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Pest categorisation of *Milviscutulus mangiferae*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Milviscutulus mangiferae* (Hemiptera: Sternorrhyncha: Coccidae), the mango shield scale, for the EU. The native range of *M. mangiferae* is uncertain. This species occurs widely in tropical and warmer subtropical regions throughout the world. Within the EU, the pest has been recorded in Italy in a greenhouse at the Botanical Garden of Padua on mango trees imported from Florida (USA); however, its establishment remains uncertain. It is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072. It is polyphagous, feeding on plant species belonging to more than 86 genera in more than 43 families including many crop and ornamental plants. It can be a serious pest of mango (*Mangifera indica*) and an occasional pest of a range of ornamental plants. Economically important crops in the EU such as citrus (*Citrus* spp.), avocado (*Persea americana*) and ornamentals such as hibiscus (*Hibiscus* spp.) and myrtle (*Myrtus communis*), are included in the host list of *M. mangiferae*. Reproduction of *M. mangiferae* is generally parthenogenetic and it completes two to three generations annually. Plants for planting, cut flowers and fruits provide potential pathways for entry into the EU. Climatic conditions in southern EU countries and host plant availability in those areas are conducive for establishment and spread. Establishment could also occur in heated greenhouses in cooler areas of the EU. The introduction of the mango shield scale is expected to have an economic impact in the EU through the reduction in yield, quality and commercial value of fruits and ornamental plants. Phytosanitary measures are available to reduce the likelihood of entry and further spread. *M. mangiferae* meets the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: mango shield scale, Hemiptera, Coccidae, pest risk, plant health, plant pest, quarantine

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1. Introduction

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

1.1.1. Background

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

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

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

1.1.2. Terms of reference

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

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1 E (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

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

1.3. Additional information

This pest categorisation was initiated following the commodity risk assessment of avocado (*Persea americana* Mill.) scions and grafted plants from Israel performed by EFSA (EFSA PLH Panel, 2021), in which *M. mangiferae* was identified as a relevant non-regulated EU pest[1] which could potentially enter the EU on *P. americana*.

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. mangiferae* EFSA has consulted the NPPO of Italy. The results of this consultation are presented in Section 3.2.2.

2.1.2. Literature search

A literature search on *M. mangiferae* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Papers relevant for the pest categorisation were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.3. Database search

Pest information, on host(s) and distribution, was retrieved from the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), the CABI databases and scientific literature databases as referred above in section 2.1.1.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

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

GenBank was searched to determine whether it contained any nucleotide sequences for *M. mangiferae* 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).

[1] The criteria for relevance of non-regulated pests in the EU is based on evidence that: (i) the pest is present in the third country under scrutiny; (ii) the pest is absent or has a limited distribution in the EU (i.e. present in three or less EU countries); (iii) the plant species is a host of the pest; (iv) one or more life stages of the pest can be associated with the specified commodity; (v) the pest may have an impact in the EU (EFSA PLH Panel, 2019).

2.2. Methodologies

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

The criteria to be considered when categorising a pest as a potential Union QP is given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel et al., 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest status. Assessing social impact is outside the remit of the Panel.

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

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (Article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/ presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes, the identity of the pest is established. *M. mangiferae* (Green) is the accepted name.

The mango shield scale, also known as mango soft scale, *M. mangiferae* (Green, 1889) (Figure 1) is an insect within the order Hemiptera, suborder Sternorrhyncha, family Coccidae. *M. mangiferae* was first described by Green in 1889, as *Lecanium mangiferae*, from *Mangifera indica* in Sri Lanka. It was also described by Green in 1904 as *Lecanium psidii* from *M. indica* in Sri Lanka, as *Lecanium wardi* by Newstead in 1917 from Molucca Apple in Guyana, as *Lecanium desolatum* by Green in 1922 from *Ficus gibbosa* in Sri Lanka, as *Lecanium ixorae* by Green in 1922 from *Ixora coccinea* in Sri Lanka, and as *Coccus kuraruensis* by Takahashi in 1939 from lemon in Taiwan (García Morales et al., 2016). Synonyms of the pest also include *Protopulvinaria mangiferae* and *Coccus mangiferae* (García Morales et al., 2016). The EPPO code[2] (Griessinger and Roy, 2015; EPPO, 2019) for this species is: MILVMA (EPPO, online).

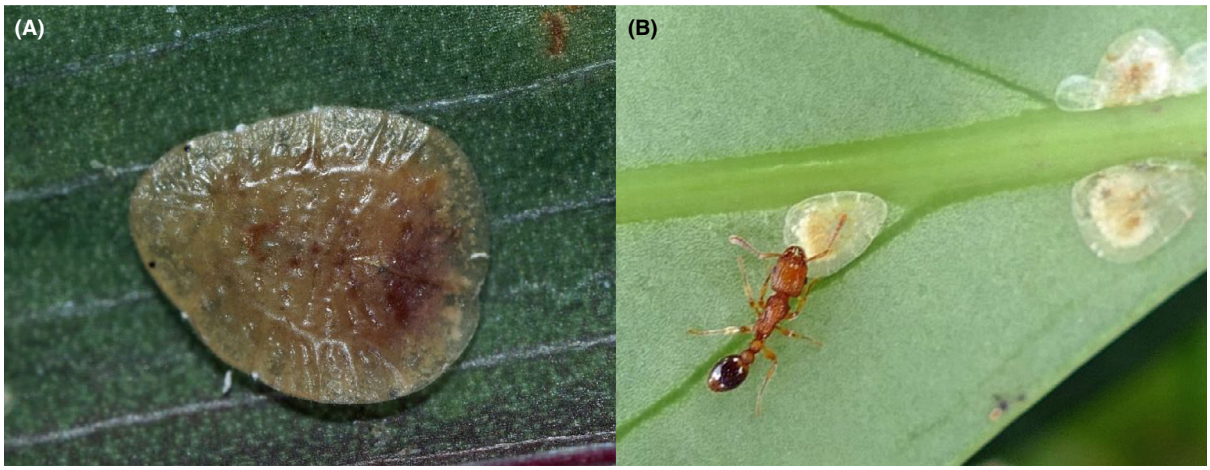

Figure 1: *Milviscutulus mangiferae*: A, adult female mango shield scale (length 4 mm) on *Dracaena* sp.; B, mango shield scales attended by an ant (*Tetramorium* sp.), on a *Schefflera* plant (Source: Chris Malumphy).

3.1.2. Biology of the pest

Reproduction of *M. mangiferae* is generally parthenogenetic although the occurrence of males at very low rates has been reported (Kasuya, 2000; EFSA, 2021). All stages can walk over the host plant to find a suitable place to settle and feed (Kasuya, 2000). They can then move for example, to find a new feeding site if the current location becomes unsuitable. Nevertheless, the first instars are the main dispersal stage and are morphologically adapted for passive dispersal by wind or on clothing and equipment. Adult females can move until they start ovipositing. After the first instar nymphs (known as crawlers) hatch, the adult females die. Females have three nymphal instars (Ben-Dov et al., 1975).

In Israel, *M. mangiferae* completes three generations per year and the peak density occurs between October and November (Wysoki et al., 1993). In Egypt, the first generation appears in spring, the second generation in summer and the third generation in autumn and winter (Attia et al., 2018; Abbas et al., 2019). *M. mangiferae* does not usually attack the fruit of mango (Anderson and MacLeod, 2008) and settles mainly on the lower side of leaves (EFSA, 2021) (Table 2).

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

Table 2: Important features of the life history strategy of *Milviscutulus mangiferae*

Life stage	Phenology and relation to host	Other relevant information
Egg	The eggs are laid under the body of female (Miller et al., 2014).	
Nymph	The crawlers settle mainly on the lower side of leaves (Plant Pests of the Middle East, online). In Israel the crawlers of the first generation appear in March–May, those of second generation in early June, and those of third generation in September (EFSA, 2021).	The duration of immature stages was estimated at 87.3 days at 20°C, 44.6 days at 25°C and 38.9 days at 30°C (Kim, 1997).
Adult	Adult females are essentially sedentary and die soon after hatching of first instar nymphs (Kasuya, 2000). Males are rare (Miller et al., 2014) and they never exceed 1% of the population (Ben-Dov et al., 1975).	The lower temperature threshold for this species was estimated at 11.7°C and the thermal constants for the development of one generation was 1,000 degree-days (Kim, 1997). On average a generation lasts 76.2 days at 25°C and 64.3 days at 30°C (Kim, 1997). In Israel the spring generation lasted 74 days, summer generation 91 days and the third generation 194 days (Hamon and Williams, 1984).

3.1.3. Host range/species affected

The mango shield scale is polyphagous, feeding on plants assigned to more than 86 genera belonging to more than 43 botanical families (Appendix A provides a full host list). It can be a serious pest of mango (*Mangifera indica*) (García Morales et al., 2016; Malumphy, 2018). In addition, *M. mangiferae* has been recorded as an occasional pest on crops such as citrus (*Citrus* spp.), coconut (*Cocos nucifera*), pineapple (*Ananas comosus*), papaya (*Carica papaya*), avocado (*Persea americana*), and guava (*Psidium guajava*) and ornamental plants (*Jasminum* spp., *Ligustrum* spp., *Hibiscus* spp., *Myrtus communis*) (García Morales et al., 2016).

3.1.4. Intraspecific diversity

No intraspecific diversity is reported for this species. As a parthenogenic species, populations of this scale insect are probably made of extremely homogenous individuals (they all come from the same stem mother), which may be diverse when considering the whole geographic/host range of the species.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, there are methods available for detection and morphological identification of *M. mangiferae*.

Detection

Careful visual examination of plants is an effective way for the detection of *M. mangiferae*. The scales occur primarily on the underside of the leaves of the host plants (Anderson and MacLeod, 2008). Plant damage might not be obvious in early infestation, but the presence of scales on the plants can be observed. During the crawler stage, infestation is difficult to detect (EFSA, 2021). However, the large amounts of honeydew, which is colonised by sooty mould fungi and cover the fruit and leaves by a thick black mass, is helpful for the detection of the insect.

One practical difficulty with detection is that *M. mangiferae* can easily be confused with the pyriform soft scale *Protopulvinaria pyriformis* (Cockerell), which is common in the Mediterranean and a pest of several ornamentals and occasionally of lemon trees (Suma and Cocuzza, 2010; Pellizzari and Porcelli, 2014). They also share many hosts such as *Citrus* spp., *Laurus nobilis* and *Schefflera* spp.

Identification

The identification of *M. mangiferae* requires microscopic examination of slide-mounted adult females and verification of the presence of key morphological characteristics. A detailed morphological

description and illustration of adult female *M. mangiferae* can be found in Abd-Rabou and Evans (2018). They also describe how to separate the closely related genus *Protopulvinaria* and include a key to separate all four species assigned to the genus *Milviscutulus*.

Molecular techniques for species identification have also been developed and GenBank contains gene nucleotide sequences for *M. mangiferae* (Yokogawa and Yahara, 2009; Lin et al., 2013; Gomez-Polo et al., 2017; Choi and Lee, 2019).

Symptoms

The main symptoms of *M. mangiferae* infestation are (Abd-Rabou and Evans, 2018; EFSA, 2021):

- large amounts of honeydew
- tree decline
- leaf yellowing
- premature leaf drop
- failure of buds to open
- death of branches and whole trees

Note that the above symptoms are common to many other plant-sap feeding insects and should not be considered as species-specific.

Description

Crawler: the body is flat and light yellow (Ben-Dov et al., 1975).

Adult: body of female flat, 4–5 mm in length, covered by a pale-green, shiny, almost transparent shield that tends to become brown, opaque and somewhat convex when and after producing eggs (Plant Pests of the Middle East, online). The body is almost triangular, bluntly pointed at the anterior apex, broadly rounded posteriorly. Preovipositing females are yellowish – green. The dorsal surface of a fully grown reproducing female is sclerotized and brown (Ben-Dov et al., 1975). Short spines extend all over the body, antennae have 6–8 segments, and the anal plates are twice as long as wide, broadening posteriorly (Plant Pests of the Middle East, online).

Miller et al. (2014) provides a detailed description of slide-mounted adult females.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

M. mangiferae is mainly a species of tropical and warmer subtropical areas (CABI, 2022, online, García Morales et al., 2016). It is distributed in many countries in Asia, South America, North America, Central America, Caribbean, Africa and Oceania (CABI, 2022, online; García Morales et al., 2016) (Figure 2). For a detailed list of countries where *M. mangiferae* is present, see Appendix B.

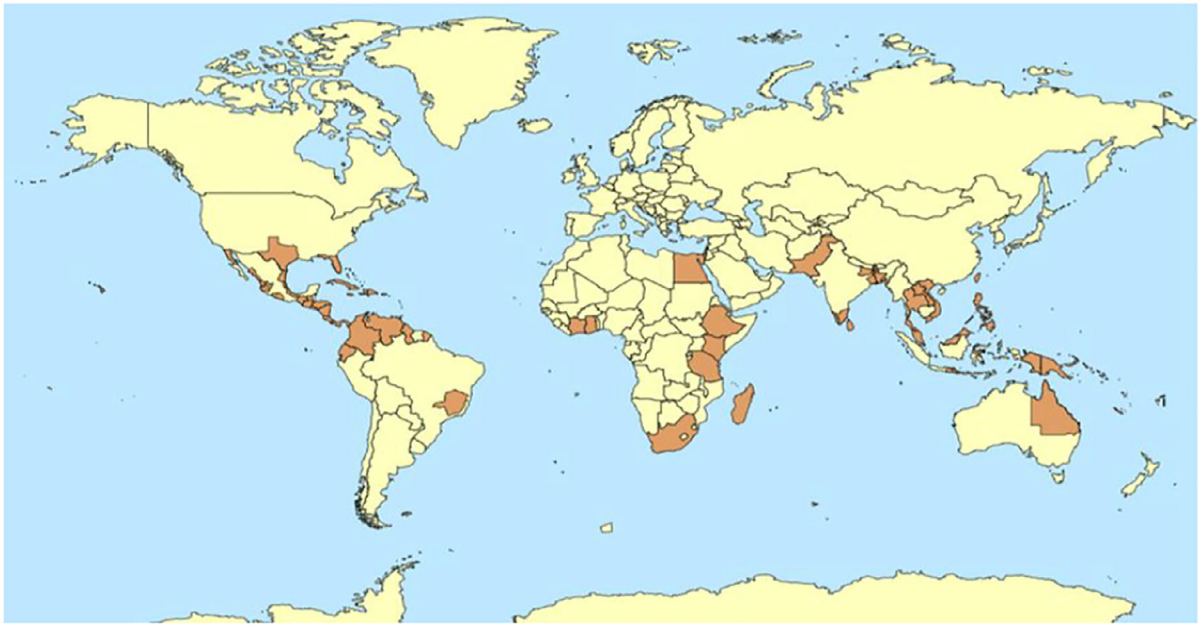

Figure 2: Global distribution of *Milviscutulus mangiferae* (data source: García Morales et al., 2016, CABI, 2022 online).

3.2.2. Pest distribution in the EU

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

No, *M. mangiferae* is not known to be present in the EU.

There was a finding of *M. mangiferae* in a tropical greenhouse at a botanical garden in northern Italy (Padua) in 2013. Pellizzari and Porcelli (2014) reported finding adult females, eggs and crawlers of *M. mangiferae* collected on the underside of leaves of mango trees, imported from Florida (USA) in September 2013. Live specimens were also found in April 2014. Control measures were taken to avoid the spread of the scale in the greenhouse, and it is not known if it is still present. Even if a small population is still present there is almost no risk of it spreading unless infested plants are moved to other tropical greenhouses because all stages are wingless and cannot walk long distances. If present, the scale can be considered not widely distributed in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

M. mangiferae is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031. However, the species is included in the list of pests that are regulated by the Commission Implementing Regulation (EU) 2021/419 as regards certain plants for planting of *Jasminum polyanthum* Franchet originating in Israel and Commission Implementing Regulation (EU) 2021/1936 as regards certain plants for planting of *Ficus carica* L. and *Persea americana* Mill. originating in Israel.

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

Hosts prohibited from entering the EU are presented in Table 3.

Table 3: List of plants, plant products and other objects that are *Milviscutulus mangiferae* 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**
11.	Plants of *Citrus* L., *Fortunella* Swingle, *Poncirus* Raf., and their hybrids, other than fruits and seed	ex 0602 10 90 ex 0602 20 20 ex 0602 20 30 ex 0602 20 80 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	All third countries
18.	Plants for planting of Solanaceae other than seeds and the plants covered by entries 15, 16 or 17	ex 0602 10 90 ex 0602 90 30 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 91 ex 0602 90 99	Third countries other than: Albania, Algeria, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Egypt, Faeroe Islands, Georgia, Iceland, Israel, Jordan, Lebanon, Libya, Liechtenstein, Moldova, Monaco, Montenegro, Morocco, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Syria, Tunisia, Türkiye, Ukraine and the UK.

Ficus carica, *Persea americana* and *Jasminum polyanthum* are listed in Annex I of EU 2018/2019, as high risk plants whose introduction into the EU is prohibited pending risk assessment. Israel and Uganda have been exempted from the prohibition (EU 2021/1936, EU 2021/419 and EU 2022/1942 (see Section 3.3.1)).

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

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

Yes, the pest is able to enter into the EU territory. The main pathways are plants for planting and cut flowers.

Comment on plants for planting as a pathway.

Plants for planting are one of the main pathways for *M. mangiferae* to enter the EU (Table 4).

Potential pathways for the introduction of *M. mangiferae* are shown in Table 4.

Table 4: Potential pathways for *Milviscutulus mangiferae* into the EU

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	Eggs, nymphs and adults	Plants for planting that are hosts of *M. mangiferae* and are prohibited to import from third countries (Regulation 2019/2072, Annex VI) are listed in Table 3. There is a temporary prohibition for high risk plants (Regulation 2018/2019). However, the hosts *Persea americana, Jasminum* and *Ficus* spp., which are considered high risk plants, are permitted from Israel ((EU) 2021/1936), (EU) 2021/419. Plants for planting from third countries require a phytosanitary certificate to be imported into the EU (Regulation 2019/2072, Annex XI, Part A).
Cut flowers	Eggs, nymphs and adults	Cut flowers from third countries require a phytosanitary certificate to be imported into the EU (2019/2072, Annex XI, Part A).
Fruit	Eggs, nymphs and adults	Fruit from third countries require a phytosanitary certificate to be imported into the EU (2019/2072, Annex XI, Part A).

The mango shield scale has a wide range of host plants (Appendix A) and many of them are imported into the EU from areas where the pest occurs. Although there are some prohibitions in imports of some host plants for planting from third countries (Regulation 2019/2072, Annex VI), there are many other hosts that can be imported to the EU with a phytosanitary certificate.

Cut flowers that are imported into the EU must have a phytosanitary certificate. Although fruits are not among the main pathways for the entry of the pest in the EU imported fruits may carry the insect and this pathway cannot be totally excluded. Detailed data of the annual imports of some host plant commodities on the EU from countries where the pest occur, and which provide potential pathways of introduction are provided in Appendix D (Table D.1–D.6).

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 12/09/2022, there were 10 records of interception of *M. mangiferae* in the Europhyt and TRACES databases. The interceptions are shown in Table 5.

Table 5: Interceptions of *Milviscutulus mangiferae* into the EU

Year	Country of export	Commodity	Plant species	No. of interceptions
2005	Thailand	Leaves	*Citrus hystrix*	1
2007	Singapore	Plants intended for planting (already planted)	*Dracaena* sp.	1
2007	Singapore	Plants intended for planting (cuttings)	*Cordyline terminalis*	1
2007	Singapore	Plants intended for planting (cuttings)	*Dracaena sanderiana*	1
2007	Singapore	Plants intended for planting (cuttings)	*Echinodorus* sp.	1
2007	Singapore	Plants intended for planting (cuttings)	*Syngonium* sp.	1
2008	Singapore	Plants intended for planting (not yet planted)	*Cordyline terminalis*	2
2009	Singapore	Plants intended for planting (not yet planted)	*Cordyline* sp.	1
2009	USA	Plants intended for planting (not yet planted)	*Mangifera indica*	1

According to Pellizzari and Porcelli (2014) the pest is one of the most frequently intercepted species of Coccidae in the UK. It has been intercepted in the UK on 69 occasions between 1996 and 2017 (see Appendix C) on imported cut flowers, ornamentals and aquatic plants (Anderson and MacLeod, 2008). It was most frequently found on *Cordyline* and *Dracaena* plants for planting imported from Singapore. Moreover, this species was intercepted 87 times on a variety of hosts at US ports-of-entry between 1995 and 2012 (Miller et al., 2014). This species was found in a heated greenhouse at a botanical garden in northern Italy in 2013, where it was introduced on mango plants imported from Florida (Pellizzari and Porcelli, 2014).

3.4.2. Establishment

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

Yes, the climate in the EU countries of southern Europe is suitable and there are many available hosts that can support establishment.

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

3.4.2.1. EU distribution of main host plants

M. mangiferae is a polyphagous pest feeding on a wide range of plants (crops and ornamentals). The main hosts of the pest cultivated in the EU between 2017 and 2021 are shown in Table 6. Among others, citrus, avocados and ornamental plants are important crops in the EU.

Table 6: Crop area of *Milviscutulus mangiferae* hosts in EU in 1000 ha (Eurostat accessed on 01/09/2022)

Crop	2017	2018	2019	2020	2021
Citrus	502.84	508.99	512.83	519.98	510.28
Avocados	12.72	13.22	17.50	19.63	21.18

Mango is produced in the EU. For example, in Spain, production is mostly located in the Canary Islands (a third country with regards to phytosanitary regulations). Production in mainland Spain is rather limited to the coastal municipalities of Málaga and Granada. Such a reduced production is not captured by EUROSTAT.

3.4.2.2. Climatic conditions affecting establishment

M. mangiferae occurs mainly in tropical and warmer subtropical regions of Asia, South America, North America, Central America, Caribbean, Africa and Oceania (CABI, 2022, online; García Morales et al., 2016). Figure 3 shows the world distribution of selected Köppen–Geiger climate types (Kottek et al., 2006) that occur in the EU and which occur in countries where *M. mangiferae* has been reported. Southern EU countries provide suitable climatic conditions for the establishment of *M. mangiferae* outdoors. Based on current distribution, establishment outdoors in Central and Northern Europe is unlikely. Nevertheless, *M. mangiferae* could occur in heated greenhouses in cooler areas of the EU.

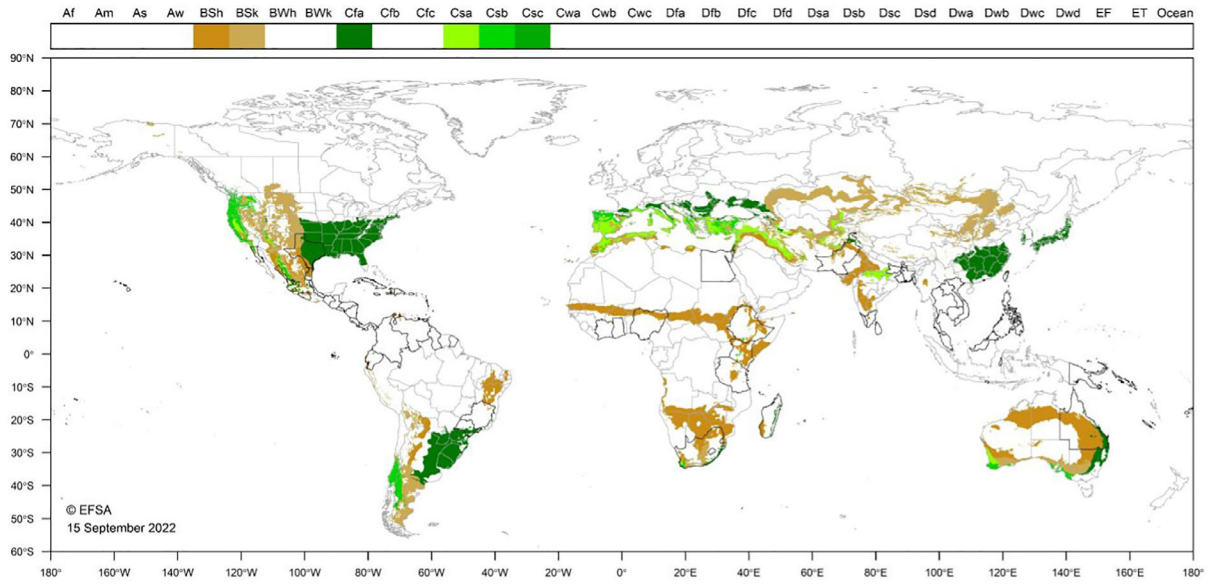

Figure 3: World distribution of Köppen-Geiger climate types that occur in the EU and which occur in countries where *Milviscutulus mangiferae* been reported

3.4.3. Spread

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

Natural spread by first instars crawling or being carried by wind, other animals, or machinery, will occur locally and relatively slowly. All stages may be moved over long distances in trade of infested plant materials.

Comment on plants for planting as a mechanism of spread.

Plants for planting provide the main spread mechanism for *M. mangiferae* over long distances.

The pest is able to spread naturally by the crawlers which is the mobile stage of the insect. However, natural dispersal is likely to be slow (Anderson and MacLeod, 2008). The same applies to passive spread on animals, clothes, and machinery. The main pathway of *M. mangiferae* spread to long distances is the trade of infested plants for planting and cut flowers (Anderson and MacLeod, 2008).

3.5. Impacts

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

Yes, if *M. mangiferae* established in the EU, it would most probably have an economic impact.

There are many hosts of mango shield scale that are cultivated plants with economic importance in the EU, including *Citrus sinensis* (orange), *C. limon* (lemon), *Mangifera indica* (mango) and *Persea americana* (avocado) (García Morales et al., 2016). The damage caused by *M. mangiferae* is due to direct feeding on the plant juices and to egestion of large amounts of honeydew. The commercial value of fruits is reduced by the thick black mass caused by the sooty mould fungi which develop and cover fruits and leaves. Photosynthesis is reduced, leaves may drop, and branches dry up. Heavy infestations may result in tree decline, death of branches or trees and severe yield losses (Abd-Rabou and Evans, 2018; Mohamed, 2020; EFSA, 2021). Mangoes are the host that suffers the most severe attacks from *M. mangiferae*. Avocados may also be heavily infested, but populations do not reach the densities of those on mangoes. Citrus crops, such as oranges and lemons, are sporadically attacked but there is no evidence of severe damage from the infestation. Many ornamental plants such as *Cordyline* sp., *Syzygium cumini* or *Dracaena* sp. are infested which cause the reduction of their ornamental value (Anderson and MacLeod, 2008).

3.6. Available measures and their limitations

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

Yes, although the existing phytosanitary measures identified in Section 3.3.2 do not specifically target *M. mangiferae* they mitigate the likelihood of its entry into, establishment and spread within the EU (see also Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (see Section 3.3.2).

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

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 7.

Table 7: Selected control measures (a full list is available in EFSA PLH Panel et al., 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Control measure/ Risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/ establishment/ spread/impact)
Require pest freedom	Pest free place of production (e.g. place of production and its immediate vicinity is free from pest over an appropriate time period, e.g. since the beginning of the last complete cycle of vegetation, or past 2 or 3 cycles). Pest free production site.	Entry/Spread
Growing plants in isolation	Place of production is insect proof originate in a place of production with complete physical isolation	Entry/Spread
Roguing and pruning	Roguing (removal of infested plants) and pruning (removal of infested plant parts only without affecting the viability of the plant) can reduce the population density of the pest.	Entry/Spread/Impact
Biological control and behavioural manipulation	Mango shield scale is attacked by several endoparasitoids of which the more important are *Microterys nietneri*, *Coccophagus eritraeensis* and *Coccophagus scutellaris* (Plant Pest of the Middle East, online; Abbas et al., 2019)	Spread/Impact
Chemical treatments on crops including reproductive material	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments. The effectiveness of insecticide applications against soft scales may be reduced by the waxy coating of the adult. Acetamiprid has been proposed in Israel against *M. mangiferae*, in the field, in a preventative manner (0.06%, spray) (EFSA, 2021). White oils are recommended for its control in mango plantations (Plant Pest of the Middle East, online).	Entry/Establishment/ Spread/Impact
Chemical treatments on consignments or during processing	The use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage could mitigate the likelihood of infestation of pests susceptible to chemical treatment.	Entry/Spread
Physical treatments on consignments or during processing	Mechanical cleaning (brushing, washing); sorting and grading, reduces the likelihood of the association of the pest in consignments ready to be exported. It therefore reduces the global pest load of consignments and limits the multiplication of pests during transport.	Entry/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 et al., 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	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/Spread

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	Summary	Risk element targeted (entry/ establishment/ spread/impact)
	Any shipments of fresh plant material from an infested country to another that is not infested should be inspected thoroughly to detect *M. mangiferae*.	
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests.	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
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	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
Certification of reproductive material (voluntary/official)	Plants come from within an approved propagation scheme and are certified pest free (level of infestation) following testing; Used to mitigate against pests that are included in a certification scheme.	Entry/Spread
Surveillance	Surveillance to guarantee that plants and produce originate from a Pest Free Area could be an option.	Spread

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- M. mangiferae may be difficult to be detected where low populations occur.
- Insecticide treatments are not very effective because of the protection of scale cover.
- *M. mangiferae* is polyphagous, making the inspections of all consignments containing hosts from countries where the pest occurs difficult.

3.7. Uncertainty

The main source of uncertainty regards the magnitude of potential impact within the EU, however there is no doubts about the occurrence of an impact. Therefore, this is not a key uncertainty likely to change the conclusion.

4. Conclusions

M. mangiferae satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest (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 identity of the pest is clearly defined and *Milviscutulus mangiferae* (Green) is the accepted name. Taxonomic keys based on morphology of adults exist. There are also molecular techniques for species identification.	None
Absence/ presence of the pest in the EU (Section 3.2)	The pest is not known to be present in the EU territory. The pest was recorded in a tropical greenhouse in Italy (Botanical Garden of Padua) on mango trees imported from Florida USA in 2013–14 but has not been recorded ever since.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*M. mangiferae* is able to enter into, become established and spread within the EU territory, especially in the southern EU MS. The main pathways are plants for planting and cut flowers.	None
Potential for consequences in the EU (Section 3.5)	The introduction of the pest could cause yield and quality losses on several crops and reduce the value of ornamental plants.	None
Available measures (Section 3.6)	There are measures available to prevent entry, establishment and spread of *M. mangiferae* within the EU. Risk reduction options include inspections, chemical and physical treatments on consignments of fresh plant material from infested countries and the production of plants for import in the EU in pest free areas.	None
Conclusion (Section 4)	*M. mangiferae* satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	
Aspects of assessment to focus on/scenarios to address in future if appropriate:		

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Abbreviations

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

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2021)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2021)
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, 2021)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2021)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2021)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2021)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2021)
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, 2021)
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, 2021)
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, 2021)

Appendix A – *Milviscutulus mangiferae* host plants/species affected

Source: García Morales et al. (2016).

Host status	Host name	Plant family	Common name
Cultivated hosts	*Ananas*	Bromeliaceae	
	Ananas comosus	Bromeliaceae	Pineapple
	Annona muricata	Annonaceae	Soursop, graviola, prickly custard apple
	Aralia	Araliaceae	
	Artocarpus	Moraceae	Breadfruit tree
	Artocarpus altilis	Moraceae	Breadfruit, breadnut, dugdug
	Artocarpus heterophyllus	Moraceae	Jackfruit
	Artocarpus integer	Moraceae	Champedak
	Bischofia javanica	Phyllanthaceae	Bishop wood, Java cedar, red cedar
	Bixa orellana	Bixaceae	Annatto, annatto tree, arnato tree, lip stick tree, lipstick plant, lipstick tree
	Blighia sapida	Sapindaceae	Ackee apple, achee, akee
	Bruguiera gymnorhiza	Rhizophoraceae	Black mangrove, large-leafed orange mangrove, oriental mangrove
	Brunfelsia nitida	Solanaceae	Cuban raintree
	Caladium	Araceae	
	Carica papaya	Caricaceae	Papaya, pawpaw
	Cascabela thevetia	Apocynaceae	Yellow oleander
	Cinnamomum	Lauraceae	Cinnamon
	Cinnamomum cassia	Lauraceae	Chinese cassia, Chinese cinnamon
	Cinnamomum verum	Lauraceae	True cinnamon tree, ceylon cinnamon tree
	Citrus aurantium	Rutaceae	Bitter orange, sour orange, bigarade, Seville orange
	Citrus limon	Rutaceae	Lemon, true lemon tree
	Citrus sinensis	Rutaceae	Sweet orange
	Cocos nucifera	Arecaceae	Coconut, common coconut palm
	Codiaeum variegatum	Euphorbiaceae	Garden croton, Bombay laurel, croton
	Cordia myxa	Boraginaceae	Sebesten, lasoda
	Cordyline fruticosa	Asparagaceae	Ti-plant, bongbush, cabbage palm, kiwi, palm lily, ti-palm
	Corymbia citriodora	Myrtaceae	lemon-scented gum, citron-scent gum, Lemon gum tree
	Dendrobium spectabile	Orchidaceae	King orchid, outstanding dendrobium
	Dracaena	Asparagaceae	
	Epipremnum	Araceae	
	Eucalyptus deglupta	Myrtaceae	Kamarere, Mindanao gum, Rainbow eucalyptus, rainbow gum
	Eugenia	Myrtaceae	
	Eugenia axillaris	Myrtaceae	White stopper
	Ficus	Moraceae	
	Ficus montana	Moraceae	Oakleaf fig
	Gardenia jasminoides	Rubiaceae	Cape jasmine, common gardenia, gardenia
	Gnetum gnemon	Gnetaceae	Gnetum, joint fir, two leaf, melinjo, belinjo, bago, tulip
	Hedera helix	Araliaceae	Ivy, Atlantic ivy, common ivy, English ivy
	Hibiscus	Malvaceae	Rosemallows

Host status	Host name	Plant family	Common name
	Ixora coccinea	Rubiaceae	Flame of woods, burning love, flame flower, jungle flame, palm of the wood
	Jasminum	Oleaceae	Jasmine
	Laurus nobilis	Lauraceae	Bay tree, bay laurel, sweet bay, true laurel, Grecian laurel, laurel
	Ligustrum	Oleaceae	Privet
	Litchi chinensis	Sapindaceae	Lichi, leechee, litchee, litchi
	Malpighia glabra	Malpighiaceae	Acerola
	Mangifera	Anacardiaceae	
	Mangifera indica	Anacardiaceae	Mango, edible mango, Indian mango
	Melia azedarach	Meliaceae	Chinaberry, Barbados lilac, China tree, Chinaberry tree, Persian lilac, pride of India, umbrella tree, white cedar
	Merremia	Convolvulaceae	Woodroses
	Monstera deliciosa	Araceae	Ceriman
	Myristica fragrans	Myristicaceae	Nutmeg, mace
	Myrtus communis	Myrtaceae	Myrtle, common myrtle
	Nauclea	Rubiaceae	
	Persea americana	Lauraceae	Avocado, avocado pear, alligator pear, holly ghost pear
	Planchonia careya	Lecythidaceae	Cocky apple, cockatoo apple, billygoat plum
	Plumeria	Apocynaceae	Frangipani
	Plumeria obtusa	Apocynaceae	
	Pometia pinnata	Sapindaceae	Fijian longan, island lychee, kasai, kava, langsir, matoa, taun tree
	Psidium friedrichsthalianum	Myrtaceae	Wild guava, Costa Rican guava
	Psidium guajava	Myrtaceae	Guava, apple guava, Brazilian guava, common guava, Guinea guava, lemon guava, pear guava, tropical guava, yellow guava
	Rhodomyrtus tomentosa	Myrtaceae	Downy rose-myrtle, downy rosemyrtle, hill gooseberry, hill guava, isenberg-bush
	Schefflera	Araliaceae	Umbrella tree
	Schefflera arboricola	Araliaceae	
	Schinus terebinthifolia	Anacardiaceae	Brazilian pepper tree, broadleaf pepper tree
	Strelitzia	Strelitziaceae	Bird of paradise
	Syzygium	Myrtaceae	
	Syzygium aqueum	Myrtaceae	Watery rose-apple, water apple
	Syzygium aromaticum	Myrtaceae	Clove, clove tree
	Syzygium cumini	Myrtaceae	Black plum, black plum tree, Indian blackberry, java plum, Malabar plum, Portuguese plum
	Syzygium jambos	Myrtaceae	Rose apple, jambos, Malabar plum, plum rose
	Syzygium suborbiculare	Myrtaceae	Red bush apple
	Terminalia catappa	Combretaceae	Singapore almond, beach almond, country almond, Indian almond, Malabar almond, sea almond, tropical almond
	Uvaria rufa	Annonaceae	Susung-kalabaw
Wild weed hosts	*Alstonia spectabilis*	Apocynaceae	
	Ardisia pachyrhachis	Primulaceae	

Host status	Host name	Plant family	Common name
	Breonia chinensis	Rubiaceae	
	Breynia cernua	Phyllanthaceae	
	Campnosperma brevipetiolatum	Anacardiaceae	
	Casearia aculeata	Salicaceae	
	Champereia manillana	Opiliaceae	
	Cinnamomum montanum	Lauraceae	
	Decaspermum	Myrtaceae	
	Diospyros caribaea	Ebenaceae	
	Elaeocarpus	Elaeocarpaceae	
	Ficus copiosa	Moraceae	
	Ficus glandulifera	Moraceae	
	Ficus septica	Moraceae	
	Ficus theophrastoides	Moraceae	
	Ficus tinctoria	Moraceae	Dye fig, humped fig
	Flagellaria	Flagellariaceae	
	Gliricidia	Fabaceae	
	Gluta tourtour	Anacardiaceae	
	Guioa	Sapindaceae	
	Gymnacranthera	Myristicaceae	
	Gynotroches axillaris	Rhizophoraceae	
	Meryta macrophylla	Araliaceae	
	Myrsine guianensis	Primulaceae	
	Nectandra coriacea	Lauraceae	
	Neolitsea zeylanica	Lauraceae	
	Oxandra lanceolata	Annonaceae	
	Palaquium formosanum	Sapotaceae	
	Parathesis cubana	Primulaceae	
	Pimelodendron amboinicum	Euphorbiaceae	
	Pseudolmedia spuria	Moraceae	
	Psychotria	Rubiaceae	
	Psychotria elliptica	Rubiaceae	
	Rhizophora apiculata	Rhizophoraceae	True mangrove
	Rhizophora mucronata	Rhizophoraceae	
	Syzygium branderhorstii	Myrtaceae	
	Syzygium erythrocalyx	Myrtaceae	Johnstone River satinash
	Syzygium graveolens	Myrtaceae	
	Syzygium parkeri	Myrtaceae	
	Terminalia brassii	Combretaceae	
	Terminalia complanata	Combretaceae	
	Timonius	Rubiaceae	
	Vanilla	Orchidaceae	
	Vitex pinnata	Lamiaceae	
	Wollastonia biflora	Asteraceae	

Appendix B – Distribution of *Milviscutulus mangiferae*

Distribution records based on CABI (2022, online) and García Morales et al. (2016).

Region	Country	Sub-national (e.g. State)	Status	References
North America	Mexico	Baja California Norte	Present	García Morales et al. (2016)
	Mexico	Chiapas	Present	García Morales et al. (2016)
	Mexico	Colima	Present	García Morales et al. (2016)
	Mexico	Guerrero	Present	García Morales et al. (2016)
	Mexico	Jalisco	Present	García Morales et al. (2016)
	Mexico	Morelos	Present	García Morales et al. (2016)
	Mexico	Nayarit	Present	García Morales et al. (2016)
	Mexico	Sinaloa	Present	García Morales et al. (2016)
	Mexico	Tamaulipas	Present	García Morales et al. (2016)
	Mexico	Veracruz	Present	García Morales et al. (2016)
	United States	Florida	Present	García Morales et al. (2016)
	United States	Texas	Present	García Morales et al. (2016)
Central America	Costa Rica		Present	García Morales et al. (2016)
	El Salvador		Present	García Morales et al. (2016)
	Guatemala		Present	García Morales et al. (2016)
	Honduras		Present	García Morales et al. (2016)
	Nicaragua		Present	García Morales et al. (2016)
	Panama		Present	García Morales et al. (2016)
Caribbean	Antigua and Barbuda		Present	CABI (2022, online)
	Barbados		Present	CABI (online)
	Cuba		Present	CABI (online)
	Dominica		Present	CABI (2022, online)
	Dominican Republic		Present	CABI (2022, online)
	Grenada		Present	CABI (2022, online)
	Guadeloupe		Present	CABI (2022, online)
	Haiti		Present	García Morales et al. (2016)
	Jamaica		Present	CABI (2022, online)
	Martinique		Present	CABI (2022, online)
	Puerto Rico		Present	CABI (2022, online)
	Trinidad and Tobago		Present	CABI (2022, online)
	U.S. Virgin Islands		Present	García Morales et al. (2016)
	Saint Croix		Present	García Morales et al. (2016)
South America	Brazil	Minas Gerais	Present	García Morales et al. (2016)
	Brazil	Sao Paulo	Present	García Morales et al. (2016)
	Colombia		Present	García Morales et al. (2016)
	Ecuador		Present	García Morales et al. (2016)
	Guyana		Present	CABI (2022, online)
	Venezuela		Present	García Morales et al. (2016)
	French Guiana		Present	García Morales et al. (2016)
EU	Italy		Intercepted	García Morales et al. (2016) Pellizzari and Porcelli (2014)*

Region	Country	Sub-national (e.g. State)	Status	References
Africa	Agalega Islands		Present	García Morales et al. (2016)
	Comoros		Present	García Morales et al. (2016)
	Cote d'Ivoire		Present	García Morales et al. (2016)
	Egypt		Present	CABI (2022, online)
	Ethiopia		Present	García Morales et al. (2016)
	Ghana		Present	García Morales et al. (2016)
	Kenya		Present	García Morales et al. (2016)
	Madagascar		Present	García Morales et al. (2016)
	Mauritius		Present	García Morales et al. (2016)
	Reunion		Present	García Morales et al. (2016)
	Seychelles		Present	García Morales et al. (2016)
	South Africa		Present	CABI (online)
	Tanzania		Present	García Morales et al. (2016)
	Zanzibar		Present	García Morales et al. (2016)
	Rodriques Island		Present	García Morales et al. (2016)
Asia	Bangladesh		Present	García Morales et al. (2016)
	China	Hong Kong	Present	García Morales et al. (2016)
	India	Kerala	Present	CABI (2022, online)
	India	Sikkim	Present	CABI (2022, online)
	India	Bihar	Present	García Morales et al. (2016)
	India	Tamil	Present	García Morales et al. (2016)
	India	West Bengal	Present	García Morales et al. (2016)
	Indonesia	Bali	Present	García Morales et al. (2016)
	Indonesia	Irian Jaya	Present	García Morales et al. (2016)
	Indonesia	Java	Present	García Morales et al. (2016)
	Indonesia	Sulawesi	Present	García Morales et al. (2016)
	Israel		Present	García Morales et al. (2016)
	Japan	Kyushu	Present	CABI (2022, online)
	Laos		Present	CABI (2022, online)
	Malaysia		Present	García Morales et al. (2016)
	Pakistan		Present	García Morales et al. (2016)
	Singapore		Present	García Morales et al. (2016)
	Sri Lanka		Present	García Morales et al. (2016)
	Taiwan		Present	CABI (2022, online)
	Thailand		Present	CABI (2022, online)
	Vietnam		Present	García Morales et al. (2016)
	Palau		Present	García Morales et al. (2016)
	Philippines		Present	García Morales et al. (2016)
	Ryukyu Islands		Present	García Morales et al. (2016)
Oceania	Australia	Queensland	Present	CABI (2022, online)
	Christmas Island		Present	García Morales et al. (2016)
	New Caledonia		Present	García Morales et al. (2016)
	Papua New Guinea		Present	CABI (2022, online)
	Solomon Islands		Present	García Morales et al. (2016)
	Tonga		Present	García Morales et al. (2016)
	Western Samoa		Present	García Morales et al. (2016)
	Fiji		Present	García Morales et al. (2016)
	United States	Hawaii	Present	CABI (2022, online)

*: According to Pellizzari and Porcelli (2014) adult females, eggs and crawlers of the *M. mangiferae* have been collected on the underside of leaves of mango trees, imported from Florida (USA) and arrived at the Botanical Garden in Padova (Italy), in September 2013. Live specimens were also found in April 2014. However, its establishment remains uncertain.

Appendix C – UK interceptions of *Milviscutulus mangiferae* 1996–2017

	Singapore	Malaysia	Ghana	Thailand	Unknown	Brazil	Costa Rica	Indonesia	Kenya	Laos	South Africa	Sri Lanka	Uganda	USA	Sum
Cordyline spp.	24	5										1			30
Dracaena spp.	19				2										21
Mangifera indica			1			1			1		1		1	1	6
Unspecified	4														4
Citrus hystrix				1						1					2
Hygrophila								1							1
Murraya koenigii			1												1
Ophiopogon japonicus	1														1
Schefflera							1								1
Syngonium	1														1
Synsepalum dulciferum				1											1
Summary	**49**	**5**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**69**

Appendix D – Import data

Table D.1: **Fresh or dried avocados (CN code: 080440)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

COUNTRY	2017	2018	2019	2020	2021
Australia			0.01		0.31
Brazil	71,040.50	68,697.61	78,673.73	48,183.83	50,803.63
China	35.28		1.23	0.04	0.12
Colombia	210,139.60	251,050.33	387,367.23	663,148.97	852,145.34
Costa Rica	21.56	9.98	428.45	686.40	201.60
Côte d'Ivoire	18.26	230.36	72.20	68.24	968.81
Cuba	73.94	41.53	131.08	34.33	56.00
Dominica	517.65	31.45	177.80	150.03	352.00
Dominican Republic	55,001.50	52,897.18	95,531.91	100,024.05	103,899.25
Ecuador	1,052.41	1,264.87	2,314.26	1,763.14	3,368.06
Egypt	5.35	4.58	79.92	363.95	38.44
Guatemala	4,291.98	7,487.42	17,084.09	15,383.92	24,717.30
India	2.06	0.52	0.06		2.35
Israel	424,267.97	370,378.23	437,318.01	345,664.24	451,762.54
Kenya	243,947.31	404,593.87	346,231.90	435,308.72	487,493.21
Madagascar				0.96	1.11
Mauritius	36.13	42.27	24.28	15.23	0.45
Malaysia		47.04			0.04
Mexico	445,611.06	463,741.28	767,878.48	716,092.02	750,934.77
Panama			474.24		0.53
Thailand	9.76	9.66	9.06	3.39	25.85
Tanzania	25,773.58	55,517.16	60,480.96	50,769.74	56,339.46
United States	1.19	2,546.86	0.02	4.66	45.38
Venezuela	233.40	111.12	71.29		
Viet Nam			0.05		0.67
South Africa	315,854.56	652,817.98	401,352.79	416,290.22	417,176.36

Table D.2: **Fresh or dried citrus (CN code: 0805)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

COUNTRY	2017	2018	2019	2020	2021
Antigua and Barbuda			19.83		
Australia	1,284.38	644.97	10,645.40	2,343.47	4,097.42
Bangladesh	229.58	159.67	322.42	1,183.66	289.22
Brazil	903,432.95	900,907.24	822,134.46	902,590.26	1,058,421.51
China	1,084,857.27	1,024,163.15	1,108,595.22	1,098,689.98	647,903.95
Colombia	79,400.99	123,887.46	136,914.85	172,197.70	194,963.20
Costa Rica	921.32	704.93	231.20	461.60	35.20
Côte d'Ivoire		246.40			
Cuba	3,863.97	4,438.14	3,422.11	556.03	18.70
Dominica	193.34	57.65	76.50	78.69	47.18
Dominican Republic	9,336.81	10,426.97	7,355.36	12,886.58	12,780.40
Ecuador	2,127.19	729.99	1,114.58	127.28	2,312.97
Egypt	2,246,998.88	2,643,272.02	2,206,932.71	2,850,745.77	3,398,717.27

COUNTRY	2017	2018	2019	2020	2021
Guyana				24.00	
Guatemala	17,178.48	27,056.89	11,816.09	17,814.26	8,712.80
Haiti	176.53	72.10	31.00	248.29	337.30
Honduras	26,365.35	18,053.26	8,521.82	11,370.41	11,263.50
India	1.00	449.63	88.51	254.95	22.37
Indonesia	555.70	779.35	836.73	864.54	872.68
Israel	969,403.62	824,601.66	812,738.57	878,713.18	780,416.05
Jamaica	3,325.11	675.68	2,409.55	1,646.87	2,441.76
Japan	417.44	270.73	319.24	162.50	184.26
Kenya		8.80		34.56	0.02
Laos	2.10			20.23	0.95
Madagascar	26.42	11.62	7.16	22.16	1.91
Mauritius		14.00		7.35	
Malaysia	39.02	83.45	7.71		
Mexico	553,818.66	589,021.12	443,743.54	349,648.63	184,527.67
Pakistan		2.45	0.59		272.00
Panama				650.40	
Philippines		0.20	7.71	0.10	
El Salvador	35.77	4.76			
Thailand	1,283.13	659.74	624.93	194.87	245.31
Taiwan				0.01	
Tanzania, United Republic of	190.01	144.12	35.95	75.50	132.27
United States	231,210.47	185,706.99	177,755.45	148,608.92	113,949.21
Venezuela	2,216.36	681.07			
Viet Nam	46,738.17	70,934.07	73,964.35	63,730.02	81,735.61
South Africa	5,802,017.61	6,381,124.73	6,196,837.96	7,830,147.60	7,942,850.56
Sri Lanka	80.98	135.62	0.20	60.10	0.03

Table D.3: **Fresh or dried pineapples (CN code: 080430)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

COUNTRY	2017	2018	2019	2020	2021
Bangladesh			1.26		0.04
Brazil	1,272.34	484.83	639.05	280.66	134.29
China	25.05	9.91	62.65	42.74	155.01
Colombia	123,462.45	91,067.04	53,663.49	42,136.78	57,589.81
Costa Rica	6,832,249.09	7,693,551.48	7,543,050.71	6,650,975.31	7,220,570.83
Côte d'Ivoire	255,038.72	220,581.56	244,175.93	203,552.53	257,422.68
Cuba	4,382.57	3,838.50	1998.42	976.85	869.55
Dominica					1.86
Dominican Republic	15,582.31	19,723.37	20,566.35	20,525.91	26,709.16
Ecuador	266,601.11	309,794.68	370,676.43	338,070.08	396,310.66
Egypt	201.60			28.16	
Guyana				22.00	
Guatemala	229.74	40.08	64.03	282.50	128.00
Honduras	23,677.66	30,157.48	15,263.16	32,977.12	34,989.52
India	17.99	75.85	11.52	1.00	11.68
Indonesia	543.77	0.09		2.50	0.69
Israel	2.81	0.20	0.01		0.00

COUNTRY	2017	2018	2019	2020	2021
Kenya	761.13	745.19	2,147.97	23,799.06	29,353.08
Madagascar	35.35	83.54	0.35	3.16	19.76
Mauritius	17,701.91	16,229.92	15,724.37	8,845.38	16,567.13
Malaysia	5.00		2.40		10.40
Mexico	2,957.94	773.74	142.42	174.97	201.44
Panama	68,463.26	89,689.65	72,371.24	64,771.59	39,200.75
Philippines	114.23	183.83	86.03	566.04	0.78
Singapore			0.29		
El Salvador			2.27		0.65
Thailand	11,093.21	9,505.48	8,056.49	8,828.72	9,053.74
Taiwan			0.07	0.05	9.63
Tanzania	193.46	191.30	150.83	187.37	1,941.29
United States	56.66	22.03	28.28	57.29	1,451.69
Venezuela		0.19	0.04		
Viet Nam	65.87	9.88	20.20	2.18	130.47
South Africa	4,475.13	5,833.47	7,460.18	6,038.45	5,246.84
Sri Lanka	5,755.44	4,125.57	2,675.19	2,636.02	1,670.55

Table D.4: **Fresh or dried guavas, mangoes and mangosteens (CN code: 080450)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

COUNTRY	2017	2018	2019	2020	2021
Antigua and Barbuda		193.61			
Australia	94.18	62.92			0.01
Bangladesh	256.66	331.27	310.73	323.91	1,538.10
Brazil	1,158,717.06	1,241,860.63	1,437,569.20	1,577,043.99	1,796,483.39
China	51.87	180.81	78.23	104.34	248.77
Colombia	2,553.75	3,139.67	6,833.02	4,131.75	5,012.70
Costa Rica	19,119.58	18,368.68	12,830.62	14,950.59	22,697.44
Côte d'Ivoire	268,109.01	278,429.74	281,610.27	230,154.91	272,078.02
Cuba	216.57	14.36	103.34	230.60	135.11
Dominica	14.45	2.55	13.96		
Dominican Republic	85,119.28	105,553.46	118,508.00	110,481.33	160,995.48
Ecuador	13,840.91	9,491.23	9,608.87	10,660.02	7,684.59
Egypt	9,186.69	4,855.57	6,407.46	12,233.16	6,222.90
Guatemala	9,771.98	25,768.70	10,953.40	8,099.52	6,680.24
Haiti		4.87			
Honduras				41.90	0.36
India	8,148.87	9,470.36	9,315.51	7,347.61	16,575.20
Indonesia	2,004.36	2,926.64	2,386.27	1,406.94	1,629.72
Israel	140,551.30	108,353.48	121,875.16	98,143.59	124,186.49
Japan				0.01	7.66
Kenya	4.08	65.09	10.30	66.53	1,497.12
Laos	620.36	603.14	806.50	525.32	285.98
Madagascar	22.10	15.02	0.66	1.05	20.64
Malaysia	197.22	170.64	72.72	44.56	19.01
Mexico	40,848.36	46,001.68	50,935.79	51,841.89	46,655.48
Pakistan	15,912.58	21,867.43	29,207.33	16,196.50	19,707.93
Panama	0.18	0.70			

COUNTRY	2017	2018	2019	2020	2021
Philippines	519.88	795.56	368.97	128.10	152.74
Singapore			0.23	0.15	0.02
Thailand	7,401.80	6,911.89	6,743.92	5,260.84	4,918.99
Taiwan		3.48	17.34	0.92	5.28
Tanzania		0.50	1.14		0.09
United States	45,478.21	54,660.34	82,580,54	82,852.21	51,111.19
Venezuela	2,033.75	2,401.44	1,939.11	282.69	522.30
Viet Nam	950.37	1,346.64	1,546.69	965.31	2,761.09
South Africa	13,015.45	9,739.99	12,116.95	8,656.28	5,777.97
Sri Lanka	1,003.35	765.31	813.83	423.16	540.14

Table D.5: **Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled (CN code: 0801)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

Country	2017	2018	2019	2020	2021
Australia	161.34	3.97	3.09	0.02	0.08
Bangladesh					4.43
Brazil	28,181.64	51,378.25	59,924.59	75,715.61	45,560.33
China	1,078.20	995.67	1,091.95	3,073.07	2,640.21
Colombia	4.91	480.00	0.62		5.17
Costa Rica	3,497.03	6,550.77	9,557.16	6,499.74	9,321.74
Côte d'Ivoire	214,918.07	250,187.34	222,932.19	214,728.15	272,340.00
Cuba				117.00	
Dominica	808.36	59.29	1.55	2.07	13.49
Dominican Republic	1731.11	2,313.84	594.68	467.96	724.24
Ecuador	40.88		339.36	276.96	18.74
Egypt	3.23	2.77	14.96	0.84	261.19
Guatemala				0.22	0.02
Honduras	364.00	407.68	281.40	131.38	1,265.37
India	243,346.77	192,497.06	205,693.06	172,138.65	126,809.33
Indonesia	287,011.09	302,686.51	259,644.02	238,720.48	354,192.65
Israel	12.32	4.95	2.36	11.16	5.27
Jamaica			0.26		0.07
Kenya	696.35	57.73	244.49	1,191.89	1734.17
Laos	0.09	280.00	0.23		
Madagascar	624.94	783.06	426.35	524.37	991.83
Mauritius		8.15	1.76	0.02	
Malaysia	8,394.49	4,041.78	2,329.06	4,411.77	8,128.87
Mexico	0.48	0.05	0.25	0.10	82.30
Pakistan	11.50	22.53	24.60	25.70	27.22
Panama	163.63				0.92
Philippines	419,893.07	419,609.28	398,109.92	395,721.76	394,019.23
Singapore	2,475.13	3,211.06	7,262.20	3,843.87	7,047.64
El Salvador	90.71		86.73	81.87	
Thailand	78,956.34	68,012.09	59,013.35	35,161.23	32,071.58
Taiwan		3.40		0.01	9.41
Tanzania	2,570.78	1,197.66	1931.29	1800.05	3,715.03
United States	1994.95	1,377.75	511.55	845.48	1,457.41
Venezuela					1.80

Country	2017	2018	2019	2020	2021
Viet Nam	798,319.82	818,389.73	967,893.87	1,177,974.48	1,285,476.91
South Africa	103.64	0.50	0.79	205.46	156.02
Sri Lanka	70,924.94	57,516.21	76,430.03	60,597.36	74,696.14

Table D.6: **Fresh pawpaws 'papayas' (CN code: 08072000)** imported in 100 kg into the EU (27) from regions where *Milviscutulus mangiferae* is known to occur (Source: Eurostat accessed on 25/8/2022)

Country	2017	2018	2019	2020	2021
Bangladesh	147.75	138.57	62.33	21.95	242.21
Brazil	320,873.67	326,553.52	338,527.11	327,546.53	355,367.07
China			3.00		
Colombia	375.78	25.65	0.17	171.99	33.98
Costa Rica	7,529.89	1,289.53	873.64	839.46	32.36
Côte d'Ivoire	23.03	5.17		6.22	8.92
Dominica					0.23
Dominican Republic	823.49	473.19	469.03	836.85	268.90
Ecuador	13,580.76	632.13	342.53		
Egypt		48.00			
Guatemala				2.00	0.00
Honduras				75.48	
India	336.28	378.24	564.48	130.39	312.47
Indonesia	0.18	0.04	62.58	42.72	0.02
Israel	661.56	714.92	276.69	224.50	
Jamaica	31.12	20.83			
Kenya			1.50	48.35	2.13
Laos	296.22	364.27	527.13	469.50	26.15
Madagascar		8.82	10.64		1.50
Mauritius					
Malaysia	114.20	12.85	38.99	0.27	6.93
Mexico	2,793.18	2,613.06	2,918.40	2,191.29	3,712.35
Pakistan	5.60	19.01	5.37		
Panama		0.60	1.00		924.90
Philippines	3.96	1.21	1.26		
Thailand	7,334.28	7,831.20	7,562.99	4,561.88	5,280.51
Taiwan	0.00		1.99		
Tanzania	0.78	0.56			47.84
United States	84.83	118.34	19.80	42.16	106.92
Venezuela			18.00		
Viet Nam	200.97	381.47	413.60	327.07	383.04
South Africa	123.55	377.24	478.96	14.08	4.00
Sri Lanka	656.39	449.05	540.82	92.27	50.06