salicifolia	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia subpubescens	Asteraceae	–	Arthur (1918)
	Stevia tephra	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia tomentosa	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia trachelioides	Asteraceae	–	Gallegos and Cummins (1981)
	Stevia viscida	Asteraceae	–	Gallegos and Cummins (1981)
Wild weed hosts				
Artificial/ experimental host				

Appendix B – Distribution of *Coleosporium eupatorii*

Distribution records based on Farr DF and Rossman AY. Fungal Databases, U.S. National Fungus Collections, ARS, USDA.

Region	Country	Sub-national (e.g. State)	Status	References
Asia	China			
		Anhui		Cummins (1956)
		Fujian		Zhuang (1983)
	Japan			Hiratsuka et al. (1992)
	Korea			Hiratsuka et al. (1992)
	Russia			Azbukina (1984)
	Taiwan			McTaggart and Aime (2018)
North America	USA	Arizona		Gilbertson et al. (1979)
	Mexico			Gallegos and Cummins (1981)
Central America	Belize			Mains (1939)
	Costa Rica			Berndt (2004)
	Guatemala			Kern (1907)
	Nicaragua			Arthur (1906)
South America	Colombia			Kern et al. (1933)
	Venezuela			Dennis (1970)
Caribbean	Cuba			Arnold (1986)
	Dominican Republic			Ciferri (1961)
	Puerto Rico			Stevenson (1975)
	Virgin Islands			Stevenson (1975)

Appendix C – Methodological notes on Figure 2

The relative probability of presence (RPP) reported here and in the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of a species, and sometimes a genus, occurring in a given spatial unit (de Rigo et al., 2017). The maps of RPP are produced by spatial multi-scale frequency analysis (C-SMFA) (de Rigo et al., 2014; de Rigo et al., 2016) of species presence data reported in geolocated plots by different forest inventories.

C.1. Geolocated plot databases

The RPP models rely on five geo-databases that provide presence/absence data for tree species and genera (de Rigo et al., 2014; de Rigo et al., 2016; de Rigo et al., 2017). The databases report observations made inside geo-localised sample plots positioned in a forested area, but do not provide information about the plot size or consistent quantitative information about the recorded species beyond presence/absence.

The harmonisation of these datasets was performed as activity within the research project at the origin of the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz, 2016; San-Miguel-Ayanz et al., 2016). All datasets were harmonised to an INSPIRE compliant geospatial grid, with a spatial resolution of 1 km^2 pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, https://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

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

Forest Focus/Monitoring data set This project is a Community scheme for harmonised long-term monitoring of air pollution effects in European forest ecosystems, normed by EC Regulation No 2152/2003[2]. Under this scheme, the monitoring is carried out by participating countries on the basis of a systematic network of observation points (Level I) and a network of observation plots for intensive and continuous monitoring (Level II). For managing the data, the JRC implemented a Forest Focus Monitoring Database System, from which the data used in this project were taken (Hiederer et al., 2007; Houston Durrant and Hiederer, 2009). The complete Forest Focus dataset covers 30 European Countries with more than 8,600 sample points.

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

European Information System on Forest Genetic Resources (EUFGIS) is a smaller geo-database that provides information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of forest stands managed for the genetic conservation of one or more target tree species. Hence, the plots represent the natural environment to which the target tree species are adapted (EUFGIS, portal.eufgis.org).

Georeferenced Data on Genetic Diversity (GD^2) is a smaller geo-database as well. It provides information about a 63 species that are of interest for genetic conservation. It counts 6,254 forest plots that are located in stands of natural populations that are traditionally analysed in genetic surveys. While this database covers fewer species than the others, it does covers 66 countries in Europe, North Africa and the Middle East, making it the data set with the largest geographic extent (INRA, online).

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

C.2. Modelling methodology

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

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

The probability to find a single species in a 1 km^2 grid cell cannot be higher than the probability of presence of all the broadleaved (or coniferous) species combined, because all sample plots are localised inside forested areas. Thus, to improve the accuracy of the maps, the preliminary RPP values were constrained to not exceed the local forest-type cover fraction (de Rigo et al., 2014). The latter was estimated from the 'Broadleaved forest', 'Coniferous forest', and 'Mixed forest' classes of the Corine Land Cover (CLC) maps (Bossard et al., 2000; Büttner et al., 2012), with 'Mixed forest' cover assumed to be equally split between broadleaved and coniferous.

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

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

Appendix D – EU annual imports of commodities of main hosts from countries where *Coleosporium eupatorii* is present, 2016–2020 (in 100 kg)

Source: Eurostat, accessed on 21 March 2023

		2016	2017	2018	2019	2020
Live forest trees	Korea, Republic of (South Korea)	:	:	:	:	:
	China	1.97	63.47	:	:	:
	Japan	80.00	:	:	:	:
	United States	51.09	67.47	0.45	0.05	0.63
	Sum	133.06	130.94	0.45	0.05	0.63

		2016	2017	2018	2019	2020
Fresh conifer branches, suitable for bouquets or ornamental purposes	China	:	:	21.65	:	:
	Costa Rica	:	:	:	0.01	:
	Colombia	:	:	:	:	0.23
	United States	:	:	:	87.00	:
	Sum	0	0	21.65	87.01	0.23

		2016	2017	2018	2019	2020
Fresh cut flowers and buds, of a kind suitable for bouquets or for ornamental purposes (excl. roses, carnations, orchids, gladioli, ranunculi, chrysanthemums and lilies)	Korea, Republic of (South Korea)	0.17	:	12.18	0.17	7.23
	China	876.79	107.48	1294.19	476.90	27.01
	Japan	538.46	298.61	256.54	240.17	242.85
	Costa Rica	576.44	463.02	574.69	469.05	202.76
	Colombia	21582.19	29,846.49	37,390.93	36,973.03	37,538.82
	Mexico	0.93	104.13	26.48	3.08	
	Taiwan	21.32	17.06	22.17	16.01	3.84
	Guatemala	97.10	42.69	116.36	62.91	314.61
	Russian Federation (Russia)	0.00	:	:	:	:
	Dominican Republic	1.10	:	:	:	:
	United States	56.50	51.32	33.69	2.63	12.63
	Sum	23,751.00	30,930.80	39,727.23	38,243.95	38,349.75