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SCIENTIFIC OPINION

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Pest categorisation of *Matsucoccus matsumurae*

EFSA Panel on Plant Health (PLH) | Claude Bragard | Paula Baptista | Elisavet Chatzivassiliou | Francesco Di Serio | Paolo Gonthier | Josep Anton Jaques Miret | Annemarie Fejer Justesen | Christer Sven Magnusson | Panagiotis Milonas | Juan A. Navas-Cortes | Stephen Parnell | Roel Potting | Philippe Lucien Reignault | Emilio Stefani | Hans-Hermann Thulke | Wopke Van der Werf | Antonio Vicent Civera | Jonathan Yuen | Lucia Zappalà | Jean-Claude Grégoire | Chris Malumphy | Alex Gobbi | Virag Kertesz | Andrea Maiorano | Oresteia Sfyra | Fabio Stergulc | Alan MacLeod

Correspondence: plants@efsa.europa.eu

Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Matsucoccus matsumurae* (Hemiptera: Matsucoccidae), the Massonian pine bast scale, for the EU territory. This pest categorisation was initiated following the commodity risk assessment of artificially dwarfed plants from China consisting of *Pinus parviflora* (Japanese white pine) grafted on *P. thunbergii* (Japanese black pine) performed by EFSA, in which *M. matsumurae* was identified as a pest of possible concern. However, its identity is not firmly established due to uncertainty regarding its taxonomic relationship with *Matsucoccus pini* (Green), a species widespread in Europe. *M. matsumurae* occurs in western China and has been reported as a pest of *P. massoniana* (Chinese red pine) and *P. thunbergii*. These hosts occur in the EU as ornamental/amenity trees. Other scales in the *Matsucoccus* genus feed on a variety of *Pinus* species and the host range of *M. matsumurae* could be wider than is currently recorded. The scale has one or two generations per year. All stages occur on the branches and stems of hosts with developing nymphs and adult females feeding through the bark on host phloem vessels. Symptoms include the yellowing/browning of host needles, early needle drop, desiccation of shoots and bark necrosis. The most serious infestations occur in hosts that are 8–25 years old and there can be some host mortality. In principle, host plants for planting and plant products such as cut branches and wood with bark could provide entry pathways into the EU. However, prohibitions on the import of *Pinus* from non-European third countries regulate these pathways. In China, *M. matsumurae* occurs in regions with temperate humid conditions and hot summers. These conditions are also found in parts of southern EU. Were *M. matsumurae* to establish in the EU, it is conceivable that it could expand its host range; however, this remains uncertain. Some uncertainty exists over the magnitude of potential impacts. *M. matsumurae* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest, assuming *M. pini* is not a synonym, which is a key uncertainty.

KEYWORDS

Japanese pine bast scale, pest risk, *Pinus* spp., plant health, plant pest, quarantine

CONTENTS

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

Matsucoccus matsumurae is one of a number of pests relevant to 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 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 following the commodity risk assessment of artificially dwarfed plants from China consisting of *Pinus parviflora* grafted on *P. thunbergii* performed by EFSA (EFSA PLH Panel, 2022), in which *M. matsumurae* was identified as relevant non-regulated EU pest which could potentially enter the EU on artificially dwarfed plants.

2 | DATA AND METHODOLOGIES

2.1 | Data

2.1.1 | Information on pest status from NPPOs

In the context of the current mandate, EFSA is preparing pest categorisations for new/emerging pests that are not yet regulated in the EU. When official pest status is not available in the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), EFSA consults the NPPOs of the relevant MSs. To obtain information on the official pest status for *M. matsumurae*, EFSA has consulted the NPPO of Sweden to clarify a recent report (García Morales et al., 2016). The results of this consultation are presented in Section 3.2.2.

2.1.2 | Literature search

A literature search on *M. matsumurae* was conducted at the beginning of the categorisation in the Scopus, ResearchGate and Google Scholar bibliographic databases, using the scientific name of the pests as search term (Appendix E). 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.

2.1.3 | Database search

Pest information, on host(s) and distribution, was retrieved from the CABI Crop Protection Compendium (CABI, online) and scientific literature databases as referred above in Section 2.1.2.

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 Interceptions to TRACES in May 2020.

GenBank was searched to determine whether it contained any nucleotide sequences for *M. matsumurae* 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. matsumurae* 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 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. While 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?

The name of the species is valid but is not firmly established and its taxonomic relationship with other members of the genus, including *Matsucoccus pini* (Green), a species widespread in Europe, is uncertain.

Matsucoccus matsumurae (Kuwana, 1905), the Japanese pine bast scale, red pine scale or pine bark scale, is a scale insect belonging to the order Hemiptera, family Matsucoccidae (Ben-Dov, 2011; García Morales et al., 2016; Kosztarab & Kozár, 1988).

The species in the *Matsucoccus* genus have been recognised as being difficult to identify and the taxonomic validity of some species is still controversial. Adult females, the most easily observable stage, are morphologically very similar and their identification often relies on very small differences in some characters, mostly body pores and scars. Furthermore, it is known that *Matsucoccus* morphology can also vary within the same species depending on the generation, location, altitude and host plant (Foldi, 2004; McClure, 1983; Rieux, 1976). DNA sequencing which often accompanied morphological identification in recent decades showed synonymy between specimens previously regarded as separate species. For example, it was possible to show that *M. resinosae* (Kuwana) in the USA and *M. thunbergianae* Miller & Park in South Korea are both synonyms of *M. matsumurae* (Booth & Gullan, 2006; Choi et al., 2019); previously, Hibbard et al. (1991) reported the three species being attracted by the same *M. matsumurae* pheromone.

The taxonomic status of *M. matsumurae* in China has been discussed in detail by Young et al. (1976). They separated the adult female *M. matsumurae* from *M. pini* based on a single morphological character (which is disputed by Booth & Gullan, 2006); and because *M. pini* can reproduce sexually and parthenogenetically, whereas *M. matsumurae* can only reproduce sexually. Recent analyses by RAPD PCR carried out in China on populations of *Matsucoccus* from the provinces of Liaoning, Shandong and Zhejiang have also shown that they all belong to the same species *M. matsumurae*, so that *Matsucoccus massonianae* Young & Hu, present in Zhejiang, should actually be considered *M. matsumurae* (Liu, Xie, Dong, Yang, et al., 2014; Ren et al., 2016; Yang et al., 2013).

There is no agreement on a possible synonymy of *M. matsumurae* and other *Matsucoccus* species known to occur in Europe [e.g. *M. mugo* Siewniak and *M. pini* (Green)].

Kosztarab and Kozár (1988) believe that both *M. mugo* and *M. pini* are synonyms of *M. matsumurae*. According to Booth and Gullan (2006), the morphological characters of females of *M. pini* fall within the range of variability of *M. matsumurae*, and the synonymy of *pini* and *matsumurae* appears probable. It has also been shown that the natural predators of *M. pini* respond to the pheromone of *M. matsumurae* (Branco et al., 2006). Foldi (2004) called *M. pini* an 'enigmatic species' and believed that the final status of *M. pini* and *M. matsumurae* can only be defined by molecular studies, because they could be a single species able to exploit different host plants in various climatic scenarios, as well as a complex of widely distributed sibling species.

Synonyms of *M. matsumurae* are *M. resinosae* Bean & Godwin, *M. thunbergianae* Miller & Park, *Xylococcus matsumurae* Kuwana (Foldi, 2004; García Morales et al., 2016) and *Matsucoccus liaoningensis* (CABI, online).

The EPPO code[1] (EPPO, 2019; Griessinger & Roy, 2015) for *M. matsumurae* is MATSRE (EPPO, online).

Table 2 is a synoptic table illustrating the uncertainty in taxonomy across continents.

TABLE 2 Species of *Matsucoccus* and the difficulties in their identification between and within continents.

Asia			
M. massonianae	***M. matsumurae***	***M. resinosae***	***M. thunbergianae***
	All three species are synonyms of *M. matsumurae* (Booth & Gullan, 2006; Choi et al., 2019) and are attracted by the same pheromone (Hibbard et al., 1991)		
RAPD PCR in China (Liaoning, Shandong and Zhejiang): *M. massonianae* in Zhejiang is *M. matsumurae* (Liu, Xie, Dong, Yang, et al., 2014; Ren et al., 2016; Yang et al., 2013)			
Europe			
M. pini	***M. matsumurae***	***M. mugo***	
Young et al. (1976): Adult female *M. matsumurae* separated from *M. pini* based on a single morphological character; *M. pini* can reproduce sexually and parthenogenetically, whereas *M. matsumurae* can only reproduce sexually. Booth and Gullan (2006): The morphological characters of *M. pini* females within the range of variability of *M. matsumurae*; therefore, the synonymy of *pini* and *matsumurae* appears probable. (Branco et al., 2006): The natural predators of *M. pini* respond to the pheromone of *M. matsumurae*.			
Kosztarab and Kozár (1988): Based on morphology of adult female, both *M. pini* and *M. mugo* are synonyms of *M. matsumurae*.			
North America (USA)			
M. resinosae	***M. matsumurae***		
McClure, 1989; Maine Forest Service, 2019: In the USA, the synonymy of *M. resinosae* with *M. matsumurae* is now widely accepted			

Given the absence of consensus regarding the taxonomic relationship between *M. matsumurae* and *M. pini*, this pest categorisation accepts both as valid species, in accordance with Scale Net (García Morales et al., 2016) and with the most recent checklist of scale insects belonging to the group of Margarodidae sensu lato (Ben-Dov, 2011). However, this is a key uncertainty as it would affect the conclusion.

3.1.2 | Biology of the pest

M. matsumurae has been reported to have two generations per year in the USA (McClure, 1983) and in East Asia (Liu, Xie, Dong, Yang, et al., 2014; McClure et al., 1983; Young et al., 1976). However, in South Korea, it has been reported to have only one generation per year (Choi & Park, 2012; Kim & Oh, 1992; Miller & Park, 1987).

Liu, Xie, Dong, Yang, et al. (2014) describe the biology of *M. matsumurae*. The development of the scale occurs in three stages for females: egg, nymph (2 instars) and adult, and four stages for males: egg, nymph (3 instars) prepupa-pupa and adult (Figure 1). The first-instar nymph (NI) is mobile (crawler) and the second-instar (NII) sessile (cyst); the third-instar (NIII) male nymph is also mobile (Liu, Xie, Dong, Yang, et al., 2014; Young et al., 1976). The overwintering stage is NI; in early March, they moult to NII and then to NIII. The apterous females originate from NII that are fixed in the bark crevices, the winged males originate from NIII. At the end of March, male NIII move on the bark in search of sites to moult into pupae inside silky cocoons formed by filaments of wax secreted by themselves. At the end of April and in May, the adults of both sexes appear, and mating takes place, from which the first-generation starts (Liu, Xie, Dong, Yang, et al., 2014). Each female lays about 250 eggs in a cottony ovisac that remains attached to the tip of the abdomen (McClure et al., 1983). The eggs hatch after 15 days and NI appear from late May to July and crawl into the bark crevices searching for suitable sites to start feeding. After moulting to NII, females produce waxy secretions to hide and begin feeding by inserting stylets into the phloem to suck the sap (Choi & Park, 2012). In both sexes, only NI and NII feed (McClure et al., 1983). Therefore, during the summer, there are NII (fixed cysts) which will produce adult females, and mobile NIII which will form pupae and adult males. The second generation appears in October–November, and NI overwinter from December to February (Figure 1; Table 3).

[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 (EPPO, 2019; Griessinger & Roy, 2015).

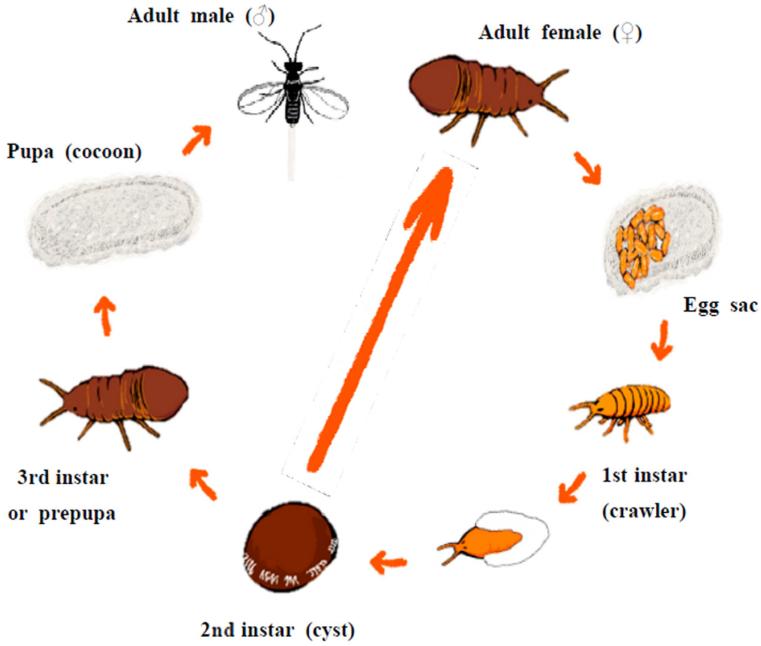

FIGURE 1 General life cycle of *Matsucoccus* species (Choi et al., 2019; https://creativecommons.org/licenses/by/4.0/).

TABLE 3 Life cycle of *Matsucoccus matsumurae* in Zehjiang (based on Liu, Xie, Dong, Yang, et al., 2014).

	January	February	March	April	May	June	July	August	September	October	November	December
Gen 1												
Eggs					■	■						
First instar					■	■	■					
Second instar							■	■	■			
Third instar								■	■	■		
Male pupae									■	■		
Adults										■	■	
Gen 2												
Eggs										■	■	■
First instar											■	■
First instar	■	■										
Second instar			■	■	■							
Male pupae				■	■							
Adults					■							

Life cycle can vary depending on locality, altitude, host plant and generation (Foldi, 2004; McClure, 1983; Rieux, 1976). In the colder northern regions of its range in China, such as Liaoning, where spring begins a month later than in the rest of the range, oviposition occurs at end of May and early June. The first generation is completed from July to October. The overwintering starts at the end of October–early November (Liu, Xie, Dong, Yang, et al., 2014). Populations of the pest are regulated by several natural enemies, mostly predators and some entomopathogenic fungi and bacteria. No parasitoids have been found to date (Xu et al., 2009).

Xu et al. (2009), Liu, Xie, Dong, Xue, et al. (2014), García Morales et al. (2016) reported 32 species of *Matsucoccus* predators. The Coccinellidae (e.g. *Harmonia axyridis, H. obscurosignata, Exochomus mongol*), Anthocoridae (*Elatophilus nipponensis*) and Chrysopidae (*Chrysopa septempunctata, C. kulingensis, C. formosa*) are effective *M. matsumurae* natural enemies. They can kill from 70% to 97% of the scale insect population. *H. axyridis, H. obscurosignata* and *E. nipponensis* are believed to be the most effective natural control agents of *M. matsumurae* in China and Japan (Cheng & Ming, 1979; McClure et al., 1983). *Harmonia axyridis* is especially considered of great interest in its possible use in biological control (McClure, 1986); this is important since *H. axyiridis* is also widespread in Europe (EPPO, online). Three species of entomopathogenic fungi (*Fusarium incarnatum-equiseti* species complex, *Lecanicillium fungicola and L. lecanii*) are known to be effective in regulating populations of *M. matsumurae*; *L. lecanii* has the most potential as a possible biocontrol agent, causing up to 100% mortality in 8 days in adult females and NIII male nymphs of the scale (Liu, Xie, Dong, Xue, et al., 2014; Liu, Xie, Dong, Yang, et al., 2014).

Key biological features of the organisms relevant to the pest categorisation are summarised in Table 4.

TABLE 4 Important features of the life history strategy of *Matsucoccus matsumurae*.

Life stage	Phenology and relation to host	Other relevant information (Stephens & Aylor, 1978; McClure et al., 1983; Hibbard et al., 1991; Foldi, 2004; Choi & Park, 2012; Choi et al., 2019)
Egg	About 250 eggs per female are laid in a cottony ovisac that remains attached to the tip of the abdomen of died female scale. Eggs are laid in May–June (1st generation) and October–November (2nd generation)	The eggs can be found in bark crevices and beneath flaks of bark on stems and branches of pine trees. Eggs hatch 2 weeks after oviposition
Nymph	NI from both male and female line feed by sucking sap from the phloem in bark crevices from late May to July (1st generation) and from late October to November (2nd generation). From December to late February, they overwinter. NII of both sexes are sessile and insert their stylets into the phloem to suck the sap. NIII are only from male line and can be found from late August to October	NI are mobile (crawlers) and move throughout the bark crevices for feeding. They can be easily dispersed by the wind up to a distance of 1600 m. NII (cysts) are sessile and do not move. They directly moult to adult females. NIII are poorly mobile as they soon moult to prepupal–pupal stage. All the nymphal stages can be passively transported by pine trunks also over long distances
Pupa	Pupae only refer to male line and can be found from late March to May (2nd-generation previous year) and September to October (1st-generation current year). They are fixed in silky cocoons formed by wax filaments in bark crevices	No precise data on duration of the pupal stage was found. However, from the life history (see Table 3), it can be assumed that it is very short (about 1 week) and preceding a little the emergence of adults
Adult	The adults of both sexes do not feed and can be observed in bark crevices and on bark (males) of stems and branches from late March to late May (2nd generation – previous year) and from late September to mid-November (1st generation current year)	Virgin females are apterous and poorly mobile; they release sex pheromone (matsuone) that strongly attracts males and even a number of natural enemies. Adult males are winged and can disperse by flying, but no data is available on flight distance. However, although males are probably weak fliers, they are easily transported by wind

3.1.3 | Host range/species affected

Matsucoccus scales are known as oligophagous species feeding on *Pinus* spp. (Foldi, 2004). The host range of *M. matsumurae* is shown in Appendix A.

3.1.4 | Intraspecific diversity

There are no reports of intraspecific variation for *M. matsumurae*.

3.1.5 | Detection and identification of the pest

Are detection and identification methods available for the pest?

Methods of detection are available, however there is uncertainty regarding morphological identification and no specific molecular method has been developed yet.

Symptoms

Symptoms are typical to sap-sucking insects. Infested pine trees usually show shortened needles and needle cast (Foldi, 2004). As consequence of sap sucking, yellowing/browning of weakened crowns and cracked bark can be also observed (Bean & Godwin, 1971; Hu & Wang, 1976). Host plants can be asymptomatic when the level of infestation is low and all insect stages can be difficult to detect within the bark crevices.

Detection

The winged adult males of *M. matsumurae* can be lured into traps using a synthetic sex pheromone, the matsuone (2E,4E,6R, 10R)-4,6-10,12-tetramethyl-2,4-tridecadiene-7-one (Hibbard et al., 1991; Lanier et al., 1989; Lee et al., 2019; Young et al., 1984). Lures useful to capture *Matsucoccus* species into traps are ethanol, alpha-pinene and monochamol (Ahmed et al., 2020). Lindgren funnel traps and various kinds of sticky traps can be used (Ahmed et al., 2020; Branco et al., 2006; Kim et al., 2016; Lee et al., 2018). Mobile apterous females and mobile nymphs passively transported by air currents can be detected by suspended glue traps of various kinds. Depending on the life cycle, all stages of development can be detected by visual inspection within bark crevices of trunks and branches.

Identification

Young et al. (1976) provide a detailed description of *M. matsumurae*, stating the validity of the species and discussing taxonomy issues also related to the distinction with other *Matsucoccus* species found in China. However, this study provides no references to support their work, but is a source for both Ben-Dov (2011) and García Morales et al. (2016).

Detailed morphological characters of life stages and illustrations of *M. matsumurae*, and comparison with other species are provided by Bean and Godwin (1971), Young et al. (1976), Yang et al. (1999), Foldi (2004), Miller et al. (2014), Choi et al., 2019, which can be helpful for identification.

Below is a summary description of main life stages of *M. matsumurae*:

Egg: Oval, amber-yellow, 0.24–0.25 mm in length and 0.31–0.15 mm in width (Bean & Godwin, 1971; Young et al., 1976).

NI: Long oval, yellow, head projecting apically, legs and antennae (crawlers); generally resembling adult female but much smaller (0.2–0.4 mm body length; 0.15–0.2 mm wide) (Bean & Godwin, 1971; Miller et al., 2014; Miller & Park, 1987; Young et al., 1976).

NII: Elliptically shaped, amber yellow to greyish yellow, lack of legs and antennae (sessile cysts), no information on size (Bean & Godwin, 1971; Miller et al., 2014).

Male NIII: Body elongate, oval. 1.6–2.0 mm long, 0.9–1.2 mm wide, legs and antennae obvious (Miller & Park, 1987).

Male pupa: In silky cocoons made by waxy filaments. No other information.

Adult male: Two-winged and midge-like shape, with a long brush of wax filaments at the end of abdomen. 1.6–2.3 mm long and 0.4–0.8 mm wide; wingspan 1.6–2.0 mm (Miller & Park, 1987).

Adult female: wingless, body elongate, orange-brown or reddish, with white ovisac on tip of abdomen when mated, 2.5–4.5 mm long and 1.2–2.5 mm wide, antennae and legs well developed (Bean & Godwin, 1971; Foldi, 2004; Miller & Park, 1987).

As noted previously, the identification of *M. matsumurae* is uncertain if based on morphological characters alone; molecular methods should be used to confirm a morphological diagnosis.

Molecular techniques (DNA extraction, PCR and sequencing) for the recognition of *Matsucoccus* species have been developed and discussed by Booth and Gullan (2006), Yang et al. (2013), Liu, Xie, Dong, Yang, et al. (2014) and Ahmed et al. (2020). For example, NADH dehydrogenase, ATP synthase, cytochrome c oxidase,16S ribosomal RNA, as well as several AA-specific t-RNA.

On GenBank (Schoch et al., 2020) a sequence for *M. matsumurae* is available: Matsucoccus – Taxonomy – NCBI (nih.gov) (https://www.ncbi.nlm.nih.gov/taxonomy/?term=matsucoccus). There are no sequences available for *M. pini*.

3.2 | Pest distribution

3.2.1 | Pest distribution outside the EU

According to García Morales et al. (2016) and Ben-Dov (2011), *M. matsumurae* has a holarctic distribution, being present in China, Japan, South Korea and the USA. In South Korea, the species is still named *M. thunbergianae* as this is the only name officially recognised by the government of the Republic of Korea (Lee et al., 2018).

M. matsumurae was first described from specimens collected in Tokyo, Japan. The scale then apparently spread to Asia (China and Korea) in the early 1940s (Liu, Xie, Dong, Yang, et al., 2014; McClure et al., 1983; Miller & Park, 1987) probably as consequence of the Japanese occupation in 1937–1945 (McClure, 1983). However, some authors believe that *M. matsumurae* is also native to China and went unnoticed until it began to cause damage in the 1960s when extensive insecticide treatments in Chinese pine forests against *Dendrolimus spectabilis* eliminated the natural enemies of *M. matsumurae* (Young et al., 1984). The introduction in North America (Connecticut, USA), where the species was initially described as *M. resinosae* by Bean and Godwin in 1955, is dated 1946 and was attributed to the import of display pines at the 1939 New York Fair (Anderson et al., 1976; Booth & Gullan, 2006) (Figure 2).

Appendix B provides national and subnational records of the species occurrence.

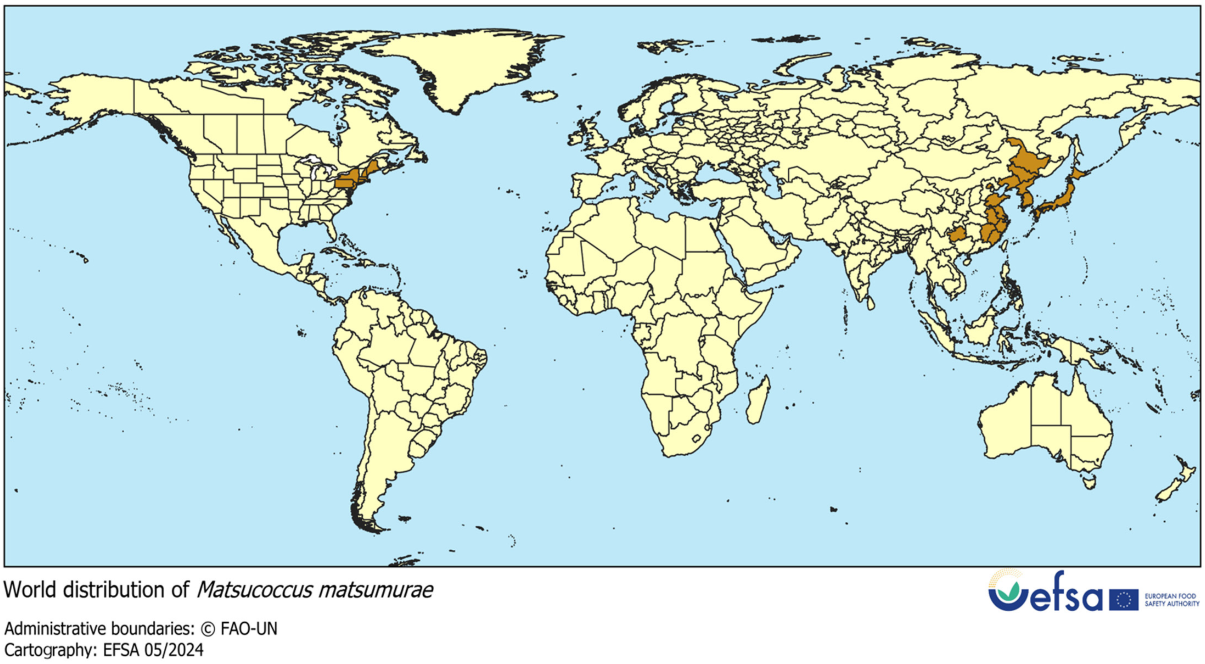

FIGURE 2 Global distribution of *Matsucoccus matsumurae* (Distribution records based on CABI, online; Foldi, 2004; García Morales et al., 2016; Maine Forest Service, 2019).

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.

Assuming *M. matsumurae* is not a synonym of *M. pini*, *M. matsumurae* is not present in the EU territory.

Because in the past most countries in the EU accepted the synonymy of *M. pini* with *M. matsumurae* proposed by Kosztarab and Kozár (1988) based on morphology, *M. matsumarae* was widely recorded in the EU MS (see Section 3.1.1). These authors reported the presence of *M. matsumurae* in 10 current EU MS (Austria, Bulgaria, Czech Republic, France, Germany, Hungary, Poland, Romania and Spain), and also in the UK and the European areas of the former USSR (see Appendix D). Similarly, reports of *M. matsumurae* in annotated check lists for the Netherlands (Jansen, 1999), Sweden and Finland (Albrecht et al., 2015; Gertsson, 2001) are based on the assumption that *M. matsumurae* and *M. pini* are synonyms. However, it is now generally accepted that DNA sequencing is needed to determine the taxonomic relationships of closely related *Matsucoccus* species. The Swedish NPPO (Boberg & Björklund, 2022) does not recognise earlier reports of *M. matsumurae* occurring in Sweden.

3.3 | Regulatory status

3.3.1 | Commission implementing regulation 2019/2072

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

3.3.2 | Hosts or species affected by *M. matsumurae* that are prohibited from entering the union from third countries

As specified in Annex VI, 1, of 2019/2072 (Table 5) plants of *Pinus* (which are host plants of *M. matsumurae,* see Section 3.1.3) are prohibited from entering the EU, other than from specified European third countries. Thus, *Pinus* from Asia and North America where the species occur is prohibited.

TABLE 5 List of plants, plant products and other objects that are *Matsucoccus matsumurae* 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	Various codes from ex 0602 20 20 to ex 0604 20 40	Third countries other than: specified European third countries (see Annex VI for details)

M. matsumurae is not included in the list of pests of concern in relation to naturally or artificially dwarfed *Pinus parviflora* and *P. thunbergii* plants for planting from Japan in Commission Implementing Regulation (EU) 2020/1217. The regulation provides for a derogation from Article 7, point 1 of Annex VI of Implementing Regulation (EU) 2019/2072 if the plants comply with the conditions set out in Regulation (EU) 2020/1217.

3.4 | Entry, establishment and spread in the EU

3.4.1 | Entry

Is the pest able to enter in the EU territory? If yes, identify and list the pathways. Comment on plants for planting as a pathway.

Yes, *M. matsumurae* could enter in the EU territory via plants for planting (except seeds and pollen), cut branches, wood with bark and isolated bark.

Plants for planting is the major pathway.

M. matsumurae lives in the bark crevices of stems, branches and twigs of adult and young pine host trees, where it can be found in all development stages (eggs, mobile and sessile nymphs, pupae, adults of both sexes) all year long. Plants of *Pinus* species (see Section 3.1.3) are possible pathways (plants for planting, wood with bark, cut branches) (Table 6).

The entry of *M. matsumurae* into China through seedlings and bonsai from Japan has been verified (Xu et al., 2006).

TABLE 6 Potential pathways for *Matsucoccus matsumurae* into the EU 27.

Pathways	**Life stage**	**Relevant mitigations** [e.g. prohibitions (Annex VI) special requirements (Annex VII) or phytosanitary certificates (Annex XI) within implementing regulation 2019/2072]
Plants for planting of host trees	Eggs, nymphs, pupae and adults on bark	2019/2072 Annex VI prohibition
Cut branches of host plants (including Christmas trees)	Eggs, nymphs, pupae and adults on bark	2019/2072 Annex VII (31 and 32) regulations on requirements for import of Plants of Pinales from third countries.
Wood with bark of host plants	Eggs, nymphs, pupae and adults on bark	2019/2072 Annex VII (76 to 82) regulations on requirements for import of wood of conifers (Pinales) from third countries.
Isolated bark of host plants	Eggs, nymphs, pupae and adults on bark	2019/2072 Annex VII (82) regulation on requirements for import of isolated bark of conifers (Pinales) from third countries

The EUROPHYT and TRACES databases do not report any interception data for *M. matsumurae* (all synonyms included) from 1995 until 31 August 2021 to the EU (EUROPHYT, online; TRACES-NT, online). No data on the species are recorded in the EUROPHYT Outbreaks.

3.4.2 | Establishment

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

Yes. Host availability and climatic conditions suggest that *M. matsumurae* could establish in the EU. Most of the EU, especially central and northern Europe, 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, 2002). Availability of hosts is considered in 3.4.2.1. Climatic factors are considered in 3.4.2.2

3.4.2.1 | *EU distribution of main host plants*

Pinus spp. (Figure 3) are widespread in the EU.

M. matsumurae has a relatively wide host range on the genus *Pinus*. In the EU, there are six species of *Pinus* believed to be hosts of *M. matsumurae* (Foldi, 2004), of which two species are with a mainly central–northern distribution (*P. mugo* and *Pinus sylvestris*) and four species with southern distribution (*Pinus haleppensis, P. nigra, P. pinea* and *P. pinaster*). However, there are uncertainties about the reliability of some of these reports (see Section 3.1.3).

Nevertheless, *Matsucoccus* scales are known as oligophagous species, and this could suggest that all species of the genus *Pinus* present in the EU are potential hosts.

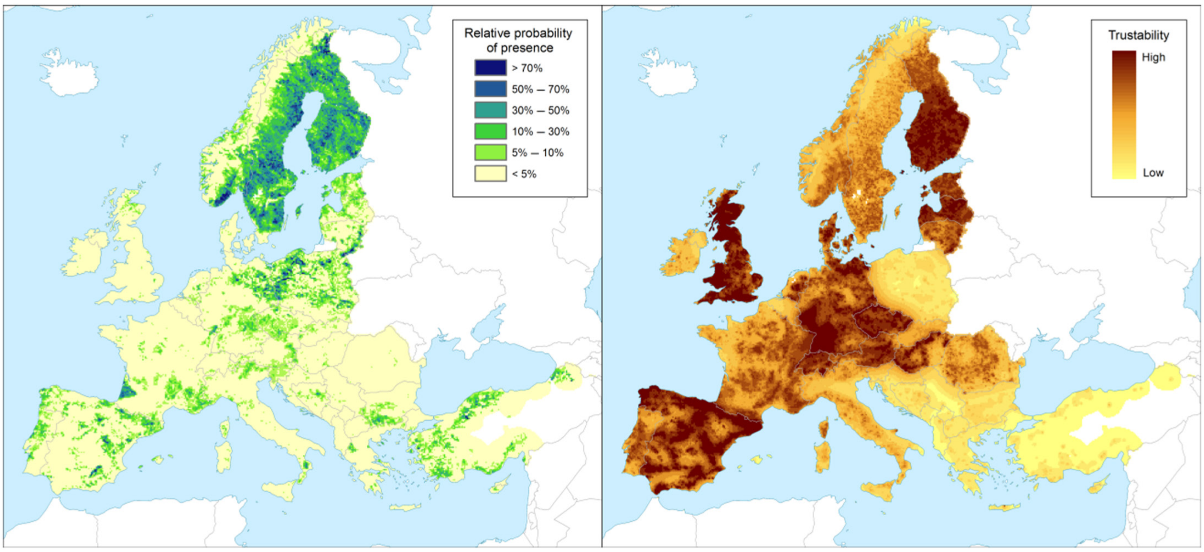

FIGURE 3 Left panel: Relative probability of the presence (RPP) of the genus *Pinus* in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds square meters. 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 D (courtesy of JRC, 2017). Right panel: Trustability of RPP. This metric expresses the strength of the underlying information in each grid cell and varies according to the spatial variability in forestry inventories. The colour scale of the trustability map is obtained by plotting the cumulative probabilities (0–1) of the underlying index (for details on methodology, see Appendix D).

3.4.2.2 | *Climatic conditions affecting establishment*

The distribution of *M. matsumurae* in both Asia (Japan, China, Korea) and North America (NE states of the USA) shows compatibility in climatic conditions with the territory of the EU (Figure 4).

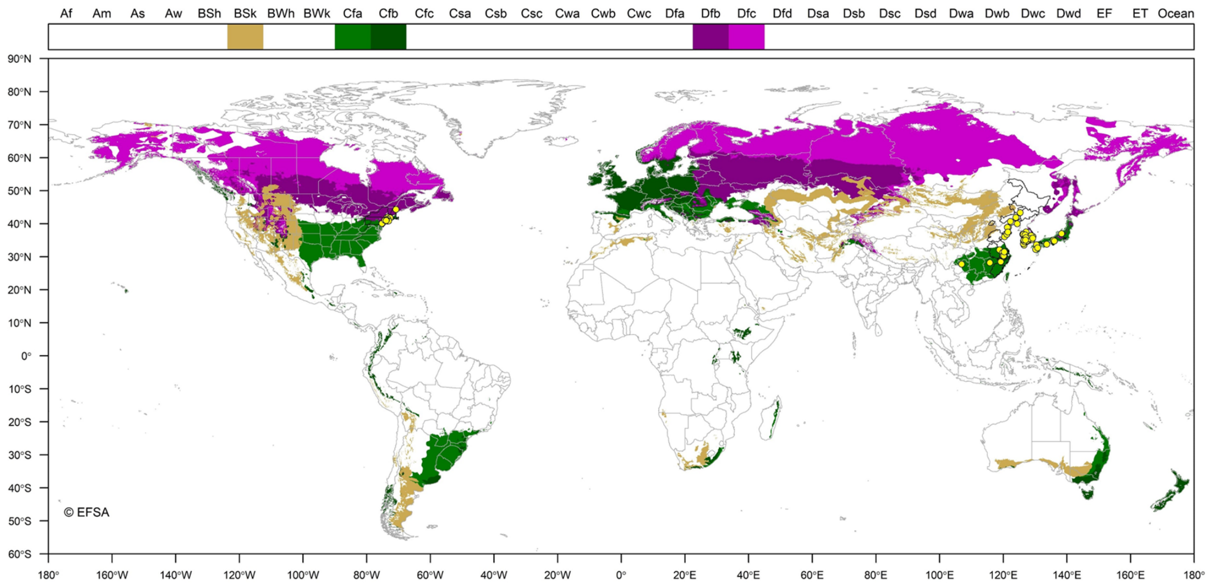

FIGURE 4 World distribution of five Koppen–Geiger climate types (BSk, Cfa, Cfb, Dfb and Dfc; Kottek et al., 2006) that occur in the EU and which occur in countries where *Matsucoccus matsumurae* has been reported.

M. matsumurae is known as a species sensitive to temperature, which can strongly affect its distribution (Foldi, 2004). In north-eastern China (Liaoning), the low winter temperatures (down to −23°C) and a short duration of the warm season (160 days) cause 96.4% mortality of overwintering nymphs, whereas winter mortality is only 6.4% in the central–eastern regions of China (Zhejiang) where the temperatures do not go lower than −5°C, and the warm season lasts 240 days. However, the high summer temperatures (over 40°C) cause severe mortality (70%–90%) of the first-generation nymphs, and this seems to prevent the spread of the scale south of its range (McClure et al., 1983).

According to McClure et al. (1983) both in Asia and in North America, the high winter mortality (> 96%) of the nymphs of *M. matsumurae* north of latitude 41°30′ N inhibits the scale spreading towards North even if the hosts are still widely present. In China and Japan, the expansion towards South beyond 30°15′ N latitude is limited by the summer mortality (70%–90%) caused by high temperatures, while in the USA, the reduced expansion to South would be attributed to the lack of *Pinus resinosa* or other pine species of the subsection *Pinus* ex subsection *sylvestris* sensu McClure. Within this latitudinal range, however, *M. matsumurae* would be able to further expand its distribution range, both because it has two generations per year and because its host range on pines is relatively wide (McClure, 1983).

Finally, climate change could also be a topic to pay attention to for the establishment of *M. matsumurae* and its spread. A correlation was observed between the increase in minimum temperatures and the spread of the scale, precisely an expansion of the range of *M. matsumurae* in North-eastern China following the increase in minimum temperatures in January (Yuan et al., 2014). This could reduce the winter mortality of the scale, a key factor already studied by McClure et al. (1983). In China, the relative resistance to low temperatures of *M. matsumurae*, in addition to climate change, suggests that its next spread to the northern province of Heilongjiang is likely (Wang et al., 2009).

3.4.3 | Spread

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

Comment on plants for planting as a mechanism of spread.

Wind and air currents are the main natural way of local spreading of mobile nymphs. All development stages moved with host plants, including plants for planting, could facilitate long-distance spread in trade.

It is known that *M. matsumurae* can spread over a short distance (300–1600 m) through the transport of mobile stages by air currents (Anderson et al., 1976; Stephens & Aylor, 1978; Yang et al., 1999; Yuan et al., 2014). Experimental tests have shown that wind speed of 5 m/s is able to transport mobile stages in the ratio of 22 individuals/m^2 per week at a distance of 1.6 km and this is considered sufficient to start new infestation at that distance (Stephens & Aylor, 1978). The newly hatched nymphs of *M. matsumurae* can live for 5 days without feeding and can survive for 15 days on wilt shoots or yellow needles fallen from the tree (Wang et al., 2009). The insects can even attach to animals (woodpeckers, great tits, squirrels) and human bodies to spread. The mobile stages of the scale can also be passively transported by motor vehicles from 6 to 54 km away (Stephens & Aylor, 1978). The transport of pine logs with bark is another important way of scale spreading over long distances (Anderson et al., 1976; Wang et al., 2009). The annual dispersion rate recorded in the USA is 1–3 km/year (McClure, 1976); in South Korea 3.3–5.9 km/year (Chung et al., 2000). However, the spread tendency is different in various directions, mainly depending on climate. In China, during a 40-year period, *M. matsumurae* expanded more than 1000 km to the South, but in the same period, the scale only spread 300 km to the North (Wang et al., 2009).

3.5 | Impacts

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

Yes, the introduction of *M. matsumurae* could have economic and environmental impacts on pine forests. However, there is a considerable uncertainty on the magnitude of impact.

As for other harmful species of *Matsucoccus*, the attack on pine trees of *M. matsumurae* causes non-specific symptoms on needles and bark, resulting from sucking sap from phloematic tissues of the stem and branches, together with inoculation of toxins (Anderson et al., 1976; Foldi, 2004; McClure, 1977). Symptoms are discoloration (yellowing/browning) of needles, early needle cast, desiccation of shoots and bark necrosis. Heavy infested pines can die in a short time (1–5 years) especially after attack of secondary pests, such as bark beetles and longhorn beetles. Pine dieback as described above has been observed in China and Korea (Hu & Wang, 1976; Kim & Oh, 1992; Liu, Xie, Dong, Yang, et al., 2014; Xu et al., 2009; Zhang et al., 2007), and in the USA (Bean & Godwin, 1971; Maine Forest Service, 2019) without important differences. Most serious damage is observed on pines 8–25 years old, growing in dense stands. Mixed forests are only slightly infested (Hu & Wang, 1976; Kim et al., 1995; Kim & Oh, 1992).

In Japan, where *M. matsumurae* is probably native, the species is not considered as a pest (McClure, 1985; Young et al., 1984). However, in China and Korea, the scale is well known as a destructive pest, capable of causing serious damage to both natural and planted pine stands, especially of *Pinus massoniana, P. densiflora, P. tabulaeformis* and *P. thunbergii* (Choi et al., 2019; Choi & Park, 2012; Kim et al., 2016; McClure et al., 1983; Miller & Park, 1987). Monitoring and control programmes are currently carried out in China and Korea; in China also local quarantine measures have been enabled (Yang et al., 1999; Zhang et al., 2007).

In the USA, *M. matsumurae* severely attacks both young and mature pines and has caused the disappearance of *P. resinosa* plantations in Connecticut and New York (Bean & Godwin, 1971; Booth & Gullan, 2006).

Recent studies carried out in Korea have shown that the quality and mechanical properties of wood from *P. thunbergii* severely damaged by *M. matsumurae* do not differ significantly from wood from healthy pines, so that it can be used for a general purpose (Won et al., 2015).

If *M. matsumurae* established in the EU, pine forests of *P. sylvestris* and *P. nigra* (subsect. *Pinus*) in southern Europe could suffer damage with a possible impact also on wood production. The risk probably concerns to a lesser extent pine species belonging to the subsection *Pinaster* (*P. pinaster*, *P. pinea*, *P. halepensis*, *P. brutia*). It should also be considered that on *P. pinaster* the *Matsucoccus* niche is already well filled by *M. feytaudi* Ducasse although displacement through competition could not be excluded.

Finally, there are considerable uncertainties about the possible consequences of the introduction of this scale species in central and northern Europe, considering that *M. pini* is widespread in Europe and has not been recorded causing significant damage to pine in recent decades, and there are many natural enemies already present.

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, *Pinus* sp. plants from third countries are banned from entering into the EU (see Sections 3.3.2 and 3.4.1). Wood of conifers (*Pinales*) from third countries can be imported under conditions (see Section 3.4.1).

3.6.1 | Identification of potential additional measures

Phytosanitary measures are currently applied to *Pinus* spp. plants for planting, to naturally and artificially dwarfed plants for planting, to *Pinales* plants and to imported wood of conifers (see Sections 3.3.2 and 3.4.1 for prohibitions and specific requirements).

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 7.

TABLE 7 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	Source imports from pest-free countries or areas.	Entry/spread
Growing plants in isolation	Growing plants under insect-proof net may have only a limited effect (EFSA PLH Panel, 2022)	Entry (reduce contamination/infestation)/spread
Use of resistant and tolerant plant species/varieties	A list of *Pinus* species that are not attacked by *M. matsumurae* is provided by Anderson et al. (1976) and McClure et al. (1983). European *Pinus* species belonging to the *Pinaster* subsection might be tolerant/resistant to *M. matsumurae* attack, but this is uncertain (see Section 3.1.3)	Establishment/impact
Roguing and pruning	Infested plants may be felled and removed from the stands (Zhang et al., 2007)	Entry/spread/impact
Biological control and behavioural manipulation	Several predators and some entomopathogenic fungi may regulate the population of the pests (see Section 3.1.2), among them, *Harmonia axyridis* (Wang, 1982; McClure, 1986). If *M. matsumurae* and *M. pini* are distinct species, whether natural enemies of *M. pini* in the EU would effectively control *M. matsumurae* to below damaging levels is uncertain	Entry/establishment/spread impact
Chemical treatments on crops including reproductive material	Natural insecticides (neem extracts and carvacrol) mixed with phosphamidon by trunk injection are effective on ornamental trees or nurseries (Lee et al., 2000). Contact insecticides could reduce the infestation by mobile stages but sessile stages hidden in the bark are difficult to be reached (EFSA PLH Panel, 2022)	Entry/establishment/spread/impact
Chemical treatments on consignments or during processing	Systemic and contact insecticides may be used to control the pests on young plants (Lee et al., 2000). Chemical fumigation of infested wood and wood chips with methyl bromide at a dosage of 30 g m^{-3} and at a temperature of no more than 20°C for 24 h is effective (Zhang et al., 2007), but this active substance is banned on the EU market	Entry/spread
Physical treatments on consignments or during processing	Bark peeling of felled trees (Zhang et al., 2007)	Entry/spread
Cleaning and disinfection of facilities, tools and machinery	Motor vehicles can carry passively the pests (Anderson et al., 1976), but the efficacy of disinfection by washing, sweeping of fumigation is not proven	Entry/spread
Waste management	Chipping, burning, incineration of infested trees and residual bark after felling. Restriction in waste movement	Establishment/spread
Heat and cold treatments	High temperature treatment of infested wood (70°C for 6 h) is effective but expensive and unpractical (Zhang et al., 2007)	Entry/spread
Post-entry quarantine and other restrictions of movement in the importing country	This information sheet covers post-entry quarantine (PEQ) of relevant commodities; temporal, spatial and end-use restrictions in the importing country for import of relevant commodities; prohibition of import of relevant commodities into the domestic country 'Relevant commodities' are plants, plant parts and other materials that may carry pests, either as infection, infestation or contamination Appropriate for pests infesting plants for planting that are difficult to detect	Establishment/spread

3.6.1.2 | *Additional supporting measures*

Potential additional supporting measures are listed in Table 8.

TABLE 8 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	Visual examination of plants or other regulated articles before and at export to assess the presence of the pests or to determine compliance with phytosanitary regulations (ISPM 5). Eggs and sessile stages are not easy to detect visually. Trapping and luring techniques can enhance the possibility to detect the pests. Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques.	Entry/establishment/spread
Laboratory testing	Appropriate diagnostic protocols, based on both morphology and molecular techniques are needed for a reliable identification of the pests (see Section 3.1.1) Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests.	Entry/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. 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	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)	Entry/spread
Certified and approved premises	Plants or plant material coming from an approved premises e.g. in a pest-free area (Table 7), can enhance the likelihood that the commodity is not infested. 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.	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).	Spread
Surveillance	ISPM 5 defines surveillance as an official process which collects and records data on pest occurrence or absence by survey, monitoring or other procedures.	Entry/establishment/spread

3.6.1.3 | *Biological or technical factors limiting the effectiveness of measures*

- Plants can be asymptomatic in early phase of infestation or when infestation is low.
- All life stages are small and difficult to detect visually, being hidden beneath bark flakes or inside bark cracks.
- Morphology-based identification may not be reliable; time consuming molecular testing is needed.
- Host plants (*Pinus* sp.) are widely distributed throughout the EU, mainly in the northern part.
- Mobile stages can easily spread by support of air currents, birds and mammals; fixed stages can be transported via wood with bark or motor vehicles.

3.7 | Uncertainty

A key uncertainty is whether *M. pini* is a synonym of *M. matsumurae*. As *M. pini* is widespread in the EU, the direct consequence of this uncertainty is the presence or absence of *M. matsumurae* in the EU territory.

4 | CONCLUSIONS

M. matsumurae satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest, assuming *M. pini* is not a synonym, which is identified as a key uncertainty. The conclusions to this pest categorisation are summarised in Table 9.

TABLE 9 The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column).

Criterion of pest categorisation	Panel's conclusions against criterion in regulation (EU) 2016/2031 regarding union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The name of the species is valid but disputed. Given the absence of consensus regarding the taxonomic relationship between *M. matsumurae* and *M. pini*, this pest categorisation accepts both as valid names based on the latest published information	Its identity is not firmly established as there is uncertainty regarding the taxonomic relationship with *Matsucoccus pini* (Green), a species widespread in Europe
Absence/presence of the pest in the EU (Section 3.2)	*M. matsumurae* is not present in the EU territory	If *M. pini* is a synonym, then the organism would be considered widespread in the EU
Pest potential for entry, establishment and spread in the EU (Section 3.4)	All life stages of *M. matsumurae* could enter the EU on plants for planting. Host availability and climatic conditions suggest that *M. matsumurae* could establish in the EU. Wind and air currents would enable local spread of mobile nymphs. All development stages can be moved with host plants, including plants for planting, facilitating long-distance spread	None
Potential for consequences in the EU (Section 3.5)	The introduction of *M. matsumurae* could have economic and environmental impacts on pine forests. However, there is a considerable uncertainty on the magnitude of impact	None
Available measures (Section 3.6)	*Pinus* sp. plants from third countries are banned from entering into the EU. Wood of conifers (Pinales) from third countries can be imported under specific conditions	None
Conclusion (Section 4)	*M. matsumurae* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest, assuming *M. pini* is not a synonym, which is a key uncertainty	
Aspects of assessment to focus on/ scenarios to address in future if appropriate	It would be very useful to resolve the taxonomic issue highlighted in Section 3.1.1	

ABBREVIATIONS

EPPO	European and Mediterranean Plant Protection Organisation
FAO	Food and Agriculture Organisation
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
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, 2023)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2023)
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, 2023)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2023)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2023)

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 & 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, 2023)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2023)
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, 2023)
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, 2023)
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, 2023)

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CONFLICT OF INTEREST

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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, Emilio Stefani, Hans-Hermann Thulke, Wopke Van der Werf, Antonio Vicent Civera, Jonathan Yuen, and Lucia Zappalà.

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REFERENCES

Ahmed, M. Z., Ray, C. H., Moore, M. R., & Miller, D. R. (2020). The *Matsucoccus* Cockerell, 1909 of Florida (Hemiptera: Coccomorpha: Matsucoccidae): Potential pests of Florida pines. *Insecta Mundi*, *0810*, 1–31.

Albrecht, A., Rinne, V., Soderman, G., & Matila, K. (2015). Check list of Finnish Hemiptera. *Jalla, Bulletin of the Finnish Expert Group on Hemiptera*, *1*, 1–29.

Anderson, J. F., Ford, R. P., Kegg, J. D., & Risley, J. (1976). The Red Pine Scale in North America. A report to the 1975 Eastern plant board. The Connecticut Agricultural Experiment Station, New Haven. *Bulletin*, *765*, 8. https://doi.org/10.5962/bhl.title.51088

Baker, R. H. A. (2002). Predicting the limits to the potential distribution of alien crop pests. In G. J. Hallman & C. P. Schwalbe (Eds.), *Invasive arthropods in agriculture: Problems and solutions* (pp. 207–241). Science Publishers Inc.

Bean, J. L., & Godwin, A. A. (1971). *Red pine scale. Forest Pest Leaflet, 10*. USDA Forest Service.

Ben-Dov, Y. (2011). An updated checklist of the scale insects (Hemiptera: Coccoidea) of the Margarodidae sensu lato group. *Zootaxa*, *2859*(1), 1–62. https://doi.org/10.11646/zootaxa.2859.1

Boberg, J., & Björklund, N. (2022). *SLU Risk Assessment of Plant Pests at the Swedish University of Agricultural Sciences. Is* Matsucoccus matsumurae *present in Sweden? Swedish Univeristy of Agricultural Sciences*.

Booth, J. M., & Gullan, P. J. (2006). Synonymy of three pestiferous *Matsucoccus* scale insects (Hemiptera: Coccoidea: Matsucoccidae) based on morphological and molecular evidence. *Proceedings of the Entomological Society of Washington*, *108*(4), 749–760.

Bossard, M., Feranec, J., & Otahel, J. (2000). *CORINE land cover technical guide – Addendum 2000*. Tech. Rep. 40. European Environment Agency. https://www.eea.europa.eu/ds_resolveuid/032TFUPGVR

Branco, M., Lettere, M., Franco, J. C., Binazzi, A., & Jactel, H. (2006). Kairomonal response of predators to three pine bast scale sex pheromones. *Journal of Chemical Ecology*, *32*, 1577–1586. https://doi.org/10.1007/s10886-006-9071-6

Büttner, G., Kosztra, B., Maucha, G., & Pataki, R. (2012). *Implementation and achievements of CLC2006*. Tech. rep. European Environment Agency. http://www.eea.europa.eu/ds_resolveuid/GQ4JECM8TB

CABI (Centre for Agriculture and Bioscience International). (online). *Datasheet Matsucoccus matsumurae*. https://www.cabi.org/isc/datasheet/75314 [Accessed on 14 May 2024].

Cheng, H.-Y., & Ming, W.-J. (1979). Population dynamics and biological control of *Matsucoccus matsumurae* Kuwana (Homoptera: Margarodidae). *Acta Entomologia Sinica*, *22*(2), 149–155.

Choi, J., Cha, D., Kim, D.-S., & Lee, S. (2019). Review of Japanese Pine Bast Scale, *Matsucoccus matsumurae* (Kuwana) (Coccomorpha: Matsucoccidae), occurring on Japanese black pine (*Pinus thunbergii* Parl.) and Japanese red pine (*P. densiflora* Siebold & Zucc.) from Korea. *Forests*, *10*(639), 1–15. https://doi.org/10.3390/f10080639

Choi, W., & Park, Y.-S. (2012). Dispersal patterns of exotic forest pests in South Korea. *Insect Science*, *19*, 535–548. https://doi.org/10.1111/j.1744-7917.2011.01480.x

Chung, Y.-J., Park, Y.-S., Chon, T.-S., Shin, S.-C., & Park, J.-D. (2000). Dispersal pattern of the black pine bast scale *Matsucoccus thunbergianae* (Homoptera: Margarodidae) in Korea. *Journal of Korean Forest Society*, *89*(3), 306–309.

de Rigo, D. (2012). Semantic Array programming for environmental modelling: Application of the Mastrave library. In R. Seppelt, A. A. Voinov, S. Lange, & D. Bankamp (Eds.), *International environmental modelling and software society (iEMSs) 2012 international congress on environmental modelling and software – Managing resources of a limited planet: Pathways and visions under uncertainty, sixth biennial meeting* (pp. 1167–1176). http://scholarsarchive.byu.edu/iemssconference/2012/Stream-B/69

de Rigo, D., Caudullo, G., Busetto, L., & San-Miguel-Ayanz, J. (2014). Supporting EFSA assessment of the EU environmental suitability for exotic forestry pests: Final report. *EFSA Supporting Publications*, *11*(3), EN-434. https://doi.org/10.2903/sp.efsa.2014.EN-434

de Rigo, D., Caudullo, G., Houston Durrant, T., & San-Miguel-Ayanz, J. (2016). The European atlas of forest tree species: Modelling, data and information on forest tree species. In J. San-Miguel-Ayanz, D. de Rigo, G. Caudullo, T. Houston Durrant, & A. Mauri (Eds.), *European atlas of forest tree species*. Publication Office of the European Union. https://w3id.org/mtv/FISE-Comm/v01/e01aa69

de Rigo, D., Caudullo, G., San-Miguel-Ayanz, J., & Barredo, J. I. (2017). *Robust modelling of the impacts of climate change on the habitat suitability of forest tree species*. Publication Office of the European Union. https://doi.org/10.2760/296501

EFSA PLH Panel (EFSA Panel on Plant Health), Bragard, C., Baptista, P., Chatzivassiliou, E., Di Serio, F., Jaques Miret, J. A., Justesen, A. F., MacLeod, A., Magnusson, C. S., Milonas, P., Navas-Cortes, J. A., Parnell, S., Potting, R., Reignault, P. L., Stefani, E., Thulke, H.-H., Van der Werf, W., Vicent Civera, A., Yuen, J., … Gonthier, P. (2022). Scientific Opinion on the commodity risk assessment of bonsai plants from China consisting of *Pinus parviflora* grafted on *Pinus thunbergii*. *EFSA Journal*, *20*(2), 7077. https://doi.org/10.2903/j.efsa.2022.7077

EFSA PLH Panel (EFSA Panel on Plant Health), Jeger, M., Bragard, C., Caffier, D., Candresse, T., Chatzivassiliou, E., Dehnen-Schmutz, K., Gregoire, J.-C., Jaques Miret, J. A., MacLeod, A., Navajas Navarro, M., Niere, B., Parnell, S., Potting, R., Rafoss, T., Rossi, V., Urek, G., Van Bruggen, A., Van Der Werf, W., … Gilioli, G. (2018). Guidance on quantitative pest risk assessment. *EFSA Journal*, *16*(8), 5350. https://doi.org/10.2903/j.efsa.2018.5350

EFSA Scientific Committee, Hardy, A., Benford, D., Halldorsson, T., Jeger, M. J., Knutsen, H. K., More, S., Naegeli, H., Noteborn, H., Ockleford, C., Ricci, A., Rychen, G., Schlatter, J. R., Silano, V., Solecki, R., Turck, D., Benfenati, E., Chaudhry, Q. M., Craig, P., … Younes, M. (2017). Scientific opinion on the guidance on the use of the weight of evidence approach in scientific assessments. *EFSA Journal*, *15*(8), 4971. https://doi.org/10.2903/j.efsa.2017.4971

EPPO (European and Mediterranean Plant Protection Organization). (2019). *EPPO codes*. https://www.eppo.int/RESOURCES/eppo_databases/eppo_codes

EPPO (European and Mediterranean Plant Protection Organization). (online). *EPPO global database*. https://gd.eppo.int [Accessed on 14 May 2024].

EUFGIS (European Information System on Forest Genetic Resources). (online). *EUFGIS database*. http://portal.eufgis.org

EUROPHYT. (online). *European Union notification system for plant health interceptions*. EUROPHYT. http://ec.europa.eu/food/plant/plant_health_biosecurity/europhyt/index_en.htm

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

FAO (Food and Agriculture Organization of the United Nations). (2018). *International Standards for Phytosanitary Measures. ISPM 5 glossary of phytosanitary terms*. FAO. https://www.ippc.int/en/publications/621/

FAO (Food and Agriculture Organization of the United Nations). (2023). *ISPM (International Standards for Phytosanitary Measures) No 5. Glossary of phytosanitary terms*. FAO. https://assets.ippc.int/static/media/files/publication/en/2023/07/ISPM_05_2023_En_Glossary_PostCPM-17_2023-07-12_Fixed.pdf

Foldi, I. (2004). The Matsucoccidae in the Mediterranean basin with a world list of species (Hemiptera: Sternorrhyncha: Coccoidea). *Annales de la Société Entomologique de France*, *40*(2), 145–168. https://doi.org/10.1080/00379271.2004.10697412

García Morales, M., Denno, B. D., Miller, D. R., Miller, G. L., Ben-Dov, Y., & Hardy, N. B. (2016). *ScaleNet: A literature-based model of scale insect biology and systematics*. http://scalenet.info/catalogue/

Gertsson, C.-A. (2001). An annotated checklist of the scale insects (Homoptera: Coccoidea) of Sweden [Förtechnung över Sveriges sköldlöss]. *Entomologisk Tidskrift*, *122*(3), 123–130.

Griessinger, D., & Roy, A.-S. (2015). *EPPO codes: A brief description*. https://www.eppo.int/media/uploaded_images/RESOURCES/eppo_databases/A4_EPPO_Codes_2018.pdf

Hibbard, B. E., Lanier, G. N., Parks, S. C., Qi, Y. T., Webster, F. X., & Silverstein, R. M. (1991). Laboratory and field tests with the synthetic sex pheromone of three *Matsucoccus* pine bast scales. *Journal of Chemical Ecology*, *17*(1), 89–102. https://doi.org/10.1007/BF00994424

Hiederer, R., Houston Durrant, T., Granke, O., Lambotte, M., Lorenz, M., Mignon, B., & Mues, V. (2007). *Forest focus monitoring database system – Validation methodology. Vol. EUR 23020 EN of EUR – Scientific and technical research*. Office for Official Publications of the European Communities. https://doi.org/10.2788/51364

Hiederer, R., Houston Durrant, T., & Micheli, E. (2011). *Evaluation of BioSoil demonstration project – Soil data analysis. Vol. 24729 of EUR – Scientific and technical research*. Publications Office of the European Union. https://doi.org/10.2788/56105

Houston Durrant, T., & Hiederer, R. (2009). Applying quality assurance procedures to environmental monitoring data: A case study. *Journal of Environmental Monitoring*, *11*(4), 774–781. https://doi.org/10.1039/b818274b

Houston Durrant, T., San-Miguel-Ayanz, J., Schulte, E., & Suarez Meyer, A. (2011). *Evaluation of BioSoil demonstration project: forest biodiversity – Analysis of biodiversity module. Vol. 24777 of EUR – Scientific and technical research*. Publications Office of the European Union. https://doi.org/10.2788/84823

Hu, H., & Wang, L. (1976). Studies on the pine bast scale *Matsucoccus massonianae* Y. and H (I). *Acta Entomologia Sinica*, *19*, 383–392. https://doi.org/10.16380/j.kcxb.1976.04.003

INRA. (online). *INRA, Biogeco, EvolTree. GD² database*. http://gd2.pierroton.inra.fr

Jansen, M. G. M. (1999). An annotated list of the scale insects (Hemiptera: Coccoidea) of The Netherlands. *Entomologica*, *33*, 197–206.

Kim, J., Kim, D.-S., Matsuyama, S., Lee, S. M., Lee, S.-C., & Park, K. I. (2016). Development of a pheromone trap for monitor black pine bast scale, *Matsucoccus thunbergianae* (Hemiptera: Margarodidae). *Journal of Asia-Pacific Entomology*, *19*(2016), 899–902. https://doi.org/10.1016/j.aspen.2016.08.003

Kim, K. C., Kim, J. W., & Lim, G. K. (1995). Biological and physiochemical structure change of black pine bast scale (*Matsucoccus thunbergianae*) in coast area of Korea. *Korean Journal of Applied Entomology*, *34*(3), 174–180.

Kim, K. C., & Oh, K. I. (1992). Bionomics, host range and analysis of damage aspects on the black pine bast scale, *Matsucoccus thunbergianae* (Homoptera: Cocoidea), in the coastal area of southwest Korea. *Korean Journal of Applied Entomology*, *31*(4), 386–395.

Kosztarab, M., & Kozár, F. (1988). *Scale insects of Central Europe*. Akadémiai Kiadó.

Kottek, M., Grieser, J., Beck, C., Rudolf, B., & Rubel, F. (2006). World map of Köppen-Geiger climate classification updated. *Meteorologische Zeitschrift*, *15*, 259–263.

Lanier, G. N., Qi, Y.-T., West, J. R., Park, S. C., Webster, F. X., & Silverstein, R. M. (1989). Identification of the sex pheromone of three *Matsucoccus* pine bast scales. *Journal of Chemical Ecology*, *15*(5), 1645–1659.

Lee, C. J., Kim, D. S., Young, H. C., Lee, S. M., Lee, S. J., & Lee, D. W. (2018). Monitoring of black pine bast scale, *Matsucoccus thunbergianae* (Homoptera: Margarodidae) using yellow sticky trap. *Korean Journal of Applied Entomology*, *57*(3), 143–149. https://doi.org/10.5656/KSAE.2018.05.0.016

Lee, S.-C., Kwon, J. H., Cha, D. J., Kim, D. S., Lee, D. H., Seo, S. M., Lee, H. R., Huh, M.-J., Jung, M., & Park, I.-K. (2019). Effects of pheromone dose and trap height on capture of a bast scale of pine, *Matsucoccus thunbergianae* (Hemiptera: Margarodidae) and development of a new synthesis method. *Journal of Economic Entomology*, *112*(4), 1752–1759. https://doi.org/10.1093/jee/toz079

Lee, S. G., Park, J. D., & Ahn, Y. J. (2000). Effectiveness of neem extracts and carvacrol against *Thecodiplosis japonensis* and *Matsucoccus thunbergianae* under field conditions. *Pest Management Science: Formerly Pesticide Science*, *56*, 706–710.

Lim, E., Lee, S. M., Kim, D. S., Kim, J. B., Lee, S. H., Choi, K. S., Park, C. G., & Lee, D. W. (2012). The spread of Black Pine Bast Scale, *Matsucoccus thunbergianae* (Hemiptera: Margarodidae) in Korea. *Korean Journal of Applied Entomology*, *51*(1), 59–65. https://doi.org/10.5656/KSAE.2011.12.0.070

Liu, W., Xie, Y., Dong, J., Xue, J., Zhang, Y., Lu, Y., & Wu, J. (2014). Pathogenicity of three entomopathogenic fungi to *Matsucoccus matsumurae*. *PLoS One*, *9*(7), e103350. https://doi.org/10.1371/journal.pone.0103350

Liu, W., Xie, Y., Dong, J., Yang, Q., Xue, J., & Tian, F. (2014). New research on *Matsucoccus matsumurae* (Kuwana) (Hemiptera: Matsucoccidae) in China. *Acta Zoologia Bulgarica*, *6*, 95–102.

Maine Forest Service, Forest Health and Monitoring Division and Department of Agriculture, Conservation and Forestry. (2019). *Red pine scale Matsucoccus matsumarae (Kuwana)*. Forest service documents, 211. :https://digitalmaine.com/for_docs/211

McClure, M. S. (1976). Colonization and establishment of the red pine scale, *Matsucoccus resinosae* (Homoptera: Margarodidae) in a Connecticut plantation. *Environmental Entomology*, *5*, 943–947.

McClure, M. S. (1977). Population dynamics of the red pine scale, *Matsucoccus resinosae* (Homoptera: Margarodidae): The influence of resinosis. *Environmental Entomology*, *6*, 789–795. https://doi.org/10.1093/ee/6.6.789

McClure, M. S. (1983). Temperature and host availability affect the distribution of *Matsucoccus matsumurae* (Kuwana) (Homoptera: Margarodidae) in Asia and North America. *Annals of the Entomological Society of America*, *76*, 761–765. https://doi.org/10.1093/aesa/76.4.761

McClure, M. S. (1985). Susceptibility of pure and hybrid stands of *Pinus* to attack by *Matsucoccus matsumurae* in Japan (Homoptera: Coccoidea: Margarodidae). *Environmental Entomology*, *14*, 535–538.

McClure, M. S. (1986). Role of predators in regulation of endemic populations of *Matsucoccus matsumurae* (Homoptera: Margarodidae) in Japan. *Environmental Entomology*, *15*(4), 976–983.

McClure, M. S. (1989). Importance of weather to the distribution and abundance of introduced adelgid and scale insects. *Agricultural and Forest Meteorology*, *47*, 291–302. https://doi.org/10.1016/0168-1923(89)90101-9

McClure, M. S., Dahlsten, D. L., Debarr, G. L., & Hedden, R. L. (1983). Control of pine bast scale in China. *Journal of Forestry*, *81*(7), 474–478.

Miller, D., & Park, S. C. (1987). A new species of *Matsucoccus* (Homoptera: Coccoidea: Margarodidae) from Korea. *Korean Journal of Plant Protection*, *26*, 49–62.

Miller, D. R., Rung, A., & Parikh, G. (2014). Scale insects, edition 2, a tool for the identification of potential pest scales at U.S.A. ports-of-entry (Hemiptera, Sternorrhyncha, Coccoidea). *Zookeys*, *431*, 61–78. https://doi.org/10.3897/zookeys.431.7474

Ren, L., Li, Z., Li, Y., & Guo, Y. (2016). Revision of scientific names for the main insect species in the monograph "Forest Insects of China (2nd Edition, 1992)". *Scientia Silvae Sinicae*, *52*(4), 110–115. https://doi.org/10.11707/j.1001-7488.20160413

Rieux, R. (1976). *Matsucoccus pini* Green (1925) (Homoptera, Margarodidae) dans de sud-est de la France. Variations intraspecifiques. Comparaison avec des especes les plus proches. *Annales de Zoologie Ecologie Animale*, *8*, 231–263.

San-Miguel-Ayanz, J. (2016). The European Union forest strategy and the forest information system for Europe. In J. San-Miguel-Ayanz, D. de Rigo, G. Caudullo, T. Houston Durrant, & A. Mauri (Eds.), *European atlas of Forest tree species*. Publication Office of the European Union. https://w3id.org/mtv/FISE-Comm/v01/e012228

San-Miguel-Ayanz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., & Mauri, A. (Eds.). (2016). *European atlas of forest tree species*. Publication Office of the European Union. https://w3id.org/mtv/FISE-Comm/v01

Sayers, E. W., Cavanaugh, M., Clark, K., Ostell, J., Pruitt, K. D., & Karsch-Mizrachi, I. (2020). Genbank. *Nucleic Acids Research*, *48*, D84–D86. https://doi.org/10.1093/nar/gkz956

Schoch, C. L., Ciufo, S., Domrachev, M., Hotton, C. L., Kannan, S., Khovanskaya, R., Leipe, D., Mcveigh, R., O'Neill, K., Robbertse, B., Sharma, S., Soussov, V., Sullivan, J. P., Sun, L., Turner, S., & Karsch-Mizrachi, I. (2020). NCBI taxonomy: A comprehensive update on curation, resources and tools. *Database*, *2020*, baaa062. https://doi.org/10.1093/database/baaa062

Stephens, G. R., & Aylor, D. E. (1978). Aerial dispersal of red pine scale, *Matsucoccus resinosae* (Homoptera; Margarodidae). *Environmental Entomology*, *7*, 556–563.

Suh, S.-J. (2020). Host plant list of the scale insects (Hemiptera: Coccomorpha) in South Korea. *Insecta Mundi*, *757*, 1–26.

Toy, S. J., & Newfield, M. J. (2010). The accidental introduction of invasive animals as hitchhikers through inanimate pathways: A New Zealand perspective. *Revue Scientifique et Technique (International Office of Epizootics)*, *29*(1), 123–133.

TRACES-NT. (online). TRAde control and expert system. https://webgate.ec.europa.eu/tracesnt

Wang, L.-Y. (1982). Control of *Matsucoccus massonianae* Young et Hu (Hom: Margarodidae) by *Leis axyridis* (Pallas). *Natural Enemies of Insects*, *4*(4), 37–39.

Wang, Z. M., Du, J. S., Zhang, L. J., Zhong, X. W., & Pi, Z. Q. (2009). The analysis for the pine bark scale, *Matsucoccus matsumurae* (Kuwana) invasion and spread possible in the Northeast China. *Chinese Agricultural Science Bulletin*, *25*(10), 107–111.

Won, K.-R., Hong, N.-E., Jung, S.-Y., Kwang, S.-L., Yoo, B.-H., & Byeon, H.-S. (2015). Estimation of damage to black pine wood (*Pinus thunbergii* Parl.) caused by *Matsucoccus thunbergianae* Miller and Park, Bangladesh. *Journal of Botany*, *44*(5), 679–687.

Xu, H., Qiang, S., Han, Z., Guo, J., Huang, Z., Sun, H., He, S., Ding, H., Wu, H., & Wan, F. (2006). The status and causes of alien species invasion in China. *Biodiversity and Conservation*, *15*, 2893–2904. https://doi.org/10.1007/s10531-005-2575-5

Xu, Z. R., Wanna, R., Ren, L., Yu, H., Huang, J., & Wang, Z. (2009). The role of parasitic wasps in biological control on exotic harmful scale insects. In Y. Wu & X.-y. Wang (Eds.), *International workshop on biological control of invasive species of forests, 20–25 September 2007, Beijing, China* (pp. 64–70). USDA Forest Service.

Yang, M. D., Shen, J., & Qy, W. (1999). Quarantine techniques for *Matsucoccus matsumurae*. *Journal of Zhejiang Forestry Science*, *19*(5), 40–43.

Yang, Q., Xie, Y. P., Fan, J. H., Shao, S. F., Wu, J., Wang, Y. S., Zhao, C. S., & Zhang, Y. W. (2013). Genetic differentiation of *Matsucoccus matsumurae* from three geographic populations in China. *Scientia Silvae Sinicae*, *49*(12), 88–96. https://doi.org/10.11707/j.1001-7488.20131213

Young, B. L., Hu, J. L., & Ren, Z. Y. (1976). Pine bast scales from China. *Acta Entomologica Sinica*, *19*, 199–204.

Young, B. L., Miller, D. R., & McClure, M. S. (1984). Attractivity of the female sex pheromone of Chinese *Matsucoccus matsumurae* (Kuwana) to male of *M. matsumurae* in Japan and to males of *M. resinosae* Bean and Godwin in the United States (Margarodidae, Coccoidea, Homoptera). *Contributions of the Shanghai Institut of Entomology*, *4*, 1–20.

Yuan, F., Liu, S., Hu, Y., Zhang, Y., Dai, Y., & Cao, R. (2014). The impact of climate change on *Matsucoccus matsumurae* dispersal in Northeast of China. *Acta Ecologica Sinica*, *34*(22), 6711–6721. https://doi.org/10.5846/stxb201302170272

Zhang, S., Liu, X., Wang, M., & Liu, Q. (2007). Monitoring and investigation methods for the *Matsucoccus matsumurae* (Kuwana) epidemic and blocking and extermination measures. *Jilin Forestry Science and Technology*, *36*(2), 39–44.

Zhiming, W., Jisheng, D., Lijun, Z., Xiaowei, Z., & Zhongqing, P. (2009). Analysis on the invasion and spread of Japanese pine scale in Northeast China. *Chinese Agricultural Science Bulletin*, *25*(10), 107–111.

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APPENDIX A

Matsucoccus matsumurae hosts

Source: literature as indicated.

Host name (all are *Pinus* species)	Common name	Reference	Grown in EU as an amenity or ornamental plant?	Listed by JRC as a species used in European forestry?
Pinus banksiana	Jack pine	Kim and Oh (1992)	Yes	No
Pinus densiflora	Japanese red pine	García Morales et al. (2016), Suh (2020)	Yes	No
Pinus densiflora cv. *umbraculifera*	Japanese red pine	Xu et al. (2009)	Yes	No
Pinus densiflora cv. *pendula*	Japanese red pine	Xu et al. (2009)	Yes	No
Pinus halepensis	Aleppo pine	Foldi (2004)	Yes	Yes
Pinus kesiya var. *langbianensis* (syn. *P. insularis*)	Khasi pine	McClure (1985)	Yes	No
Pinus koraiensis	Korean pine	EFSA PLH Panel (2022)	Yes	No
Pinus luchuensis	Luchu pine	Xu et al. (2009)	Yes	No
Pinus massoniana × *P. thunbergii*	–	Xu et al. (2009)	–	No
Pinus mugo*	Dwarf mountain pine	Foldi (2004)	Yes	Yes
Pinus nigra*	Black pine	Foldi (2004)		Yes
Pinus pinaster	Maritime pine	Foldi (2004)	Yes	Yes
Pinus pinea	Stone pine	Foldi (2004)	Yes	Yes
Pinus pumila	Japanese stone pine	Zhiming et al. (2009)	Yes	No
Pinus resinosa	Red pine	García Morales et al. (2016)	Yes	No
Pinus rigida	Pitch pine	Foldi (2004)	Yes	No
Pinus strobus	Weymouth pine	Kim and Oh (1992)	Yes	No
Pinus sylvestris*	Scots pine	Foldi (2004)	Yes	Yes
Pinus taeda	Loblolly pine	Kim and Oh (1992)	Yes	No
Pinus taiwanensis	Taiwan red pine	Xu et al. (2009)	Yes	No
Pinus tabuliformis	Chinese pine	García Morales et al. (2016)	Yes	No
Pinus massoniana	Chinese red pine	García Morales et al. (2016)	Yes	No
Pinus thunbergii	Japanese black pine	García Morales et al. (2016), Miller and Park (1987), Kim and Oh (1992), Lim et al. (2012), Won et al. (2015), Choi et al. (2019)	Yes	No

*The reports of *P. nigra*, *P. mugo* and *P. sylvestris* as hosts for *M. matsumurae* by Foldi (2004) are not supported by references and should be treated with uncertainty.

APPENDIX B

Distribution of *Matsucoccus matsumurae*

Distribution records based on CABI (online), García Morales et al. (2016), Foldi (2004), Maine Forest Service (2019).

Region	Country	Sub-national (e.g. state)	Status
North America	USA	Connecticut	García Morales et al. (2016)
		New Jersey	García Morales et al. (2016)
		New York	García Morales et al. (2016)
		Massachusetts	García Morales et al. (2016)
		New Hampshire	García Morales et al. (2016)
		Pennsylvania	García Morales et al. (2016)
		Rhode Island	García Morales et al. (2016)
		Maine	Maine Forest Service (2019)
Central America			No records, presumed absent
Caribbean			No records, presumed absent
South America			No records, presumed absent
Europe			No records, presumed absence
Africa			No records, presumed absent
Asia	Japan	Honshu	CABI (online)
	China	Anhui	García Morales et al. (2016)
		Beijing	García Morales et al. (2016)
		Hebei	Foldi (2004)
		Jiangsu	Foldi (2004)
		Jilin	García Morales et al. (2016)
		Liaoning	García Morales et al. (2016)
		Shandong	García Morales et al. (2016)
		Shanghai	García Morales et al. (2016)
		Zhejiang	García Morales et al. (2016)
	South Korea		García Morales et al. (2016)
Oceania			No records, presumed absent

APPENDIX C

Methodological notes on Figure 3

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.

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, 2016, 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 data sets 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 data sets 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, http://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

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

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 & Hiederer, 2009). The complete Forest Focus dataset covers 30 European Countries with more than 8600 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 data set used in the C-SMFA RPP model came from the Biodiversity module, in which plant species from both the tree layer and the ground vegetation layer was recorded for more than 3300 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 3200 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 EEUFGIS (online).

Georeferenced Data on Genetic Diversity (GD^2) is a smaller geodatabase as well. It provides information about a 63 species that are of interest for genetic conservation. It counts 6254 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).

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 1 km^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

[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), 1–8.

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.

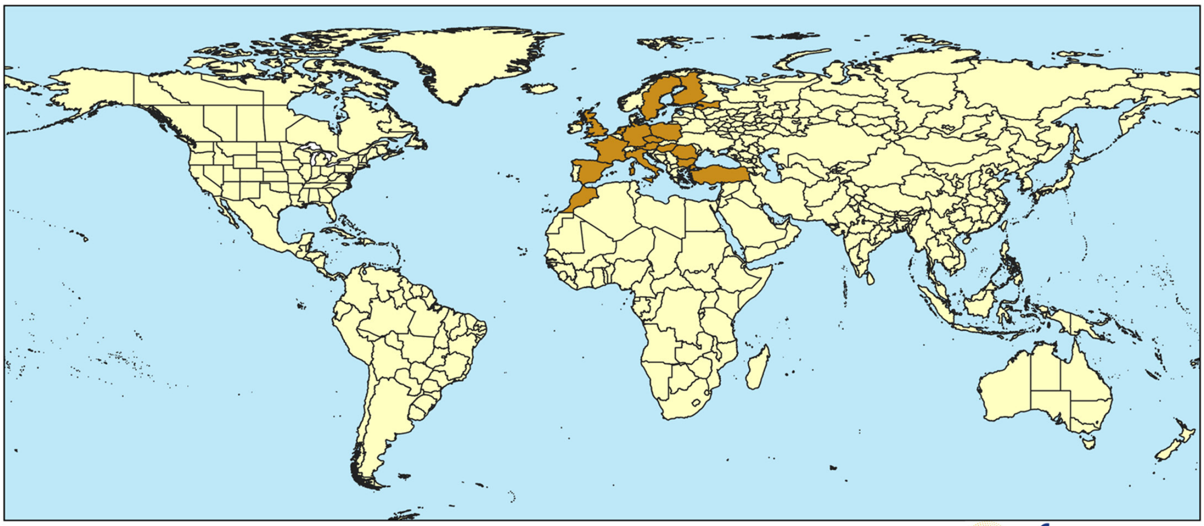
The robustness of RPP maps depends strongly on sample plot density, as areas with few field observations are mapped with greater uncertainty. This uncertainty is shown qualitatively in maps of 'RPP trustability'. RPP trustability is computed on the basis of aggregated equivalent number of sample plots 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, 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 × 10 pixels or 25 × 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

Global distribution of *Matsucoccus pini*

Distribution records are based on García Morales et al. (2016).



World Distribution of *Matsucoccus pini*

Administrative boundaries: © FAO-UN
Data Source: Scalenet.info
Cartography: EFSA 06/2024

APPENDIX E

PRISMA 2009 Flow Diagram