EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES

Pest Risk Analysis for *Ceratocystis ficicola* (Ascomycota: Ceratocystidaceae)

Ficus carica 'Vasilika honey-white' with defoliation caused by *Ceratocystis ficicola* (Greece).
EPPO Global Database. Courtesy: Panaghiotis Tsopelas (GR).

EPPO Technical Document No. 1097
September 2025

EPPO
21 Boulevard Richard Lenoir
75011 Paris
www.eppo.int
hq@eppo.int

The risk assessment follows EPPO standard PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (EPPO, 2012) as recommended by the EPPO Panel on Phytosanitary Measures. Pest risk management was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5) (EPPO, 2011). The risk assessment uses the terminology defined in ISPM 5 Glossary of Phytosanitary Terms (IPPC Secretariat, 2023).

Cite this document as:
EPPO (2025) EPPO Technical Document No. 1097. Pest risk analysis for *Ceratocystis ficicola* (Ascomycota: Ceratocystidaceae). EPPO, Paris. Available at https://gd.eppo.int/taxon/CERAFC/documents

Based on this PRA, *Ceratocystis ficicola* was added to the EPPO A2 List of pests recommended for regulation as quarantine pests in 2025. Measures for *Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media are recommended.

Pest Risk Analysis for
Ceratocystis ficicola (Ascomycota: Ceratocystidaceae)

PRA area: EPPO region
Prepared by: Expert Working Group (EWG) on *Ceratocystis ficicola*
Dates: 2024-04-22/25.

Composition of the Expert Working Group (EWG):

DOUANLA-MELI Clovis (Mr)	JKI, Federal Research Centre for Cultivated Plants, Institute for National and International Plant Health, Germany
ERINCIK Ömer (Mr)	Adnan Menderes University, Türkiye
GUITIAN CASTRILLON JoseMaria (Mr)	Tecnologias y Servicios Agrarios, S. A. - TRAGSATEC, Spain
JIKUMARU Shota (Mr)	Hiroshima Prefectural Technology Research Institute, Japan
NIGRO Franco (Mr)	UNIBA, Italy
TSOPELAS Panaghiotis (Mr)	Institute of Mediterranean Forest Ecosystems, Greece

Observer

PAUTASSO Marco (Mr)	EFSA (European Food Safety Authority), Italy

EPPO

MUSOLIN Dmitrii (Mr)	EPPO, France
TANNER Rob (Mr)	EPPO, France hq@eppo.int

All personal communications in this PRA were obtained in 2023-11 to 2024-04 from the following experts: Antonio Gugliuzzo (University of Catania, Italy), Shota Jikumaru (Hiroshima Prefectural Technology Research Institute, Japan), Yuji Kajitani (Fukuoka Plant Protection Office, Japan), Hisashi Kajimura (Nagoya University, Japan), and Panaghiotis Tsopelas (Institute of Mediterranean Forest Ecosystems, Greece).

The first draft of the PRA was prepared by the EPPO Secretariat.

Ratings of likelihoods and levels of uncertainties were made during the meeting. These ratings are based on evidence provided in the PRA and on discussions in the group. Each EWG member provided a rating and a level of uncertainty anonymously and proposals were then discussed together in order to reach a final decision. Such a procedure is known as the Delphi technique (Schrader *et al.*, 2010).

Following the EWG, the PRA was reviewed by the following core members: N. Avendano Garcia, E. Gachet, A. Korycinska, A. MacLeod, C. McGee, R. Potting, G. Schrader, D.J. van der Gaag; as well as by the EPPO Secretariat (C. Picard).

The PRA, in particular the section on risk management, was reviewed and amended by the EPPO Panel on Phytosanitary Measures on 2024-10. EPPO Working Party on Phytosanitary Regulation and Council agreed that *Ceratocystis ficicola* should be added to the A2 List of pests recommended for regulation as quarantine pests in 2025.

CONTENTS

Summary of the Pest Risk Analysis for *Ceratocystis ficicola*

PRA area:
EPPO region (Albania, Algeria, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Guernsey, Hungary, Ireland, Israel, Italy, Jersey, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, Morocco, Netherlands, Norway, North Macedonia, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom, Uzbekistan).

Describe the endangered area:
The endangered area constitutes the areas of the EPPO region where *F. carica* is established, with higher impact expected in the Mediterranean region where *F. carica* are commercially grown. It may also establish and cause damage in protected conditions throughout the EPPO region.

Main conclusions:
Entry: The likelihood of entry on fig (*Ficus carica*) plants for planting was considered as very high with a low uncertainty (potted plants with growing media attached). Entry on bonsai *F. carica* plants was considered as high likelihood with moderate uncertainty. Entry on bare rooted plants was considered high with a high uncertainty and entry on cuttings and rooted cuttings was moderate with a high uncertainty. Entry on conveyance vehicles and equipment that have been operated in a fig production area was moderate with a high uncertainty.

Establishment: There is a very high likelihood that *C. ficicola* can establish in the EPPO region with a low uncertainty. It has already established in Greece and Italy. The pest is more likely to establish outdoors in Mediterranean countries with commercial fig production than in other areas (e.g. Northern Europe). The likelihood of establishment under protected conditions is assessed as very high with a low uncertainty.

The magnitude of spread was rated as moderate with a moderate uncertainty. The EWG considered the main factor for spread is human assisted spread with natural spread having a lower magnitude.

The magnitude of impact in the current area of distribution was rated as high with a low uncertainty. The magnitude of impact in the EPPO region is expected to be similar to that in the current area of distribution. However, the uncertainty is increased to moderate due to a lack of experience in controlling the pest (e.g. experience with resistant rootstock) in the EPPO region. Impact may be different depending on the country, and the speed at which measures can be developed, authorized and implemented.

Phytosanitary risk for the *endangered area*	**High** X	Moderate ☐	Low ☐
Level of uncertainty of assessment	High ☐	**Moderate** X	Low ☐

Other recommendations:
The EWG noted possible topics for future research:

- Management strategies for *C. ficicola*, including development of biological control,
- Need for a fast (in field) validated diagnostic test for *C. ficicola*,
- Biology and epidemiology of the disease,
- Susceptibility and resistance of *Ficus* taxa,
- Origin and genetic diversity of *C. ficicola*,
- Role of insects in spreading *C. ficicola*.

The EWG also noted the need to include *C. ficicola* into existing fig certification schemes.

Stage 1. Initiation

Reason for performing the PRA: *Ceratocystis ficicola* (Ascomycota: Ceratocystidaceae) is a fungus causing a serious vascular wilt of fig trees, *Ficus carica*. The pest was first noticed to cause damage to figs in Japan in the 1970s (Kato *et al*., 1982), but it was properly formally described only in 2011 (Kajitani & Masuya, 2011). In 2018, the disease was observed for the first time in the EPPO region in Greece, in orchards in Attica and later detected on the Euboea Island in 2019 (Tsopelas *et al*., 2021). In 2021 and 2022, the pest was recorded in Italy in Apulia (Habib *et al*., 2022) and Sicily (Crous *et al*., 2023), respectively. It is not known how the pest entered the EPPO region. Affected plants show reduced shoot growth and leaf yellowing, wilting, poor growth of new branches, and eventually die. In Greece, severe damage and tree mortality have also been observed (Tsopelas *et al*., 2021). In Japan, severe infestations have been observed in fig orchards and it is reported that some growers have abandoned their orchards because of the extensive damage caused by *C. ficicola* (EPPO, 2022). As *C. ficicola* was recently detected in the EPPO region, and as the pest is reported to cause some mortality to *F. carica*, an important cultivated species in Mediterranean countries, the EPPO Secretariat added this pest to the EPPO Alert List in 2022 (EPPO, 2022). The Panel on Phytosanitary Measures (PPM) selected *C. ficicola* as a possible priority for PRA in March 2023, and the Working Party for Phytosanitary Regulations (WPPR) selected it for PRA in June 2023.

PRA area: the EPPO region as of 2024 (map at https://www.eppo.int/ABOUT_EPPO/eppo_members).

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification. Kingdom: Fungi; Phylum: Ascomycota; Subphylum: Pezizomycotina; Class: Sordariomycetes; Subclass: Hypocreomycetidae; Order: Microascales; Family: Ceratocystidaceae; Genus: *Ceratocystis*; Species: *Ceratocystis ficicola* Kajitani & Masuya.

Synonyms. *Ceratocystis fimbriata* f. sp. *caricae* Kajitani et Kudo (Kajitani & Kudo, 1993; Kajitani & Masuya, 2011).

Anamorph. *Thielaviopsis* sp. (Kajitani & Masuya, 2011).

Disease. Vascular wilt of fig trees (sometimes called canker-wilt or Ceratocystis canker).

EPPO code. CERAFC.

Notes on taxonomy. *Ceratocystis* canker was first reported in Aichi Prefecture of Japan in the 1970s and 1980s on the fig cultivar 'Masui-Dofin' (*Ficus carica* L. cv. Masui-Dauphine) (Kato & Miyagawa 1980; Kato *et al*. 1981; Kato *et al*., 1982; Yakushiji *et al*., 2019). The disease was considered to be caused by *Ceratocystis fimbriata* sensu lato, based on morphological observations. *C. fimbriata* has been reported on *Ficus* species in other countries, for example in San Paulo, Brazil, where a high mortality of *F. carica* was attributed to *C. fimbriata* (Kajitani & Masuya 2011; Harrington *et al*., 2011). However, Kato *et al*. (1981, 1982) noted that the perithecia of the causal fungus were larger than those of *C. fimbriata* on sweet potato (*Ipomoea batatas*). Kajitani and Kudo (1993) confirmed morphological and physiological differences between the fungus on fig trees in Japan and *C. fimbriata* on sweet potato and proposed a new forma specialis, i.e., *Ceratocystis fimbriata* f. sp. *caricae* Kajitani et Kudo. However, Kajitani and Kanematsu (1997) considered the fungus to be a distinct species from *Ceratocystis fimbriata*. Kajitani and Masuya (2011) described the causal fungus of Ceratocystis canker of fig in Japan as *Ceratocystis ficicola* sp. nov. based on morphological characteristics and DNA sequence data. Further studies of DNA sequence data have shown that *C. ficicola* resides in the Asian-Australian clade of *Ceratocystis*, while *C. fimbriata* is in the Latin American clade (Liu *et al*., 2017).

Tsopelas *et al*. (2021) note that although in Japan the disease is commonly referred to as *Ceratocystis* canker, both canker and wilt occur (canker precedes and even triggers wilt) and the disease is best described as canker-wilt.

2. Pest overview

Information about some elements of the biology and ecology of *C. ficicola* was not found, despite including literature from Japan (in English or Japanese) where this pest is causing damage since the 1970s. Consequently, in some cases, information on other *Ceratocystis* species with similarities has been used in this PRA.

The genus *Ceratocystis* was established in 1890 and comprises of some 40 or more species (de Beer *et al*., 2014; Marincowitz *et al*., 2020) of ascomycete fungi which are generally associated (symbionts) with beetles (Coleoptera) (Harrington, 2013). The genus contains a number of serious causal agents of plant diseases such as black rot (*C. fimbriata*) of sweet potato and wilt diseases, for example canker stain (*C. platani*) of plane (*Platanus* spp.) (EPPO A2 List; EPPO, 2024a) (Kajitani & Masuya, 2011; Harrington, 2013). Other important pathogens in the genus include *C. manginecans* on mango plants (van Wyk *et al*., 2007), *C. cacaofunesta* on cacao (Espinal *et al*., 2023) and the more recent epidemics in forests of the Hawaiian Islands by *C. lukuohia* and *C. huliohia* on *Metrosideros polymorpha* (Hughes *et al*., 2020). In woody hosts, the important (economically damaging) *Ceratocystis* species colonise the sapwood and eventually kill the host. In some hosts, *Ceratocystis* species also attack the cambium and inner bark tissue causing cankers. The disease cycles of *Ceratocystis* species are varied and epidemics can occur when a number of favourable factors occur simultaneously. Some *Ceratocystis* species (as is the case for *C. ficicola*) are soil-borne pathogens which can infect hosts via roots (see Section 2.2).

2.1. Morphology

A description of *C. ficicola* is available in Kajitani and Masuya (2011), Tsopelas *et al*. (2021) and Crous *et al*. (2023) – see Annex 2.

2.2. Biology and lifecycle

The life cycle of *C. ficicola* has not been fully described. However, the overall life cycle of *Ceratocystis* species is common throughout the genus with variations in some aspects (Cabrera *et al*., 2016).

In general, *Ceratocystis* species have teleomorph (sexual) and anamorph (asexual) stages of reproduction (Nasution *et al*., 2019). Ascospores are formed in the ascus and are released on the top of the neck of the perithecium. Unlike conidia, ascospores are held together in a sticky, hydrophobic matrix, not readily separated by water but they can adhere to the hydrophobic exoskeleton of beetles. Propagule production without sexual fusion results in the production of conidia that are formed from conidiophores developing from the mycelium and can extend in a filament chain.

Both ascospores and conidia can be spread within the infected plant (by the movement of insects), and can potentially be dispersed locally by rain, water, and insects (Kile, 1993; Harrington, 2013; Luchi *et al*., 2013; EPPO 2023). More details are provided in Section 2.4.

Teleomorphic and anamorphic spores of *C. ficicola* are formed in nature on freshly cut wood surfaces. Endoconidia of *C. ficicola* have also been observed inside the infected wood (Kajii *et al*., 2013). According to Harrington (2013), all *Ceratocystis* species that affect woody plants can start infections through wounds and spread into the sapwood tissues. This is also true for *C. ficicola*; inoculation studies have shown that aboveground parts of trees can be infected through wounds (Kajii *et al*., 2013; Sumida *et al*., 2016b).

Many species of *Ceratocystis* form long-lived aleurioconidia, which are pigmented, thick-walled, chlamydospore-like spores formed on specialized conidiophores. *C. ficicola* produces these resting spores, which are found in infected wood. This spore stage is found in the soil. Harrington (2013) note that aleurioconidia in wood probably contribute to survival of the fungus in the frass of woodboring insects and sawdust. Species that form aleurioconidia can be soil-borne pathogens that can directly infect roots. Studies in Japan suggest that *C. ficicola* is a soil-borne pathogen that persist in the soil as thick-walled aleurioconidia (Kajii *et al*., 2013; Yakushiji *et al*., 2019; Jiang *et al*., 2022).

In Greece, *C. ficicola* has been consistently isolated from soils associated with dying fig trees. Kajii *et al*. (2013) note that the pathogen invades the roots and the main stems of host plants, causing xylem dysfunction and wilt symptoms on infected fig trees. In cross sections of main stems, dark brown radial discolouration of the sapwood tissues was evident at the bases of affected trees, extending upwards and downwards to the roots (Kajii *et al*., 2013).

It is not known how long aleurioconidia of *C. ficicola* survive in the soil, but based on evidence of survival for similar species, the EWG considered this could be for more than four months. *C. platani* can survive for more than 105 days in soil during the winter, but temperatures of 35–40 °C negatively affect its survival in soil (Accordi, 1989). Grosclaude *et al*. (1993) showed that endoconidia of *C. platani* (*Ceratocystis fimbriata* f. sp. *platani*) can survive for six months in the soil.

Based on the literature and the opinion of the EWG, the main aspects concerning the life cycle of *C. ficicola* are:

- *Ceratocystis ficicola* has a perennial disease cycle,
- It is a soil borne pathogen,
- *Ceratocystis ficicola* may enter the host via wounded roots. It is not clear if *C. ficicola* can infect intact roots,
- *Ceratocystis ficicola* may enter the host via wounds on the trunk or branches,
- Once the plant is infected, the hyphae grow vertically or radially through the host tissue. The pathogen can also progress in the vascular tissue of the plant, but usually close to the base (variation may be seen with different cultivars),
- Sticky ascospores, and conidia formed within insect galleries can attach to insects, making it possible to transport the pathogen within the host,
- *Ceratocystis ficicola* can survive in the soil as aleurioconidia (for more than three months).

2.3. Nature of the damage and disease progression in the host

Affected plants show reduced shoot growth and leaf yellowing (chlorosis), wilting, poor growth of new branches, and eventually the tree will die. In Greece, the disease has been found on young as well as mature trees (20–30 years-old) (Tsopelas *et al*., 2021).

The nature of damage and disease progression in *F. carica* in Japan is as follows (Sumida *et al*., 2015, 2016a,b):

1) The infection starts from roots (in soil) or from the galleries of bark or ambrosia beetles.
2) A discoloured area is formed near the inoculated location and it expands. Vessels become dysfunctional in the discoloured areas.
3) The host's parenchyma cells develop a defensive response. Brown coloured substances were observed around the hyphae inside the vessels, xylem fibres, and radial and axial parenchyma cells. It results in formation of damaged heartwood in the xylem, and water flow stops in that area.
4) As the distribution of the fungus expands, the discoloured area expands, and the water-permeation function of the main trunk decreases. The xylem discolours above the inoculation site (5 cm, 10 cm).
5) The amount of water supplied to the branches and leaves decreases, and the host withers. At this stage, almost no water passages were observed in all areas between 10 cm below and 10 cm above infestation centre.

Root lesions have been observed on rootlets of artificially inoculated fig cuttings cultivar 'Celeste' (note that the name *C. fimbriata* is used for the fungus in the paper, but it is most likely *C. ficicola*; Hosomi *et al*., 2012).

2.4. Dispersal

Spores of *C. ficicola* are not considered airborne, however, insect frass contaminated with spores may be moved by wind, rain splash or running water over short distances (Harrington, 2013). The literature mentions abiotic factors such as rain and wind as mechanisms to transmit spores (Kajitani, 1999) though there is no supporting evidence. No information has been found on the natural dispersal capacity of *C. ficicola.*

Insects may act to disperse spores locally between trees in an orchard and between orchards, although there is no direct evidence for this. Local spread by the ambrosia beetle, *Euwallacea interjectus* has been observed and documented for Japan (Morita *et al*., 2012). See Section 2.5 for further information.

Dispersal via human activity is mentioned in the literature, such as used machinery and equipment (Tsopelas *et al*., 2021). This is covered in detail in Section 11.

2.5. Transmission

Transmission from contaminated soil

One mechanism for the transmission of *C. ficicola* to the host is from the soil to the host's roots (Kajitani & Masuya, 2011; Kajii *et al*., 2013; Morita *et al*., 2013, 2020; Tsopelas *et al*., 2021). However, see Section 2.2 as there is no evidence that intact roots can be infected. This type of transmission would potentially be relevant for transplanted fig plants as they would be likely to have partly wounded roots.

Morita *et al*. (2013) showed that twigs of *F. carica* consistently become infected when placed in infected soil (see Section 2.6).

Experimental soil inoculation with *C. ficicola* (nine times in 3 years; 2 L of suspension with 10^5 conidia/mL per pot) resulted in the death, or inhibited growth, of own-rooted trees (Kamimori *et al*., 2022). To estimate the initial infection period for fig cuttings with soilborne inoculum, 1-year old fig cuttings were planted in a contaminated orchard in Japan (*F. carica* 'Houraishi' and *F. carica* 'Masui Dauphine' cuttings; 18 and 28 cuttings, respectively) (Morita *et al.*, 2015). First infection of fig plants was detected at 97 days after planting, and then the infection rates of cuttings increased in both *F. carica* varieties. External symptoms, wilting and death, were not observed in the cuttings of either *F. carica* variety until three years after planting. These results indicate that infection of *C. ficicola* starts in the year of planting without any external symptoms.

Water and wind-mediated transmission

Spores of *C. ficicola* are not thought to be airborne. However, contaminated insect frass can be transmitted by wind, rain splash or running water over short distances. New infections may arise if the frass comes into contact with fresh wounds on the trees and can also contaminate the soil in fig orchards (Harrington, 2013; Tsopelas *et al*., 2021).

Seed-borne transmission / pollen transmission

No information has been found on seed or pollen related transmission.

Transmission by invertebrates

Euwallacea interjectus **(Coleoptera: Curculionidae: Scolytinae: absent from the EPPO region)**

The ambrosia beetle, *Euwallacea interjectus* infests living *F. carica* trees in orchards in Japan (see Annex 3), with female adults invading tree trunks near the ground. Once a trunk is colonized, *E. interjectus* continues to reside in the same living tree, feeding and producing galleries in the xylem and sapwood for a few years as long as the condition in the trunk is suitable for their reproduction (Kajii *et al*., 2013; EPPO, 2000).

In the Japanese literature, it is widely mentioned that *E. interjectus* is a vector of *C. ficicola* in Japan (Kajitani, 1996, Nitta *et al*., 2005 [cited in Kajitani & Masuya, 2011]). However, in the literature there remains a debate on the role of *E. interjectus* as a vector. For example, Morita *et al.* (2012) reported from field observations in Hiroshima Prefecture in western Japan that the disease became an 'epidemic in relation to the activity of vector beetles. However, Morita *et al.* (2012) noted that many researchers and orchard owners did not believe that the beetle was a vector of this disease, supposing instead that *E. interjectus* is a 'secondary pest' and cannot affect healthy trees. The potential role of *E. interjectus* in the transmission of *C. ficicola* was only recognized late in the history of fig cultivation in Japan, which made it difficult to distinguish it from 'pure' soil-borne diseases. Recent research (Jiang *et al*., 2021) concurs with the latter, suggesting that *E. interjectus* is not a true vector but rather a passive carrier of *C. ficicola* by exoskeleton contamination (Jiang *et al*., 2021) and frass contamination (as previously noted by Morita *et al*., 2012).

Jiang *et al*. (2019) carried out a non-destructive observational study on the mycangia (a specialised structure where fungal spores or hyphae are contained and can proliferate) of *E. interjectus* through computed microtomography scans. Paired mycangia were found within the head of *E. interjectus* females which contained 'a hyphal-like mass' which Jiang *et al*. (2019) hypothesized to be a nutritional fungus. Elytral mycangium, like those found in *Xyleborinus saxeseni* (Coleoptera: Curculionidae) and the bark beetle *Dendroctonus frontalis* (Coleoptera: Curculionidae) (Happ *et al*., 1971; Yuceer *et al*., 2011), were not found. Jiang *et al*. (2019) noted that it is likely that the association of *E. interjectus* and *C. ficicola* is incidental which is consistent with the observations of Kajitani (1999) and Kajii *et al*. (2013). Jiang *et al*. (2019) goes on to note that the punctures and/or setae of the elytra might accidentally trap fungal spores and by chance, *C. ficicola* is transported among fig trees.

This is further supported by Jiang *et al*. (2021), who conducted experiments where adult *E. interjectus* were collected from *F. carica* 'Houraishi' individuals known to be infected with *C. ficicola*. Adults were dissected into body parts (head, thorax, and abdomen) which were washed in distilled water and vortexed for 15 seconds and subsequently placed on PDA plates and incubated. *C. ficicola* was not identified from any of the body parts.

Frass of *E. interjectus* has been shown to contain viable hyphae and spores of *C. ficicola.* Morita *et al*. (2012) showed that the frass obtained from an *E. interjectus* gallery was contaminated with *C. ficicola*. In addition, Morita *et al.* (2012) noted that soil contamination with *C. ficicola* around the fig-stem portion with *E. interjectus* infestation tended to be high.

Jiang *et al.* (2022) showed that infection can occur in above ground material in conditions similar to that of beetles boring into a stem of a tree. Jiang *et al*. (2022) mimicked this condition by drilling holes into 2-year old saplings of *F. carica* ('Masui Dauphine'; 2–4 cm diameter) and inserting toothpicks infected with *C. ficicola* and *C. ficicola* + *Fusarium kuroshium* (*Neocosmospora kuroshio*). For both, subsequent infection and sapling death was observed.

Morita *et al*. (2012) specifically studied the relationships between *C. ficicola* and *E. interjectus* in Japan and reported that *C. ficicola* was found in the xylem of all the trees with *E. interjectus* infestation. This suggests that *C. ficicola* is mostly transmitted by *E. interjectus* in Japan at least in some areas.

It should be noted that Tsopelas *et al*. (2021) discussed the relationships between *C. ficicola* and *E. interjectus* and stressed that in Greece, infestation by wood boring insects in *C. ficicola*-infected fig trees had not been observed.

To conclude, based on the evidence detailed above, *E. interjectus* is not considered a true vector[1] in this PRA. It is likely that *E. interjectus* is a passive carrier[2] of *C. ficicola* within the host and to the soil (mainly by infected frass). There is no evidence that adults can transfer the pathogen from an infected tree to a healthy tree. Transfer from an infected tree to a tree with a wound is possible, though there is no supporting evidence in the literature.

***Cryphalus dilutus* (Coleoptera: Curculionidae: Scolytinae, an invasive species recently introduced in the EPPO region)**

Gugliuzzo *et al*. (2023) recently suggested that *Cryphalus dilutus* can be a vector of *C. ficicola* in Italy. Samples of wood were taken from fig trees showing signs of wood boring insect attack and wilting symptoms (indicative of *C. ficicola*) from Noto (Siracusa Italy) and Aci Castello (Catania, Italy). The identification of the insect was confirmed through morphological and molecular identification methods. *Ceratocystis ficicola* (and

[1] For this PRA: A true vector is: an insect which carries microorganisms either internally or on their mouth parts and transmits the microorganism mechanically through feeding.
[2] For this PRA: A passive carrier is: an insect that can carry a microorganism internally or externally and can transmit it to a host via contact (i.e. via frass or transfer of a spore from the exoskeleton).

Botryosphaeriaceae and *Neocosmospora* spp.) were isolated from the infected wood. Fungal species were isolated from the bark beetles which spontaneously emerged from the sampled wood by grinding individual beetles in a sterile solution which was then placed on PDA plates and incubated. Cultures of *C. ficicola* and *Neocosmospora* spp. were identified from the beetle solution. This suggests that *C. ficicola* was associated with emerging individuals though it is not known if the fungus is passively carried on the exoskeleton or internally (i.e. ingested into the body).

To conclude, based on the evidence detailed above, *C. dilutus* is not considered a true vector (see description for *Euwallacea interjectus*) in this PRA. It is likely that *C. dilutus* is a passive carrier of *C. ficicola* within the host and to the soil (mainly by infected frass). Further research is required to determine if the insect can vector *C. ficicola*. There is no evidence that adults can transfer the pathogen from an infected tree to a healthy tree.

Association with other invertebrate species

Associations are only reported between *C. ficicola* and *E. interjectus*, and *C. ficicola* and *C. dilutus*. However, associations with other bark and ambrosia beetles may be possible (EWG opinion).

Other associations

Neocosmospora kuroshio (syn. *Fusarium kuroshium*) (Hypocreales: Nectriaceae) may increase the severity of the disease and the symptoms of *C. ficicola* in the host (Jiang *et al*., 2022). *N. kuroshio* is a mycangial fungus symbiotically carried by *E. interjectus* and is not directly pathogenic to *F. carica* (Jiang *et al*., 2022). Jiang *et al*. (2022) outlined the relationships between *E. interjectus* and *C. ficicola* and *N. kuroshio* in fig orchards in Japan. The authors hypothesised that *E. interjectus* can infect healthy fig trees where there is no *C. ficicola* inoculum in the soil. Both *C. ficicola* and *N. kuroshio* are transmitted to the trees by the insect and the two fungi in a synergistic action contribute to accelerated wilting of the host (Jiang *et al*., 2022). The authors showed that when *C. ficicola* and *N. kuroshio* were inoculated into fig saplings (*F. carica* 'Masui Dauphine'), death occurred four days faster compared to inoculation with *C. ficicola* alone.

There may be the possibility of transmission of *C. ficicola* by birds which become contaminated with the fungus while foraging for insects from infected to injured fig plants.

Grafting

In general, wilt diseases caused by *Ceratocystis* spp. can be transmitted via grafting (Harrington, 2013). Usually, plants are produced by cuttings, and in Japan, certain cultivars are produced via grafting to more resistant rootstock. The disease can be transmitted with infected grafting tools (Tsopelas *et al*., 2021).

2.5. Survival outside of living host plants

Ceratocystis ficicola can survive in soil (Tsopelas *et al*., 2021), in the frass and on the exoskeleton of *E. interjectus* (Jiang *et al*., 2019) (see Sections 2.2 and 2.4). No information has been found on the survival period of any spore types on/in the aforementioned substrates.

No information has been found on survival rates on dead hosts. Some species of *Ceratocystis* have been recorded to survive up to five years in wood (CABI, 2024).

Tsopelas *et al*. (2021) noted that the pest can survive in the rhizosphere soil of *F. carica*. The EWG considered this could be for more than four months (see Section 2.2).

2.6. Temperature requirements

The temperature requirements of *C. ficicola* to complete its life cycle, and for survival under field conditions are poorly known. No detailed information has been found on the temperature requirements for sporulation or germination of the different spore types.

Under laboratory conditions, Kajitani & Masuya (2011) compared growth rates of *C. ficicola* to that of *C. fimbriata* s. str. The optimal temperature for growth of *C. ficicola* was 20–25 °C. No growth was observed at 5 °C or 35 °C. Similar results (25 °C as optimum for growth) were shown by Souliotis (2022) using cultures of *C. ficicola* in Greece.

Characterising colony growth on V8 medium in Greece, Tsopelas *et al*. (2021) reported that the optimum growth temperature was 25 °C, with a radial growth of 20–23 mm/week. The fungus grew well at 30 °C but no growth was observed at 35 or 40 °C. When the cultures were transferred to 25 °C after 2 weeks of incubation at 35°C, the colonies resumed normal growth, but incubation for 2 weeks at 40 °C killed the fungus and no growth was observed on the plates after transferring these to 25 °C.

The EWG noted that growth rates may vary depending on the strain, media used and therefore the figures detailed above have limited relevance for natural conditions (apart from the extremes).

Morita *et al*. (2013) developed a bait twig method for detection of *C. ficicola* in soil (also see Section 2.12) and tested efficacy of this method under controlled conditions with a temperature range of 5 to 30 °C. Very limited infection was seen at 5, 10 and 15 °C. The optimal temperature for infection of the twigs in soil was 20 to 30 °C for 7 days.

2.7. Humidity

There is no known information on the humidity or dew period requirements for *C. ficicola.*

Based on literature for other *Ceratocystis* species (e.g. Harrington, 2013), both aspects are likely to be important for the survival of the fungus and, in the case of the latter, important for the germination and infection transfer to the host.

2.8. Symptoms of infection

Symptoms of *C. ficicola* on *F. carica* are similar to those of many other tree diseases caused by *Ceratocystis* species (Tsopelas *et al*., 2017, 2021; Nasution *et al*., 2019).

External symptoms:
- lengthwise lesion spread is a characteristic for Ceratocystis canker lesion on fig trees (Miwa *et al*., 2014);
- lesion spread observed near buds (Miwa *et al*., 2014);
- shoot growth reduced/stunted (Morita *et al*., 2018);
- in some trees, most of the leaves drop by the end of summer, while some of the unripe fruits retain on the trees indicating rapid death (Figure 1B) (Tsopelas *et al*., 2021);
- thinning and yellowing (chlorosis) of the foliage (discoloration; wilt; defoliation), either on some of the branches or over the entire crowns (Figure 1A) (Tsopelas *et al*., 2021; Habib *et al*., 2023);
- complete defoliation by the end of the summer in many of the affected mature trees, although full foliage had been present on these trees early in the spring (Tsopelas *et al*., 2021);
- on mature trees, extensive bark cankers were observed at the bases of the trunks (Tsopelas *et al*., 2021), on the lower part of the trunk and in some cases on lateral branches (Habib *et al*., 2023);
- the affected trees eventually die (Morita *et al*., 2016; Tsopelas *et al*., 2021).

Symptoms within the host:
- necrotic dark brown sapwood (xylem discoloration) is visible after removal of the bark in the lower part of the trunks (Figures 1C–E), and these lesions extend upwards (Tsopelas *et al*., 2021);
- necrotic sapwood can be present with no external symptoms (cankers) (Figure 2);
- infected trees have necrotic roots (Tsopelas *et al*., 2021).

The development of symptoms on the 'Houraishi' cultivar was described by Morita *et al*. (2018) in Japan as follows:
- the end of June onwards: stunting of shoot growth;

- the end of June onwards: discoloration of the outer surface of the trunk at the ground level;
- then: discoloration expanded to the upper part of the trunk and depression formed along the discoloration;
- at the end of July: partial yellowing (chlorosis) and wilting of leaves;
- by the end of August: all leaves wilted;
- in October: cracks at the depression of the stem expanded to the main branches.

In some cases, in Japan, symptoms are not expressed until 3 years after planting (and infestation) and the number of dead trees increases 3–5 years after planting. Time between leaf wilt and tree death was approximately 1 month; tree mortality rate was 90 % after 10 years (Morita *et al*., 2018).

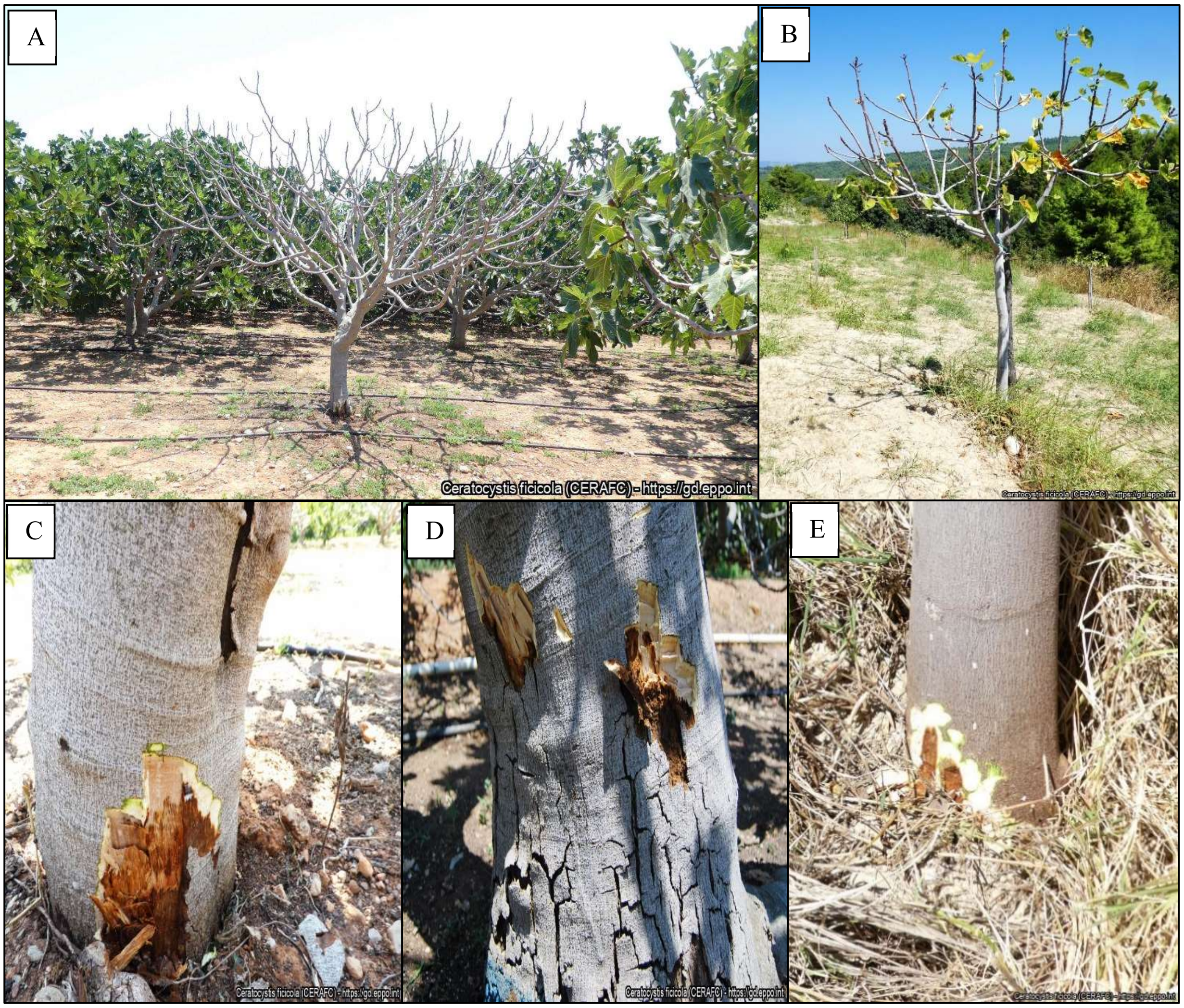


Figure 1. Field images of infected fig trees in Greece: (A) infected mature tree of 'Vasilika honey-white' cultivar with symptoms of leaf wilt and defoliation, (B) infected young tree of 'Smyrna' cultivar defoliated at the end of summer, with some of the unripe fruit still on the tree; and (C, D, E) cankers at the bases of trees, with extensive wood staining under the dead bark. All images: EPPO Global Database; Courtesy: Panaghiotis Tsopelas (GR).

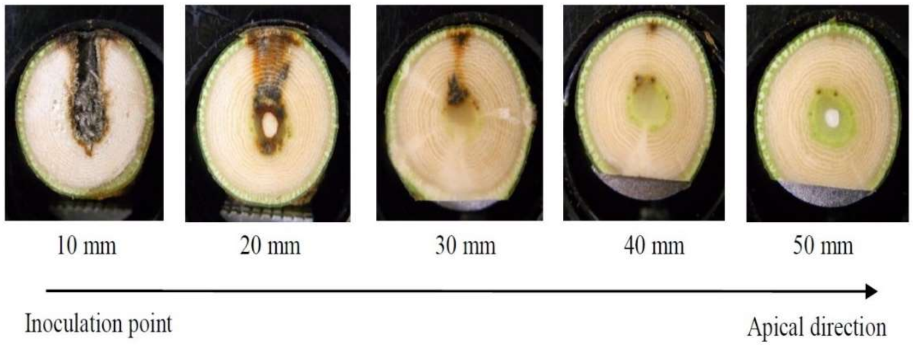


Figure 2. Lesion spreading on the cross-section of the branch of *Ficus carica* 'Masui Dauphine'. Images show cross-sections (10, 20, 30, 40, and 50 mm in the apical direction from the inoculation point). Visible signs of infection are likely to be observed closer to the infection point (EPPO Global Database; Courtesy: Yuka Miwa, Akihiro Hosomi, and Takaaki Ishii (JP)).

2.10. Natural enemies

No information has been found on natural enemies of *C. ficicola.*

2.11. Susceptibility

Ficus carica is highly susceptible to *C. ficicola*. The susceptibility of fig cultivars varies and information about susceptibility of fig cultivars and varieties to *C. ficicola* is limited and sometimes contradictory.

For management purposes in Japan, susceptible fig cultivars are grafted on rootstocks with some level of resistance.

Some ambiguity exists on the total number of fig cultivars in existence with numbers ranging from 700 to over 1000 (Condit, 1955; Flaishman *et al*., 2017; Ramadan, 2023). A much smaller number of cultivars are used in large scale commercial production of fig fruit.

Rootstock

A lot of research has been conducted to find resistant rootstock and develop breeding programmes in Japan (Yakushiji *et al*., 2012; Shirasawa *et al*., 2020; Morita *et al*., 2021; Kamimori *et al*., 2022). In most of these studies 'Masui Dauphine' is used as a scion. Among rootstock cultivars, *F. carica* 'Ischia Black', 'Negronne', and BC1 (backcross hybrids between the common fig *F. carica* and its wild relative *F. erecta*) 'Reikodai 1 go[3]' [= Reikodai 1 go] (BC1 from interspecific hybridization) were tested more often than others (see Annex 4).

'Celeste' ('Malta') is susceptible but the disease infection has a lower rate of mortality (Hosomi *et al*., 2012; Morita *et al*., 2020).

'Boldido Negra' and 'Ischia Black' show some resistance (Hosomi *et al*., 2012, 2015). Hosomi *et al*. (2012) stressed that these varieties of *F. carica* are not truly resistant[4].

'Negronne' (= 'Bordeaux'), 'Kibaru', and 'Reikoudai 1 gou' (=BC1 line Reikodai 1 gou), a back-cross derived from interspecific hybridization of *F. carica* and *F. erecta*, are considered most resistant (Hosomi *et al*., 2012, 2015; Hosomi, 2019; Morita *et al*., 2021; Shirakami *et al*., 2022).

---

[3] The names Reikodai 1 go and Reikodai 1 gou are used in publications but are considered here as the same

[4] Defined as the ability of a plant variety to restrict the growth and development of a specified pest or pathogen and/or the damage they cause when compared to susceptible plant varieties.

'Zidi' is considered 'resistant', but only in a single paper (Hosomi, 2019). However, the EWG considered it is not resistant.

Scion

'Masui Dauphine' (= 'Masui-Dofin'; = 'San Piero'), a major cultivar in Japan, and 'Horaishi' ('Houraishi') are highly susceptible to the pest (Kajitani *et al*., 1992; Kajitani & Masuya, 2011; Hosomi *et al*., 2012; Morita *et al*., 2015, 2018, 2020; Jiang *et al*., 2022; Shirakami *et al*., 2022).

In Greece, the cultivars 'Vasilika honey-white', 'Vasilika black', and 'Smyrna' are susceptible to *C. ficicola* (Tsopelas *et al*., 2021).

The EWG considered that there are no truly resistant cultivars or interspecific hybrids of *F. carica*.

2.12. Detection and identification methods

Detection

External symptoms (see Section 2.8) are important to further investigate the presence of the disease but similar symptoms can also be caused by other pathogens, such as *Armillaria* and *Phytophthora* species (Tsopelas, unpublished data). The most characteristic symptom of *C. ficicola* on infected fig trees is the extensive staining of the sapwood and the formation of cankers, especially at the base of the main stem of fig trees. Species of *Phytophthora* also cause cankers at the base of the main stem of fig trees, however, wood discoloration is limited in the external part of the stem under the bark (a few mm) (Tsopelas, unpublished data), while in the case of *C. ficicola*, wood discoloration extends deep into the sapwood (Kajii *et al.,* 2013).

For accurate diagnosis, isolation and identification of the causal agent is necessary (Harrington, 2013). However, no recognised international standards are available for detection and identification of *C. ficicola*.

Visual examination is not an appropriate method for the detection of *C. ficicola* as some infected trees can be asymptomatic. Samples would need to be sent to the laboratory for testing (e.g. molecular identification, see below).

The pest can be detected in living host material by direct observation under a light microscope. Detailed morphological description of the pest is provided by Kajitani & Masuya (2011), Tsopelas *et al*. (2021) and Crous *et al*. (2023).

The pest can be also isolated from infested wood (Gugliuzzo *et al*., 2023).

In Japan, a baiting method has been developed for the detection of *C. ficicola* in soil (Kajitani, 1995; Morita *et al*., 2013). A baiting method for the detection of *C. platani* (EPPO, 2014) was used by Tsopelas *et al*. (2021) for the detection of *C. ficicola* in soil. It is very reliable and faster than one described by Morita *et al*. (2013), where with the methods used by Tsopelas et al. (2021) results can be obtained in 7–10 days.

The fungus has been isolated from the beetle *C. dilutus*, reared as a colony on PDA plates and then identified in a study conducted in Italy (description of the method: Gugliuzzo *et al*., 2023).

Morphological identification

For morphological identification see Annex 2.

Molecular identification

A TaqMan real-time PCR assay developed using the ITS gene for amplifying DNA from *Ceratocystis* species can be used for identification at the generic level (e.g. the group of species in total). Specific conventional and real time PCR assays for *C. ficicola* are under development in UNIBA, Italy. In the meantime, the use of multiple barcode regions can provide sufficiently reliable specific identification. This consists of finding the closest matching reference record using a combination of Basic Local Alignment Search Tool (BLAST) hit identity and multilocus sequence analysis (MLSA) with sequence data of *C. ficicola* contained in the publicly available databases.

Sequences of ITS, TEF1, TUB2, RPB2 genes of *C. ficicola,* including that of the type material, are present in NCBI (National Center for Biotechnology Information), of which two ITS sequences were mined to be presented in BOLD (Barcode of Life Data, 2023).

3. Is the pest a vector?

Yes ☐ No ▣

4. Is a vector needed for pest entry or spread?

Yes ☐ No ▣

Euwallacea interjectus and *C. dilutus* can play a role in the passive spread of *C. ficicola* (see Section 2.4). However, a vector is not needed for pest entry or spread (see Section 2.2). Remark: *C. ficicola* is present in Greece and there is no evidence of bark beetle presence on fig trees infected with *C. ficicola* (Tsopelas *et al*., 2021).

The important details of *E. interjectus* and *C. dilutus* are detailed below, and where necessary, further information is provided in relevant sections of the PRA (for example, Sections 8 and 11). This PRA considers the risk of introducing *C. ficicola* with *E. interjectus* and *C. dilutus* for relevant pathways (see Section 8). However, considering uncertainty on the importance of these two passive vectors, a complete PRA for the two beetle species was not produced.

The information below is taken from EPPO (2020) unless otherwise stated.

Euwallacea interjectus (Scolytinae)

Biology: A major part of the lifecycle of this barkbeetle is within the hosts, mating takes place within the galleries and the females emerge to invade healthy tree trunks near the ground. *E. interjectus* is an inbreeder and haplodiploid. Females are able to lay eggs and produce a brood even if they have not copulated and are not fertilized (parthenogenesis). Jiang *et al.* (2021) showed that the sex ratio of adults emerging from the galleries was about 31 females to 1 male. No general information on the size of the plant parts attacked was found, but Kajii *et al*. (2013) assessed two *F. carica* trees infested by *E. interjectus*, which had a basal stem diameter of 29 cm and 14 cm, respectively (with a trunk height/age of 43 cm/26 years and 39 cm/8 years, respectively). In addition, Jiang *et al*. (2021) detailed that beetles emerged from *F. carica* branches of a tree infected with *C. ficicola*. The branches, cut from the same tree were 11.5 cm in diameter and 31.5 cm in length; and 12.8 cm in diameter and 39.5 cm in length.

Distribution: Absent from the EPPO region[5]. Present in Asia (China, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Vietnam) and North America (USA: Florida, Georgia, Kentucky, Louisiana, South Carolina, Texas, Virginia and Hawai'i).

Hosts: Anacardiaceae (*Mangifera indica, Lannea coromandelica, Spondias mangifera*), Burseraceae (*Garuga pinnata*), Combretaceae (*Terminalia bellirica, T. myriocarpa, T. nudiflora*), Dipterocarpaceae (*Shorea assamica, S. robusta*), Euphorbiaceae (*Euphorbia royleana, Hevea brasiliensis, Macaranga denticulata*), Fabaceae (*Delonix elata, Erythrina* sp.*, Pterocarpus marsupium, Wisteria* sp.*, Xylia xylocarpa, Castanopsis indica*)*,* Lamiaceae (*Gmelina arborea, Tectona grandis*), Lauraceae (*Machilus* sp.), Malvaceae (*Bombax ceiba, Bombax insigne, Kydia calycina, Pterygota alata* [*Sterculia alata*]*, Pterocymbium tinctorium* [*Sterculia campanulate*]).

Cryphalus dilutus (Scolytinae)

[5] Scolytinae spp. (non-European) are regulated quarantine pests in the European Union (Annex II Implementing Regulation (EU) 2019/2072) and may also be regulated by other EPPO countries.

Biology: *C. dilutus* is a small bark beetle that can breed in twigs, branches, and trunks of its host. Massive infestations of *C. dilutus* can cause host dieback resulting in the partial drying of the main branches and can cause leaves to yellow. The dieback can lead to tree death, which mainly affects old trees regardless of their vigor (Gaaliche *et al*., 2018). In Malta, more than 50 % of fig trees infested with *C. dilutus* died between 2011 and 2017 (Cutajar & Mifsud, 2017). In Italy, beetles have been found in both big (30–40 cm diameter) and smaller (<20 cm diameter) trunks and branches (A. Gugliuzzo, University of Catania, IT, pers. comm., 2023). In Asia, *C. dilutus* has been recorded from *Mangifera indica* branches 2-5 cm in diameter (Johnson *et al*., 2020).

Distribution: Asia, the EPPO region (Algeria, France, Italy [Sicily], Malta, Tunisia), Mexico.

Hosts: species from Anacardiaceae, Moraceae.

5. Regulatory status of the pest

Ceratocystis ficicola is not listed as a quarantine pest by any EPPO country according to the EPPO Global Database (EPPO, 2023b). It was added to the EPPO Alert List in 2022 (EPPO, 2022).

Information about the regulatory status of *C. ficicola* elsewhere in the world was sought. *Ceratocystis ficicola* was not found in quarantine lists of any country (performed up to 2024-03-25).

6. Distribution

Ceratocystis ficicola was first described from Japan in 1981. It has since been reported in 33 of the 47 prefectures of Japan (Kajitani & Masuya, 2011) (Annex 3). In the EPPO region, *C. ficicola* has been reported from Greece and Italy (including Sicily) (Table 2, Fig. 3). The pest is not known to occur anywhere other than in these three countries. Readers should refer to EPPO (2024b) for up-to-date information on the global distribution of *C. ficicola.*

Table 2. Global distribution of *Ceratocystis ficicola*

Continent	Distribution	Comments	References
EPPO region	**Greece**	First identified in 2018 in two neighbouring fig orchards in the Attica region. Found in 2019 and 2020 on Euboea Island.	Tsopelas *et al*. (2021)
	Italy (mainland)	First found in 2021 near Salento (Puglia)	Habib *et al.* (2023)
	Italy (Sicily)	Detected in sample collected in 2022 in Noto from *F. carica*	Crous *et al*. (2023)
Asia	**Japan** Honshu	 *first – 1970s and 1980s in Aichi Prefecture, 1996 (?) – Hiroshima Prefecture, 2006 – Niigata Prefecture, 2009 – Fukushima Prefecture, 2011 – Miyagi Prefecture, Fukuoka Prefecture (holotype, 1990)	Kato *et al*. (1982) Morita *et al*. (2013)
	Kyushu		Kajitani & Masuya, (2011)
	Shikoku	Ehime and Tokushima Prefectures	Kajitani (2017); Y. Kajitani, pers. comm. (2023)
		Cultivation areas infested with fig wilt disease were reported in 33 out	Kajitani (2017)

Continent	Distribution	Comments	References
		of 47 prefectures of Japan until 2017 (see Appendix 3).	

* Occurrence in prefectures is detailed where information is available.

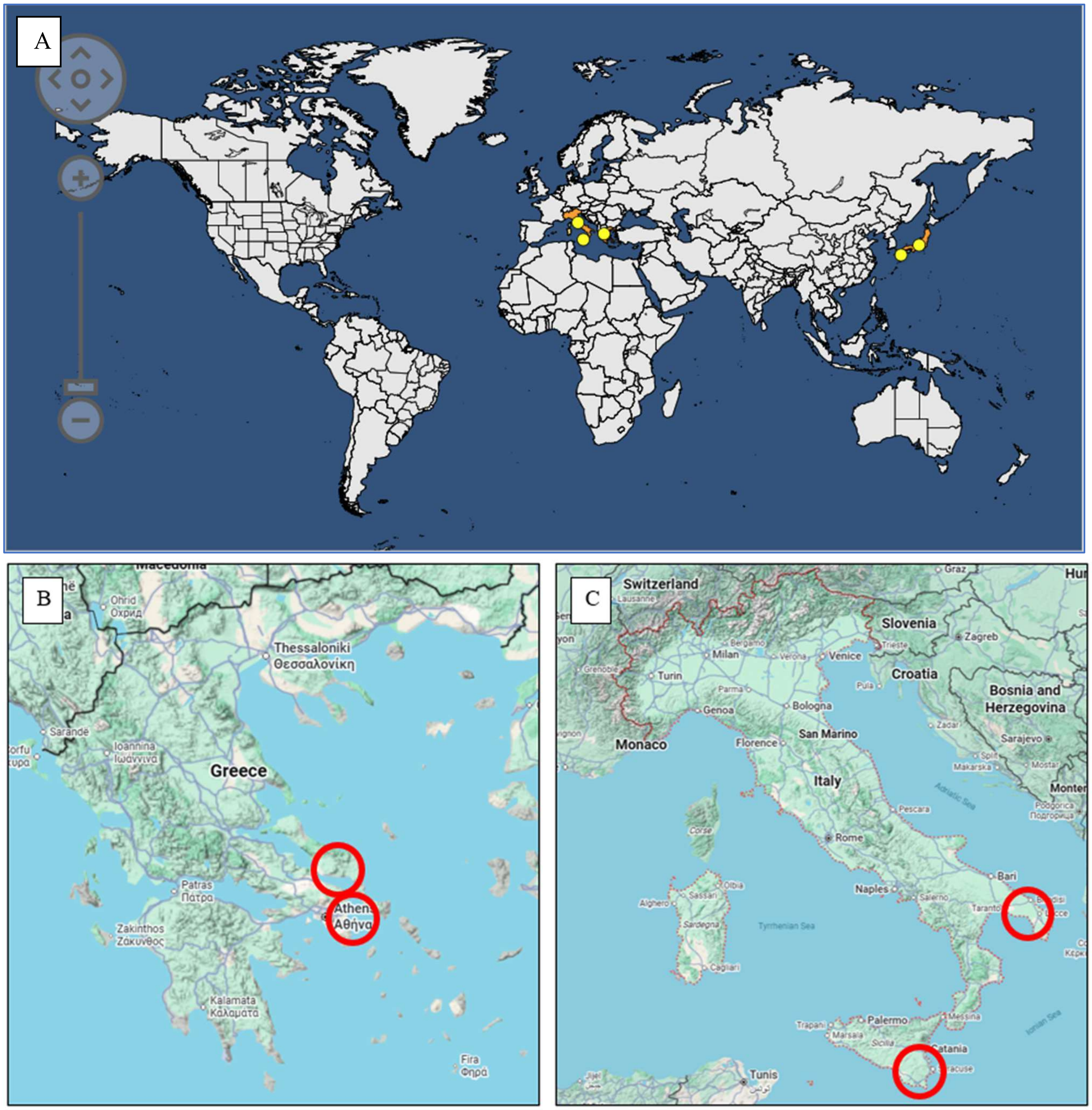


Figure 3. (A) Distribution of *Ceratocystis ficicola* (as of October 2024). In orange: Countries where *C. ficicola* is present are shown in orange. (B, C) Locations where *C. ficicola* was recorded in the EPPO region: in Greece (B: Attica region in 2018 and on Euboea Island in 2019–2020) and Italy (C: Salento [Pulgia], 2021 and Noto [Sicilia] in 2022). Prepared by the EPPO Secretariat based on information in Table 2.

It should be noted that the origin of *C. ficicola* is unknown (Tsopelas *et al*., 2021). Although *C. ficicola* was first identified in Japan, Kajitani and Masuya (2011) noted that two possible scenarios exist for its occurrence in the country. Either (1) *C. ficicola* is non-native to Japan and is an invasive pest, or (2) it is native to Japan and 'over time' has come into contact with the highly susceptible host, *F. carica.* The second scenario would imply that other hosts exist for *C. ficicola* as *F. carica* is not native to Japan. However, there is no evidence of additional hosts in the literature.

7. Host plants and their distribution in the PRA area

Ceratocystis ficicola has a narrow host range with only one species *F. carica* known to be attacked under field conditions (Table 3). See Section 2.11 for known cultivar susceptibility.

Table 3. Hosts of *Ceratocystis ficicola*

Hosts	Presence in PRA area (Yes/No/Not known)	Comments	References for host status
Rosales			
Ficus carica	Yes. Present in: cultivation for fruit production, horticulture, natural environment	**Major host**. Cultivated throughout the Mediterranean region for its fruit, naturalised in other areas (e.g. Spain – Canary Islands), grown widely throughout the EPPO region in urban areas as an ornamental species for private gardens and amenity areas.	Kajitani & Masuya (2011); Tsopelas *et al*. (2021); Gugliuzzo *et al*. (2023); Habib *et al*. (2022, 2023)

Species infected under experimental conditions

Ficus benjamina proved susceptible in inoculation experiments conducted in Greece (Tsopelas *et al*., 2021). Tsopelas *et al*. (2021) showed that *F. benjamina* was less susceptible to *C. ficicola* compared to *F. carica.* The mean internal lesion length was significantly lower than that of *F. carica*. No spores were observed. Based on this study, the EWG did not consider that *F. benjamina* is a host. *F. benjamina* is cultivated as an ornamental with numerous varieties which are frequently grown as house plants.

8. Pathways for entry

Ceratocystis ficicola has not been intercepted on any pathway. A number of possible pathways have been suggested in the literature, including plants for planting and contaminant of used machinery and equipment. Additional possible pathways are suggested by the EWG for assessment.

The following pathways for entry of *C. ficicola* are discussed in detail in this PRA in Section 8.1:
- *Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media (Table 4);

The following pathways are discussed in Section 8.2 but not considered in detail:
- Conveyance vehicles and equipment;

The following pathways are considered very unlikely and are discussed in Section 8.3:
- Round wood and sawn wood of *Ficus carica* (with or without bark),
- *Ficus carica* wood chips, hogwood, processing wood residues and sawdust,
- *Ficus carica* cut branches,
- Soil or other growing media,
- Non-host plants for planting with growing media,
- *Ficus carica* fresh fruit,
- Dried *Ficus carica* fruit,
- Dried *Ficus carica* leaves,
- Travellers, their luggage and clothes and footwear,
- Natural spread.

8.1. Pathways investigated in detail

Information on import prohibitions and phytosanitary measures is not provided for all countries in the PRA area.

Data on trade was extracted from FAO Stats (FAO, 2023) for the whole EPPO region.

8.1.1. Plants for planting (except seeds, tissue culture, pollen) with or without growing media

Table 4. Pathway: Host plants for planting

Pathway	***Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media**
Coverage	This pathway concerns the host plant *F. carica* and its varieties and cultivars from countries where the pest occurs (including in the EPPO region), and covers: • Plants for planting in pots or similar (including bonsais) with or without growing media, plants with bare roots, and cuttings (including scions and rooted cuttings); • Associated packaging material; • The pathway includes *F. carica* plants for planting carried by travellers and in the internet trade. Plants can enter the EPPO region or a country within the EPPO region for planting for commercial production of fig or for the ornamental horticulture trade. Entry e.g. by travellers may be facilitated/increased for neighbouring countries of the EPPO infected countries. Seeds, tissue culture and pollen are excluded because the pest is not associated with these pathways. However, when tissue culture is utilised under non-protected conditions, such material is included.
Pathway prohibited in the PRA area?	Yes, partly in some EPPO countries. For EU countries: • It is prohibited to introduce plants for planting, other than seeds, *in vitro* material and naturally or artificially dwarfed woody plants for planting of *F. carica* from third countries other than from Israel (EU, Implementing Regulation 2021/1936; EU, 2021). For the United Kingdom: • It is prohibited to introduce *F. carica* plants for planting pending risk assessment, with the exception of EU Member States, Liechtenstein and Switzerland (regulated and notifiable) (www.gov.uk). For Israel • Vegetative propagation material of *F. carica* (excluding seeds) is prohibited from import. No information on the requirements of other non-EU EPPO countries has been found.
Pathway subject to a plant health inspection at import?	Yes. Plant health regulations usually specify that plants for planting (with often exceptions for seeds) are regulated and should be imported with a Phytosanitary Certificate and are consequently subjected to import inspection e.g. for the EU and Eurasian Economic Union.
Pest already intercepted?	No. There is no evidence that *C. ficicola* has been intercepted on plants for planting from countries where the pest is known to occur.
Plants concerned	*Ficus carica*
Most likely stages that may be associated	All stages of the fungus may be associated with plants for planting though this will potentially differ for different types of plant material (see below). *C. ficicola* may be present in any plant material covered in this pathway. Both dormant and non-dormant plants may be infected with the fungus. Aleurioconidia may be present in soil attached to plants. It is not known if the fungus can survive in other types

Pathway	*Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media
	of growing media. **Plants for planting (including bonsais) in pots with growing media** – These plants may be grown in soil or commercial growing media outdoors or under protected conditions. Mycelium developing internally is the most likely stage associated with rooted plants. Depending on the age of the plant and the disease progression in the plant, aleurioconidia, conidia, ascospores may be present. If the plants were grown in contaminated soil, there is the potential that aleurioconidia may be present on the roots or in the soil that may remain attached to the roots. It is unlikely that *E. interjectus* or *C. dilutus* (sometimes hereafter referred to as the two beetles), that may act as passive carriers of the fungus, would be associated with plants for planting except larger plants exported from areas where the beetle occurs. EFSA (2021) note that in Israel bare rooted plants for planting can be 20–100 cm tall with a base trunk diameter of up to 2 cm. Plants grown in pots are likely to be a similar size though bonsai may have a wider trunk diameter. The EWG consider that plants imported from countries where the pest is present may be similar in size. There is no information on the minimum size of plants the female beetles will utilise for egg laying. It has been reported that *E. interjectus* has been found infesting branches 11.5 cm in diameter and *C. dilutus* has been found in branches <20 cm diameter. The EWG considers both beetles are unlikely to infest plants for planting with a ≤2 cm trunk diameter. **Bare rooted plants for planting** – These plants may have been grown in soil or commercial growing media outdoors or under protected conditions. EFSA (2021) note that in Israel this type of plant can be 20–100 cm tall with a base trunk diameter of up to 2 cm. The EWG consider that plants imported from countries where the pest is present may be similar in size. Mycelium developing internally is the most likely stage associated with bare rooted plants. Depending on the age of the plant and the disease progression in the plant, aleurioconidia, conidia, ascospores may also be present. If the plants were grown in contaminated soil, there is the potential that aleurioconidia may be present on the roots or in small particles of soil that may remain attached to the roots even after washing. It is unlikely that the two beetles would be associated with this type of plant material due to the small base diameter. **Unrooted cuttings (scions)** – usually with one or more buds. The EWG considered that unrooted cuttings will be similar in size to rooted cuttings. EFSA (2021) noted that in Israel rooted cuttings can be about 10 cm long with a ~1 cm base diameter. The EWG consider that plants imported from countries where the pest is present may be similar in size. Cuttings from infected trees may be infected with the fungus. Due to the small size (including girth) and the practice when the healthiest parts of the tree are used for scion, it is unlikely that cuttings will have cankers or any spore type associated. Mycelium developing internally in the cutting is the most likely stage to be associated with unrooted cuttings. It is unlikely that the two beetles would be associated with this type of plant material due to the small diameter of the cutting. **Rooted cuttings** – grown in sterilised growing media for a short/defined period (e.g. 1 year). EFSA (2021) noted that in Israel this type of plant material can be about 10 cm long with a ~1 cm base diameter. The EWG consider that plants imported from countries where the pest is present may be similar in size. Mycelium developing internally is the most likely stage associated with rooted cuttings. It is unlikely that the two beetles would be associated with this type of plant material due to the small diameter of the cutting.

Pathway	*Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media
Important factors for association with the pathway	The fungus may be present internally within the plant and infected plants may be asymptomatic. It is unlikely that any of the plant material covered in this pathway will have cankers with sporulating bodies as the plants are traded as young plants and any infection is unlikely to have developed to showing symptoms. There may be requirements in place in importing countries for growing media accompanying plants that would mitigate the risk. For example, in the EU (a) growing medium at planting: free from soil and organic matter, or treated, and (b) since planting: measures to maintain the growing medium free from harmful organisms, or plants shaken free from the media and, if replanted, using growing media meeting above requirements. It is unlikely that the consignment would show any symptoms of infection due to the young age of the plants. Plants will have no leaves. Plants grown from cuttings can remain asymptomatic for 3 years (Morita *et al*., 2015). Detection of *C. ficicola* in commercial consignments would be difficult and most likely depend on laboratory testing (requiring reliable methods for latency testing). Soil would need to be tested in the laboratory. In some EPPO countries, all consignments of plants for planting would be subject to an inspection (e.g. in the EU). Cuttings (scions) are likely to be taken from healthy trees. The pest may be present in nurseries if those are located in infested areas. No information has been found on the fungus infesting plants in nurseries in the area where the pest is present. If nurseries are close to areas where the pest is present, especially fig orchards, the likelihood of association with the pest is higher, especially if hygiene measures (e.g. disinfecting pruning tools) to prevent contamination were not routinely undertaken. Since the pest is present in the EPPO region, human assisted entry could be facilitated to neighbouring countries.
Survival during transport and storage	*Ceratocystis ficicola* is expected to survive transport and storage. The fungus can be present inside the host. Short and long distance transport of *F. carica* plants for planting may be carried out within the temperature growth limits of the fungus. Potentially, under optimal conditions, the fungus could continue development within the host during transport. Shipment under cool conditions is unlikely to have an effect on spore viability but it may reduce its proliferation while in cold storage. Aleurioconidia have the potential to survive during transport and storage if present with rooted cuttings. It is not known how long this spore type can survive in soil or if it can survive on other types of growing media. There is no information on the duration of survival of any spore types or mycelium on artificial surfaces though it is likely that the survival of any spores would be limited to a few days. Generally, spores are very sensitive to desiccation (Harrington, 2013).

Pathway	*Ficus carica* plants for planting (except seeds, tissue culture, pollen) with or without growing media
Trade	No detailed data are available for import of host plants for planting into EPPO countries. Import of *F. carica* plants is prohibited into the EU from third countries except from Israel (EU, 2021). ISEFOR data for 2020 details imports from Israel into Germany (approx.. 700 plants for ornamental use).
Transfer to a host	As the commodity is intended for planting there is a potential of pest transfer to *F. carica* if infected plants are planted in areas close to host plants. Plants for planting will generally be planted in favourable conditions for their development and these may also be favourable for pest development. Transfer to another host plant will depend on where the plants will be used. Transfer would be less likely for plants that are used indoors (e.g. bonsais). *Ceratocystis ficicola* is a soil pathogen which can persist in the soil. There are indications in the literature that the fungus can persist in the soil in the absence of host plants though it is not known for how long (Morita *et al*., 2013, 2020). Therefore, transfer can occur if contaminated plants or soil are placed temporarily in an area where fig plants are planted at a later date (e.g. in a nursery).
Likelihood of entry and uncertainty	The EWG rated the likelihood and uncertainty for each type of plant for planting separately. All ratings are based on a scenario without EU prohibition in place and assuming that all imported *F. carica* plants originate from a country where the pest occurs and are not inspected at export. **Plants for planting (excluding bonsais) in pots with growing media: very high likelihood with low uncertainty.** *Justification for rating*: main pathway of spread in the literature (Japan) / plants can be asymptomatic / plants may have been grown outside for some or all of their growth / associated soil may contain aleurioconidia / one infected plant can lead to establishment. *Justification for uncertainty*: known movement along the pathway in Japan / association with soil / asymptomatic. **For bonsais: high likelihood with moderate uncertainty** Same justification of rating for plants for planting *Justification for uncertainty*: association with soil / asymptomatic/ moderate uncertainty reflects possibilities of transfer to other host plants – bonsais kept in protected conditions. **Bare rooted plants for planting; high likelihood with a high uncertainty** *Justification for rating:* Plants may have wounded roots as a result of the transplanting process which can become infected/ unknown if plants were grown previously in infected soil/ pest that can be asymptomatic / one infected plant can lead to establishment.

Pathway	*Ficus carica* **plants for planting (except seeds, tissue culture, pollen) with or without growing media**
	Justification for uncertainty: plants may have been grown outside for some or all of their growth / potential for contaminated soil particles to remain on roots / unknown if the fungus is able to leave the plant and enter another/ without details on the growing conditions it is difficult to assess the probability of association. **Unrooted cuttings (scions): moderate likelihood with a high uncertainty** *Justification for rating:* potential for entry with asymptomatic scions / can be transmitted by tools for collecting cuttings *Justification for uncertainty:* systemic pathogen / uncertainty if disease will be present in area of tree where cuttings are taken / cuttings taken from healthy trees, asymptomatic, genetic variability. **Rooted cuttings: moderate likelihood with a high uncertainty** *Justification for rating:* potential for asymptomatic entry / can be transmitted by tools for collecting cuttings / systemic *Justification for uncertainty:* systemic pathogen / uncertainty if disease will be present in area of tree where cuttings are taken / cuttings taken from healthy trees, asymptomatic, genetic variability.

8.2. Pathways considered but not investigated in detail

Conveyance vehicles and equipment

This pathway concerns machinery and vehicles that have been operated in a fig production area. Vehicles and equipment used for fig production are unlikely to be specialized machinery.

Associations:

- Conveyance vehicles and equipment may be contaminated with soil, roots or sawdust containing propagules of *C. ficicola;*
- Aleurioconidia may be associated with soil and other propagules may be associated with sawdust;

Survival during storage and transport:

- Propagules may survive during transport and storage. Some species of *Ceratocystis* have been recorded to survive up to five years in wood (CABI, 2024).

Transfer:

- Conveyance vehicles and equipment used in an infected area may be moved to areas where the pest is not present yet and the host is present;
- Soil or sawdust could transfer propagules.

Rating: Moderate likelihood with a high uncertainty: If there is any movement of used machinery from the countries where the pest occurs into an EPPO country, phytosanitary procedures such as decontamination may be applied. Recommendations of phytosanitary measures are given in the International Standard for Phytosanitary Measures 41 (ISPM 41; FAO, 2017). This pathway is also relevant for spread within the EPPO region (Section 11).

8.3. Unlikely pathways: very low likelihood of entry (in no particular order)

Round wood and sawn wood of *Ficus carica* (with or without bark)

This pathway covers all types of round wood and sawn wood of hosts. *F. carica* is not normally used for wood production. The wood contains a latex that is a skin irritant which may reduce the use of the wood (Khatib & Vaya, 2010). There is no evidence that round or sawn wood of *F. carica* is commonly used or if it is traded. It is unlikely that the commodity will come from countries where the two beetles are present and therefore this association is not considered further in this pathway. However, it cannot be excluded that the wood of hosts may be used and traded, especially between neighbouring countries as firewood.

Association:

- All stages of the fungus (aleurioconidia, conidia, ascospores, mycelium) may be associated with wood.
- *C. ficicola* is associated with the trunk, branches of fig trees from young to old trees.

Survival during storage and transport:

- The fungus may survive during transport and storage. Some species of *Ceratocystis* have been recorded to survive up to five years in wood (CABI, 2024);

Transfer:

- Wood is often stored outdoors. This may provide optimal conditions for sporulation or germination of existing spores in the wood.

Uncertainty rating for round wood and sawn wood of *Ficus carica* (with or without bark): Low: lack of trade.

***Ficus carica* wood chips, hogwood, processing wood residues and sawdust**

This pathway covers woodchips, hogwood and processing wood residues of *F. carica*. There is no evidence that any of these commodities made from *F. carica* are commonly produced or if they are traded. It is unlikely that the commodity will come from countries where the two beetles are present and therefore this association is not considered further in this pathway. However, it cannot be excluded that these commodities may be used and traded, especially between neighbouring countries.

Association:

- All stages of the fungus (aleurioconidia, conidia, ascospores, mycelium) may be associated with wood, even the smallest pieces. However, treatment of the wood and drying could reduce sporulation;
- *C. ficicola* is associated with the trunk and branches of fig trees from young to old trees.

Survival during storage and transport:

- The fungus may survive during transport and storage. Some species of *Ceratocystis* have been recorded to survive up to five years in wood (CABI, 2024).

Transfer:

- Waste plant material can be used for making mulch and utilised outdoors;
- Wood products are often stored outdoors though hosts have a limited distribution in the EPPO region;
- Sawdust from *Platanus* species infected with *C. platani* is known to be highly infective (EPPO, 2023). It may play an important role in local dissemination;
- Transfer to a natural outside environment may provide optimal conditions for sporulation or germination of existing spores in the wood.

Uncertainty rating for *Ficus carica* wood chips, hogwood, processing wood residues and sawdust pathway: Low: lack of trade.

Ficus carica cut branches

This pathway covers cut branches of hosts, used for decoration or other ornamental purposes. In the EU, cut branches of hosts require a phytosanitary certificate (Commission Implementation Regulation (EU) 2019/2072; EU, 2019). It is not known whether cut branches of the host are used, nor if they are traded internationally (including between neighbouring countries). Cut branches for ornamental purposes are expected to be high value and consequently of good quality, and therefore infested material is unlikely to be traded. Given its biology, *C. ficicola* can be associated with branches (Habib et al., 2023 note cankers on lateral branches) though the extent of disease progression throughout the host and to all parts of the plant is not known, and may be limited. Depending on the shipment method, the pest can survive in branches. In the EPPO countries where industrial waste is subject to composting or incineration / anaerobic digestion, the possibility of escape would be lower.

Uncertainty rating for *Ficus carica* cut branches pathway: Low: lack of trade.

Soil or other growing media

This pathway covers soil / growing medium as a commodity. Soil / growing medium associated with other pathways is covered under those (e.g. plants for planting). All stages of the fungus (aleurioconidia, conidia, ascospores, mycelium), may be associated with soil or other growing medium. It is very unlikely that soil or other growing media will be collected from areas where *C. ficicola* is present. The import of soil and growing media is usually regulated in EPPO countries (e.g. soil and growing media as such from all third countries other than Switzerland, cannot be imported into the EU according to Annex VI point 19 and 20 of Commission Implementing Regulation (EU) 2019/2072 (EU, 2019)). Import of soil is prohibited to Russian Federation (Federal Law 206-FZ of 21.07.2014 On Plant Quarantine; version amended on 11.06.2021). If soil or growing media in which infested plants were previously grown is imported, it may be an important pathway for entry of the pest. However, this is considered unlikely for growing media for professional use. This pathway is relevant for spread within the EPPO region (Section 11).

Uncertainty rating for soil or other growing media pathway: Low: pathway is regulated in many EPPO countries.

Non-host plants for planting with growing media

This pathway covers non-host plants in pots or similar (including bonsais) with soil or growing media which is infected with *C. ficicola*. Aleurioconidia may be associated with soil of non-host plants for planting, the association with the pathway, survival during transport and storage, and transfer to a host plant are less likely for soil associated with non-host plants than for soil associated with host plants. It is not known how long the fungus can survive in soil without a host and it is not known if the fungus can survive on other types of growing media apart from soil. If the fungus is able to survive transport in soil of a non-host plant, transfer to a host or an area where the host will be planted is unlikely.

Uncertainty rating for Non-host plants for planting with growing media pathway: Low: soil highly unlikely to be collected from contaminated soil.

Ficus carica fruit

This pathway covers fresh fig fruit and the associated packaging. There is no evidence that *C. ficicola* can develop in or on fruit. Therefore, this pathway is concerned with fig fruit and the associated packaging being contaminated with propagules. Infected stem material is unlikely to be associated with collected fruit as this would reduce the quality of fruit and it would most likely be discarded. Fruit and the associated packaging may become contaminated in the orchard during the harvesting of the fruit or in the packing house. Taghavi *et al*. (2023) noted that the number of studies dealing with postharvest technologies for fresh figs is somewhat limited, but it is generally accepted that storage temperature is low (0–2 °C) and relative humidity (RH) is high (Gözlekçi *et al*., 2005; Bahar & Lichter, 2018). These temperatures are unlikely to stimulate germination of any spores present on the commodity. It is not known whether the fungus can survive prolonged cold storage. There is no reported trade of fresh fig fruit from Japan to the EPPO region (FAO, 2023). Trade in fresh fig fruit from Greece to other EPPO countries is reported as: 2019, 159 t; 2020, 375 t; and 2021, 301 t (FAO, 2023). Trade in fresh fig fruit from Italy to other EPPO countries is reported as: 2019, 1601 t; 2020, 1975 t; and 2021, 2224 t (FAO, 2023). Regarding transfer to a host, host occurs in the EPPO region. As host fruit is imported for consumption or processing, transfer with fruit directly provided to the consumer is generally considered very unlikely (the pest will be discarded by the final consumer in a closed waste bin). Transfer seems more likely if fruit arrives in areas close to production facilities (packing houses), where damaged fruit may be discarded in open bins close to host plants. The risk is therefore higher where imported fruit is stored or repacked close to production facilities.

Uncertainty rating for *Ficus carica* fruit pathway: Low: no data on contamination of fruit/ not known to adhere to fruit / transfer to a host very unlikely**.**

Dried *Ficus carica* fruit

This pathway covers dried fig fruit as a commodity. Through the processing of the commodity, it is unlikely that propagules will be associated with the pathway. The dehydration process will likely kill any spores that are present on the fruit as a contaminant. Drying of fig fruit can occur by natural drying or artificial drying. There is no report of trade of dried fig fruit from Japan to the EPPO region (FAO, 2023). Trade in dried fig fruit from Greece to other EPPO countries is reported as: 2019, 2279 t; 2020, 1583 t; and 2021, 1646 t (FAO, 2023). Trade in dried fig fruit from Italy to other EPPO countries is reported as: 2019, 286 t; 2020, 363 t; and 2021, 526 t (FAO, 2023).

Uncertainty rating for dried *Ficus carica* fruit pathway: Low: no data on contamination of dried fruit / not known to adhere to fruit / transfer to a host very unlikely.

Dried *Ficus carica* leaves

This pathway covers dried leaves of *Ficus carica* as a commodity. Leaves may be used for cooking or for herbal drinks (e.g. https://www.herboristerie.com/plantes-en-vrac-michel-pierre/1007-figuier-feuilles-en-vrac.html shipped from Morocco). Through the processing of the commodity, it is unlikely that propagules will be associated with the pathway. The dehydration process will likely kill any spores that are present as a contaminant.

Uncertainty rating for dried *Ficus carica* leaf pathway: Low: no data on contamination of dried leaves / not known to infect leaves/ not known to adhere to leaves / transfer to a host very unlikely.

Travellers, their luggage and clothes and footwear

No regular inspections of travellers or their luggage is carried out in the EPPO region. Spores may become attached to luggage, clothes and footwear either on their own or attached soil. There is no information on the survival of propagules on such items. It is unlikely that travellers will be walking through areas with *C. ficicola* infestations either within the EPPO region or outside. This pathway is relevant for spread within the EPPO region (Section 11).

Uncertainty rating for Travellers, their luggage and clothes and footwear pathway: Low: travellers unlikely to move within infested orchards / spores unlikely to survive on footwear and clothes**.**

Natural spread

This pathway covers the natural movement of *C. ficicola.* The fungus is present in Japan, and in the EPPO region in Greece and Italy. Natural spread may also include movement via rain splash and movement in water (e.g. rivers and irrigation). This pathway is relevant for spread within the EPPO region (Section 11).

Uncertainty: Low: limited natural dispersal capacity of the pest.

8.4. Overall rating of the likelihood of entry

The EWG considered the overall rating based on the worst case scenario: Plants for planting (excluding bonsais) in pots with growing media from areas where the fungus is present. Plants can be asymptomatic and may have been grown outside for some or all of their growth.

Rating of the overall likelihood of entry	*Very low* ☐	*Low* ☐	*Moderate* ☐	High ☐	***Very high*** **X**
Rating of uncertainty			***Low*** **X**	*Moderate* ☐	*High* ☐

9. Likelihood of establishment outdoors in the PRA area

Data on parameters for the establishment of *C. ficicola* is generally lacking and therefore a comprehensive assessment of the establishment is not possible. Key factors that will limit or promote the establishment of the fungus include availability of host plants, temperature (ambient air temperature and soil temperature), humidity and dew period.

Ceratocystis ficicola is already established outdoors in the EPPO region in Greece and Italy (on Sicily).

9.1. Host plants

For a list of popular fig cultivars (though not exhaustive) in Mediterranean countries of the EPPO region see Annex 5. In the PRA area, large scale commercial production of *F. carica* for fruit production is mainly restricted to Mediterranean countries (Hassaini *et al*., 2023; Ramadam, 2023) (see Annex 6). In 2021, the five EPPO countries with the largest area of fig harvest were Algeria, Morocco, Spain, Tunisia, and Türkiye (FAO, 2023) (Fig. 4a). Further details, for the period 2017–2021, on all EPPO countries producing fig for the commercial production of the fruit can be found in Annex 6. In the EPPO region, *F. carica* is a popular ornamental species and is grown in urban and semi-urban areas, in private gardens, parks and other areas used by the public (Fig. 4b).

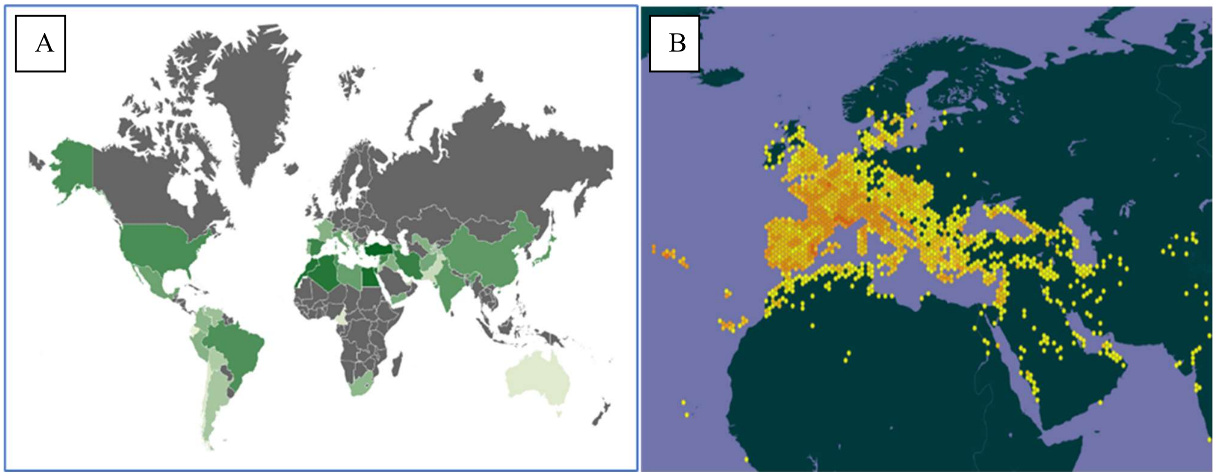


Figure 4. (A) Fig producing countries of the world (atlasbig.com; green) with darker green shaded countries depict a higher fig production; (B) distribution of *Ficus carica* in the EPPO region based on records in the GBIF (2023).

Additionally, *F. carica* is reported in some EPPO countries as a 'food refuse alien', meaning that individual plants occur in areas as a result of the fruit being discarded (Manual of the alien plants of Belgium, 2023). The Euro+Med (2006) details the species is naturalised in many countries of the EPPO region, such as Albania, Austria, the Azores, Great Britian, Bulgaria, France, Germany, Greece, Ireland, Switzerland, Hungary, Portugal, Romania, Spain, Türkiye, and Ukraine. In other countries, the species is transient, e.g. in Belgium and the Czech Republic.

The Plants of the World database (POWO, 2023) noted that *F. carica* is native to the following EPPO countries: Armenia, Azerbaijan, Cyprus, Georgia, Greece, Russia (North Caucasus), Türkiye.

9.2. Climatic suitability

The native range of *C. ficicola* is not known and therefore it is not possible to make any climatic comparisons with the native and introduced ranges.

Köppen-Geiger climate types

Ceratocystis ficicola is reported from the following Köppen-Geiger (Beck *et al*., 2023) climate types:

(1) Warm temperate summer-dry type, with hot summers (Csa)

Ceratocystis ficicola is reported from Greece and Italy from areas with a Köppen-Geiger climate Csa (See Annex 7). In Greece, in the Markopoulo Mesogaias municipality in East Attica, canker-wilt of fig trees was detected at one location with orchards of mature fig trees distributed over approximately 10 ha. In the Istiaia-Aidipsos municipality, in the northern part of Euboea Island, the disease was found in fig orchards at four locations (villages) more than 10 km apart, on young as well as mature trees.

In Italy, *C. ficicola* was found in Apulia (Habib *et al*., 2022; Crous *et al*., 2023) within the Köppen-Geiger climate Csa (Beck *et al*., 2023). In this region, *F. carica* is grown on a total area of 2,118 ha (Habib *et al*., 2023).

In the EPPO region, Csa occurs in the Mediterranean region. The majority of commercial fig cultivation for the production of fruit is within Köppen-Geiger climate Csa and BSk (Beck *et al*., 2023) (Fig. 3b).

(2) Warm temperate fully humid type, with hot summers (Cfa)

In Japan, *C. ficicola* is recorded in the Köppen-Geiger climate Cfa (Beck *et al*., 2023) (see Annex 7). In the EPPO region, this climate type occurs across the EPPO region at latitudes of approximately 40 to 48 °N.

(3) Hot summer subtype (Dfa)

In Japan, *C. ficicola* is recorded in the Köppen-Geiger climate Dfa (Beck *et al*., 2023) (see Annex 7). In the EPPO region, this climate type occurs in areas which do not grow fig on a commercial scale (e.g. Southern Ukraine, Southern Russia, and limited areas in the northwest of Kazakhstan).

The climate in the fig producing countries in the Mediterranean region is suitable for the establishment of the pest.

Temperature within the soil

No specific information was found on the effect of soil temperature on the establishment of *C. ficicola.* Soil temperature will likely affect the germination of aleurioconidia in the soil. Morita *et al*. (2013) used a bait twig method for detection of *C. ficicola* in soil (see section 2.6 for further details) and showed that below 15 °C infection by *F. carica* was significantly limited. There is no information on the soil depth that *C. ficicola* propagules are detected. It is unlikely that soil temperatures in the Mediterranean region will affect the establishment of the pest.

Soil humidity

Soil humidity may be important for the survival of the fungi and important for its proliferation in the soil (as it is for other *Ceratocystis* species, e.g. Stahr & Quesada-Ocampo, 2020). However, no information has been found on this aspect. A lack of soil humidity may act to limit the potential area of establishment. Minimum annual precipitation may be important, but may not be limiting in areas where irrigation is applied.

Climate change

Climate change may affect the establishment of *C. ficicola.* The following factors may affect the potential for establishment in Mediterranean countries:

- Warmer temperatures/ extreme temperatures/ hotter summers/ milder autumn months/ warmer soil temperatures.
- Precipitation pattern and drier conditions/ increased drought/ increased flooding/ decreased humidity.
- Warmer temperatures at higher latitudes (e.g. Northern Europe) may increase the potential for establishment of the host and the pest, but uncertainty is high.
- Warmer temperatures in the Mediterranean region may decrease the potential for establishment of the host and the pest

9.3. Other factors

- *Ceratocystis ficicola* can be difficult to detect due to its presence in the soil and it can remain asymptomatic in the host for up to three years (see Section 2). This may aid its establishment as sources of inoculum may not be detected;
- *Ceratocystis ficicola* may establish, and remain undetected in populations of *F. carica* in the natural environment, as *F. carica* is native to some EPPO countries and naturalised in others (Section 9.1).

9.4. Conclusions

The climatic conditions in Mediterranean countries where fig trees are present would not be a limiting factor for the establishment of the pest.

The likelihood of *C. ficicola* establishing outdoors was rated for Mediterranean countries where *F. carica* is grown under commercial production. In these areas, the likelihood of establishment is very high with a low rating for uncertainty (climate suitability and the presence of host plants).

There is also the potential for establishment in native and naturalised populations of *F. carica.*

Rating of the likelihood of establishment outdoors	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☐	***Very high*** **X**
Rating of uncertainty			***Low*** **X**	*Moderate* ☐	*High* ☐

In other parts of the EPPO region, the likelihood of establishment may be lower with a higher uncertainty (whether it could survive winter). The higher uncertainty would reflect that there is no evidence that the fungus can survive temperatures below freezing.

10. Likelihood of establishment in protected conditions in the PRA area

Ficus carica may be grown under protected conditions for the commercial production for fruit and for the production of plants for planting. However, the majority of commercial production for fruit is conducted in the open. Plants may be grown for all or part of their lifecycle in protected conditions. For example, plants for planting may initially be propagated under protected conditions and then grown- outside in the field.

Ceratocystis ficicola may survive in protected conditions throughout the year. The management of temperatures under protection (e.g. polytunnels, glasshouses) maintains average temperatures between 20 and 35 °C, which are suitable for the pest (see Section 2.6).

Ceratocystis ficicola will be difficult to detect in protected conditions as (1) it can persist in the soil and (2) it can remain asymptomatic for up to three years (Morita *et al*., 2015). In nurseries under protected conditions, the production cycle of *F. carica* plants for planting may be only 1 or 2 years.

Note: This section does not refer to indoor house plants.

The likelihood of establishment is very high with a low rating for uncertainty (climate suitability and the presence of host plants).

Rating of the likelihood of establishment in protected conditions	*Very low* ☐	*Low* ☐	*Moderate* ☐	*High* ☐	***Very high*** **X**
Rating of uncertainty			***Low*** **X**	*Moderate* ☐	*High* ☐

11. Spread in the PRA area

11.1. Natural spread

No information has been found on the rate or distance of spread of *C. ficicola* in the current area of distribution including the PRA area. Therefore, a detailed analysis on the spread pathways is not possible.

After an initial introduction, *C. ficicola* spreads within the orchard via abiotic mechanisms (rain splash, water movement; Kajitani, 1999).

Aleurioconidia could be spread via water movement if released in water bodies. Aleurioconidia of *C. platani* have been reported to infest waterways which can aid the spread (Vigouroux & Stojadinovic, 1990; Grosclaude *et al*., 1991; Tsopelas *et al*., 2017).

The spread of *C. ficicola* can be facilitated by bark and ambrosia beetles. In the EPPO region, local spread may occur between trees in an orchard or between orchards when females emerge to find a new host. Local spread by bark beetles has been observed and documented for Japan (Morita *et al*., 2012).

The EWG considered that natural spread is limited – spores are not known to be airborne and spread by insects is local. Natural spread may contribute to the local dispersal of the fungus within orchards and between orchards.

11.2. Human-assisted spread

The EWG considered that human-assisted spread is the main dispersal mechanism.

Host plants for planting
In Japan, Kajitani (2017) inferred that the main spread into a fig field without *C. ficicola* is the introduction of diseased cuttings. *Ceratocystis ficicola* can be spread by infected plants for planting. This is generally considered the mechanism that has resulted in the spread of the pest where it occurs both nationally and internationally (Tsopelas *et al*., 2021).

Host plants for planting could contribute to the widespread dispersal of *C. ficicola* in the EPPO region.

Movement of infected wood material
The movement of infected wood material can contribute to the spread of *C. ficicola.* Infected trees will be removed from the orchard and could be disposed of in a suitable habitat where the pest can proliferate. Disposal could be the whole tree, the tree cut up into sections or the wood chipped. Wood could also be processed (round wood, sawn wood, and wood chips) and traded, potentially at a local scale (e.g. regionally, nationally) or between neighbouring countries (where orchards are close to country borders) as firewood or for other purposes.

The movement of infected wood material could contribute to the localised dispersal of *C. ficicola* in the EPPO region.

Movement of contaminated soil
Soil on its own may be a pathway for spread of *C. ficicola* as it can contain aleurioconidia. Contaminated soil can be moved within and between orchards for planting or during management of the place of production. If nurseries are close to the place of production, soil may be moved between orchards and nurseries.

The movement of contaminated soil could contribute to the local dispersal of *C. ficicola* within and between places of production.

Used machinery and equipment
Ceratocystis ficicola may also spread with tractors used for ploughing that move infested soil and wood debris within or between orchards. Deep ploughing also causes root wounding, allowing the pathogen to infect the host, which can then increase the amount of inoculum for spread. The use of infested ploughing machinery is likely to be a major pathway for pathogen dissemination in the fig orchards of Euboea Island. A major pathway of disease spread for *C. platani* in many areas of Europe has been from terracing machinery that transmit the pathogen over short and long distances (Tsopelas *et al*., 2017).

Aleurioconidia have been observed by Kajii *et al*. (2013) within *F. carica* infected with *C. ficicola*. Contaminated pruning and cutting tools may therefore act to spread the fungus to healthy trees.

Used machinery and equipment could contribute to the local dispersal of *C. ficicola* within and between orchards and nurseries. If heavy machinery is utilised in a collective way, *C. ficicola* may be spread over long distances.

Other

Other agricultural practices may act to spread the pest locally. Irrigation of host plants in orchards or nurseries could act to locally spread the pest.

Cutting or felling infected trees would produce contaminated sawdust that can spread the pathogen. Spore release can occur locally within orchards contaminating the soil.

Conclusion of the magnitude of spread

The EWG scored the magnitude of spread to be moderate with a moderate uncertainty. The EWG considered the main factor for spread is human assisted spread with natural spread having a lesser magnitude. The moderate uncertainty includes lack of data on rate or distance of spread in the EPPO region, the role of insects in facilitating spread, and the role of agricultural practices in facilitating spread.

Rating of the magnitude of spread	*Very low* ☐	*Low* ☐	***Moderate*** **X**	*High* ☐	*Very high* ☐
Rating of uncertainty			*Low* ☐	***Moderate*** **X**	*High* ☐

Uncertainty: role of bark and ambrosia beetles in dispersing the fungus.

12. Impact in the current area of distribution

In Japan, *C. ficicola* has caused serious losses in several fig plantation areas (Kajitani & Masuya, 2011). Some farms abandoned their orchards because of the extensive damages caused by *C. ficicola* (Shimizu *et al.*, 1999; Morita *et al.,* 2012). Morita *et al*. (2012) showed that in combination with *E. interjectus* infestation, *C. ficicola* can infest 88 % of fig trees in an orchard and induce a 45 % mortality.

In Hiroshima Prefecture of Japan, the rate of damage in fig orchards is estimated to be 15 % (S. Jikumaru, 2024, pers. comm.). The total loss due to the presence of the pest is estimated to be 12.4 million Euros per year for the worst-case scenario in the whole of Japan (S. Jikumaru, 2024, pers. comm.).

In Greece, infected trees have been reported to die. In a newly planted 6 ha orchard on Euboea Island, 3 years after planting, approx. 40–50 % of the trees were dead or dying with evident disease symptoms (Tsopelas *et al*., 2021). This land had not previously been used for fig tree cultivation.

In Italy, similar impacts have been observed where in severe cases, tree mortality was observed in the Salento area (Apulia) (Habib *et al*., 2023). Affected plants showed symptoms of leaf wilt and extensive defoliation. In two orchards located in Salice Salentino and Squinzano disease incidence exceeded 80 %.

Environmental impact is not reported in the literature.

Control methods

Chemical control

Fungicides are not known to be effective against *C. ficicola.*

Several chemical fungicides were proposed in Japan to eradicate the disease by soil fumigation (drenching the soil around the plants) with chloropicrin, thiophanate-methyl, triflumizole, benomyl wettable powder, Difolatan (captafol) w.p. or TPN dust (chlorothalonil) (Hirota *et al*., 1984; Shimizu *et al*., 1999; Togawa *et al*., 1999; Morita *et al*., 2018). The suggested protocols assumed two (spring and autumn) or even monthly (from March to November) applications of fungicides; in some cases, seasonal alternation of different active substances was suggested, e.g. a series of monthly drenches using Difolatan from March to May, thiophanate-methyl from June to August, and Difolatan from September to November (Hirota *et al*., 1984). The effectiveness of thiophanate-methyl wettable powder drenches was enhanced by mulching the soil with polyethylene film and adjustment of the soil pH to 8.0 (Hirota *et al*., 1984). However, multiple applications of fungicides make chemical control labour-intensive and expensive.

Timing of fungicide application is important: application of thiophanate-methyl and triflumizole after the appearance of canker stains has been found to be largely ineffective (Shimizu *et al*., 1999).

Soil applications of fungicides to prevent infection by *C. ficicola* should be carried out just after planting of *F. carica* cuttings (Morita *et al*., 2015).

In Japan, fungicides are not applied during harvest season (at least 30 days before picking fruits) because of registration restrictions (possible residuals) (Shimizu *et al*., 1999; Morita *et al*., 2018).

Potential of application of fungicides in the EPPO region is limited, as most of the above suggested fungicides are not approved in the EU. Among the suggested active substances, it is likely that only tebuconazole is currently approved in the EU (https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/active-substances/details/779)

Use of resistant rootstock
In Japan, the only current control/containment solution is to use highly resistant rootstock, e.g. BC1 hybrids 'Reikodai 1 go' (Morita *et al*., 2021; Kamimori *et al*., 2022). This highly resistant rootstock (although not immune) has been on the market in Japan since 2022 (S. Jikumaru, 2024, pers. comm.).

Biological control
There are no known biological control measures available for this pest. In Japan, as *E. interjectus* has been suggested to vector the pest, Kuroda (2013) and Morita and Jikumaru (2013) recommended development of the pest management measures to control this beetle. Jiang and Kajimura (2020) demonstrated that the earwig *Forficula auricularia* L. has some potential as a biological control agent again *E. interjectus*.

Other control measures
Saranya (2021) suggested disinfection of pruning and grafting tools as supplementary control measures based on the strategies known to control other *Ceratocystis* pests. *C. platani* has been controlled by removing and burning infected material (Forest Research, 2024). This method can also be applied for infected fig trees.

Rating of the magnitude of impact in the current area of distribution		*Very low* ☐	*Low* ☐	*Moderate* ☐	***High*** **X**	*Very high* ☐
Rating of uncertainty				***Low*** **X**	*Moderate* ☐	*High* ☐

13. Potential impact in the EPPO region

Will impacts be largely the same as in the current area of distribution? **Yes, though the level of uncertainty is increased.**

In the EPPO region, the main fig cultivars in commercial production are susceptible to the pest.

Economic losses in the field can be expected in areas where the pest can establish outdoors. There is some evidence that fig production is already declining in some EPPO countries (e.g. Algeria: Mellal *et al*., 2023) due to warming temperatures and the increase of the number of pest species. If *C. ficicola* becomes established and spread in the region, this may promote a further decline in fig production.

Impact will be more severe where fig trees are cultivated for fruit. Within the EPPO region, approximately 70 % of the worlds fig fruit production occurs in Mediterranean countries (Flaishman *et al*., 2008). Any impact on commercial fig fruit production will have negative economic impacts in areas where the pest occurs. These negative impacts can potentially include a reduction in yield, a reduction in the production of fig fruit in an infested area, increased costs in management and control practices.

In areas where the pest cannot establish outdoors, establishment indoors and subsequent yield losses might still occur but such a situation may be easier to control.

If *C. ficicola* becomes widely established in Mediterranean countries in the EPPO region, there may be economic consequences for producers of *F. carica* plants for planting. Plants may need to be grown under strict protected conditions which can be costly. In addition, research and development of resistant cultivars may increase the cost of fig plants in the EPPO region.

The availability of control methods will influence potential impact. There are no effective fungicides to control *C. ficicola*. Impact may be different depending on the country, and the speed at which measures can be developed, authorized and implemented.

Availability of resistant varieties of fig in the EPPO region will take time to develop as at present, there are no truly resistant varieties available. Using rootstocks would increase costs for fruit production.

Ficus carica is native to areas of the EPPO region (see Section 9.1) and therefore there may be impacts on native biodiversity. This may include impacts on the plant species itself and also at higher trophic levels.

Rating of the magnitude of potential impact in the PRA area	*Very low* ☐	*Low* ☐	*Moderate* ☐	***High*** **X**	*Very high* ☐
Rating of uncertainty			*Low* ☐	***Moderate*** **X**	*High* ☐

Uncertainty: limited experience on the pest in the EPPO region, susceptibility of cultivars to the disease / time to develop measures.

14. Identification of the endangered area

The endangered area constitutes the areas of the EPPO region where *F. carica* is established, with higher impact expected in the Mediterranean region where *F. carica* are commercially grown. It may also establish and cause damage in protected conditions throughout the EPPO region.

15. Overall assessment of risk

Entry: The likelihood of entry on fig (*Ficus carica*) plants for planting was considered as very high with a low uncertainty (potted plants with growing media attached). Entry on bonsai *F. carica* plants was considered as high likelihood with moderate uncertainty. Entry on bare rooted plants was considered high with a high uncertainty and entry on cuttings and rooted cuttings was moderate with a high uncertainty. Entry on conveyance vehicles and equipment that have been operated in a fig production area was moderate with a high uncertainty.

Establishment: There is a very high likelihood that *C. ficicola* can establish in the EPPO region with a low uncertainty. It has already established in Greece and Italy. The pest is more likely to establish in Mediterranean countries with commercial fig production than in other areas (e.g. Northern Europe). The likelihood of establishment under protected conditions is assessed as very high with a low uncertainty.

The magnitude of spread was rated as moderate with a moderate uncertainty. The EWG considered the main factor for spread is human assisted spread with natural spread having a lower magnitude.

The magnitude of impact in the current area of distribution was rated as high with a low uncertainty. The magnitude of impact in the EPPO region is expected to be similar to that in the current area of distribution. However, the uncertainty is increased to moderate due to a lack of experience in controlling the pest (e.g.

experience with resistant rootstock) in the EPPO region. Impact may be different depending on the country, and the speed at which measures can be developed authorized and implemented.

Summary of ratings:

	Likelihood	**Uncertainty**
Entry (overall)	**Very high**	**Low**
Plants for planting: in pots with growing media	Very high	Low
Bonsais	High	Moderate
Plants for planting: bare rooted	High	High
Plants for planting: unrooted cuttings	Moderate	High
Plants for planting: rooted cuttings	Moderate	High
Conveyance vehicles and equipment	Moderate	High
Establishment outdoors	Very high	Low
Establishment in protected conditions	Very high	Low
Spread	Moderate	Moderate
Magnitude of impact in the current area of distribution	High	Low
Magnitude of potential impact in the PRA area	High	Moderate

Stage 3. Pest risk management

16. Phytosanitary measures

16.1. Measures on individual pathways to prevent entry

Considering the likelihoods of entry, establishment and impact being high and the low to moderate uncertainties for these aspects, the EWG recommended that measures should be recommended for the following pathways (see 0).

For the pathway 'Conveyance vehicles and equipment', measures are given in the International Standard for Phytosanitary Measures (ISPM 41, FAO, 2017).

The EWG recommended that measures should be applied to *Ficus carica* L.

Pathways	Measures identified for the exporting country
Ficus carica plants for planting (except seeds, tissue culture, pollen) with or without growing media	Pest free area (PFA) (ISPM 4, ISPM 29) (see requirements for establishing a PFA below). **OR** Pest free place/site of production[1] (see ANNEX 1) . **OR** Pest-free production site for the specified pest, established according to EPPO Standard PM 5/8 *Guidelines on the phytosanitary measure 'Plants grown under physical isolation'* **OR** Post-entry quarantine (in the framework of a bilateral agreement) (see ANNEX 1).

[1] *The choice between pest free place of production and pest free production site is a decision to be taken by the NPPO based on the operational capacities of the producers and biological elements.*

Requirements for establishing a PFA:

- To establish and maintain the PFA (ISPM 4, ISPM 29), a general surveillance in the area prior to establishment of the PFA and continued every year may be sufficient.
- In specific cases, specific surveillance should also be carried out in the zone between the PFA and known infestation area to demonstrate pest freedom. The detection surveys to establish and maintain the PFA should be targeted for the pest and should be based on appropriate combination of visual examination and testing of host plants and soil.
- Because a 3-year asymptomatic period has been observed so far, surveillance for several growing periods should be carried out in fig cultivation areas.
- There should be restrictions on the movement of host material, soil associated with hosts and equipment used (originating from areas where the pest is known to be present) into the PFA, and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation.

16.2. Eradication and containment

Harrington (2013) noted that complete eradication of an exotic *Ceratocystis* sp. from even a limited area is difficult, but local introductions may be eliminated if quickly identified and measures are applied.

Early detection would be essential for the eradication and containment of *C. ficicola* but is complicated by:

- The persistence of propagules in the soil,

- Asymptomatic host plants,
- Passive carriers which spread the pest.

If the pest is detected, thorough inspection, testing of host plants should be carried out to delimitate infested areas. A suitable buffer zone may be established. The size of the buffer zone should depend on the host presence in the vicinity, environmental conditions in the area, and any factor that may reduce spread (e.g. natural barriers).

Eradication may be possible in limited settings, such as early detection of isolated infections under protected conditions or in a nursery. Removal of infested plants including roots (which is very difficult to perform) and disposal of soil should be performed. Intensive monitoring of the site and its surroundings, testing plants and soil, should be conducted. Attempts to control the pest in Japan had limited success. Removal of infected plants, and applications of fungicides around newly planted ficus trees to the soil, replanting with available cultivar were unsuccessful (Morita & Jikumaru, 2018).

There should be restrictions on the movement of hosts, soil associated with hosts and equipment. Public information and outreach campaigns may help an earlier reporting and better implementation of measures.

Planting of host plants should be avoided in areas where the soil may be contaminated.

Eradication would be difficult or impossible once the fungus has formed sporulating bodies which can spread into the environment from an initial outbreak.

In the Apulia region (IT) the following non-mandatory recommendations have been issued (F. Nigro, pers. comm., January 2025):
• voluntary removal of trees showing wilting symptoms,
• uprooting of plants exhibiting severe wilting,
• treatment of the crown and the basal portion of the trunk with lime slurry during summer (to prevent bark beetle attacks) and iron sulfate slurry during winter. These treatments are empirical methods traditionally applied by elder farmers to distressed plants, as no registered fungicide or insecticide is currently authorized for use on fig trees.

17. Uncertainty

The EWG used the categories of main sources of uncertainties (under development) (EPPO, 2024c):
- *Key uncertainties*: likely to significantly affect the overall conclusions (including overall risk and overall uncertainty) of the PRA (i.e. the determination of whether the pest has the characteristics of a quarantine pest, and the pathways that should be managed);
- *Other main uncertainties*: not likely to affect the overall conclusions of the PRA but likely to impact conclusions of individual part(s) of the risk assessment or risk management.

Key uncertainties	Other main uncertainties
	Capacity of the pest to spread by root connection to neighbouring trees
	Ability of the pest to spread within branches (as linked to the possibility to spread by pruning)
	Asymptomatic nature of disease (duration of this stage, etc.) and testing
	Role of passive vectors in transmitting the fungus
	Actual distribution of the pest in the world
	Uncertainty of life cycle
	Susceptibility of different *Ficus* species/varieties/cultivars

18. Remarks

The EWG noted possible topics for future research:

- Management strategies for *C. ficicola*, including development of biological control,
- Need for a fast (in field) validated diagnostic test for *C. ficicola*,
- Biology and epidemiology of the disease,
- Susceptibility and resistance of *Ficus* taxa,
- Origin and genetic diversity of *C. ficicola*,
- Role of insects in spreading *C. ficicola*.

The EWG also noted the need to include *C. ficicola* into existing fig certification schemes.

19. References (including for Annexes)

Accordi SM (1989) [The survival of *C. fimbriata* f. sp. *platani* in the soil]. *Informatore Fitopatologico* **39**, 57–62.

Bahar A, Lichter A (2018) Effect of controlled atmosphere on the storage potential of Ottomanit fig fruit. *Scientia Horticulturae,* **227**, 196–201.

Barcode of Life Data Systems (2023) (BOLD; https://www.boldsystems.org/index.php/Public_SearchTerms (accessed on 21.11.2023).

Beck HE, McVicar TR, Vergopolan N, Berg A, Lutsko NJ, Dufour A, Zeng Z, Jiang X, van Dijk AIJM, Miralles DG (2023) High-resolution (1 km) Köppen-Geiger maps for 1901–2099 based on constrained CMIP6 projections, *Scientific Data* **10**, 724. https://doi.org/10.1038/s41597-023-02549-6

CABI (2024) *Ceratocystis fimbriata* (Ceratocystis blight). CABI Compendium. https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.12143

Condit IJ (1955) Fig varieties: a monograph. *Hilgardia* **23**, 323–538. https://ucanr.edu/datastoreFiles/391-296.pdf

Crous PW, Akulov A, Balashov S, Boers J, Braun U, Castillo J, Delgado MA, Denman S, Erhard A, Gusella G, Jurjević Ž, Kruse J, Malloch DW, Osieck ER, Polizzi G, Schumacher RK, Slootweg E, Starink-Willemse M, van Iperen AL, Verkley GJM, Groenewald JZ (2023) New and Interesting Fungi. 6. *Fungal Systematics and Evolution* **11**, 109–156. https://doi/org/10.3114/fuse.2023.11.09

Cutajar S, Mifsud D (2017) Good Agricultural Practice (GAP) for Fig tree cultivation. Plant Protection Directorate, Lija, Malta, 30 pp.

de Beer ZW, Duong TA, Barnes I, Wingfield BD, Wingfield MJ (2014) Redefining *Ceratocystis* and allied genera. *Studies in Mycology*, **79**, 187–219.

EFSA PLH Panel (EFSA Panel on Plant Health), Bragard C, Dehnen-Schmutz K, Di Serio F, Jacques M-A, Jaques Miret JA, Justesen AF, MacLeod A, Magnusson CS, Milonas P, Navas-Cortes JA, Parnell S, Potting R, Reignault PL, Thulke H-H, van der Werf W, Civera AV, Yuen J, Zappala L, Battisti A, Mas H, Rigling D, Mosbach-Schulz O and Gonthier P (2021) Scientific Opinion on the commodity risk assessment of *Ficus carica* plants from Israel. *EFSA Journal* **19**(1), 6353, 248 pp. https://doi.org/10.2903/j.efsa.2021.6353

EPPO (2011). PM 5/3(5) Decision-support scheme for quarantine pests. https://www.eppo.int/media/uploaded_images/RESOURCES/eppo_standards/pm5/pm5-03-05-en.pdf

EPPO (2012) PM 5/5 Decision-support scheme for an Express Pest Risk Analysis. *EPPO Bulletin* 42(3), 457–462. https://www.eppo.int/RESOURCES/eppo_standards/pm5_pra

EPPO (2014) PM 7/14 (2) *Ceratocystis platani*. *EPPO Bulletin,* **44**, 338–349. https://onlinelibrary.wiley.com/doi/epdf/10.1111/epp.12159

EPPO (2020) EPPO Technical Document No. 1081, EPPO Study on the risk of bark and ambrosia beetles associated with imported non-coniferous wood. EPPO Paris Available at https://www.eppo.int/RESOURCES/eppo_publications

EPPO (2022) *Ceratocystis ficicola*: addition to the EPPO Alert List https://gd.eppo.int/reporting/article-7270

EPPO (2023a) *Ceratocystis platani*. EPPO datasheets on pests recommended for regulation. https://gd.eppo.int (accessed 2023-12-27)

EPPO (2024a) *Ceratocystis platani* (CERAFP). https://gd.eppo.int/taxon/CERAFP (accessed 2024-03-27)

EPPO (2024b) EPPO Global Database. https://gd.eppo.int/https://gd.eppo.int/ (accessed 2024-03-27)

EPPO (2024c) Guidance on Pest Risk Analysis. Available at: https://www.eppo.int/RESOURCES/eppo_standards/pm5_pra

Espinal R, Ferreira de Santana S, Castro Santos V, Nicolle Ramos Lizardo G, José Santana Silva R, Xavier Corrêa R, Lopes Loguercio L, Góes-Neto A, Priminho PirovaniPriminho Pirovani C, Luize Camargos Fonseca P, Roberto Guimarães Rocha Aguiar E (2023) Uncovering a vomplex virome associated with the *Cacao* pathogens *Ceratocystis cacaofunesta* and *Ceratocystis fimbriata*. *Pathogens*, **9**, 287.

EU (2019) Commission Implementing Regulation (EU) 2019/2072 of 28 November 2019 establishing uniform conditions for the implementation of Regulation (EU) 2016/2031 of the European Parliament and the Council, as regards protective measures against pests of plants. *Official Journal of the European Union*, L319 (10.12.2019), 1–279. https://eur-lex.europa.eu/eli/reg_impl/2019/2072/oj

EU (2021) Commission Implementing Regulation (EU) 2021/1936 of 9 November 2021 amending Implementing Regulation (EU) 2018/2019 as regards certain plants for planting of *Ficus carica* L. and *Persea americana* Mill. originating in Israel, amending Implementing Regulation (EU) 2020/1213 as regards the phytosanitary measures for the introduction of those plants for planting into the Union territory and correcting the latter Implementing Regulation. *Official Journal of the European Union*, L396/27. https://eur-lex.europa.eu/eli/reg_impl/2021/1936/oj

Euro+Med (2006-): Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. Published on the Internet http://ww2.bgbm.org/EuroPlusMed/ [accessed DATE].

FAO (2017) International movement of used vehicles, machinery and equipment. IPPC, Rome.

FAO (2023) FAOSTAT. https://www.fao.org/faostat/en/#home

Flaishman MA, Peer R, Freiman ZE, Izhaki Y, Yablovitz Z (2017). Conventional and molecular breeding systems in fig (*Ficus carica* L.). *Acta Hortic*. **1173**, 1–10 https://doi.org/10.17660/ActaHortic.2017.1173.1

Flaishman M, Rodov V, Stover E (2008) The fig: botany, horticulture, and breeding. *Horticultural Reviews* **34**, 113–197. https://doi.org/10.1002/9780470380147.ch2

Forest Research (2024) Canker stain of plane (*Ceratocystis platani*). Available at: https://www.forestresearch.gov.uk/tools-and-resources/fthr/pest-and-disease-resources/canker-stain-of-plane-ceratocystis-platani/

Gaaliche B, Ben Abdelaali N, Mouttet R, Ben Halima-Kamel M, Hajlaoui MR (2018) Nouveau signalement de *Hypocryphalus scabricollis* (Eichhoff, 1878) en Tunisie, un ravageur emergent sur figuier (*Ficus carica* L.). *EPPO Bulletin* **48**, 164–166. https://doi.org/10.1111/epp.12459

GBIF Global Biodiversity Information Facility (2023) https://www.gbif.org/

Gözlekçi S, Erkan M, Karaşahin I, Şahin G (2005). Effect of 1-methylcyclopropene (1-MCP) on fig (*Ficus carica* cv. Bardakci) storage. Paper presented at the III International symposium on Fig 798.

Grosclaude C, Olivier R, Pizzuto JC, Romiti C (1991) Etude experimentale du transport de l'inoculum de *Ceratocystis fimbriata* f. *platani* par l'eau d'une riviere [Experimental study on the transport of inoculum of *Ceratocystis fimbriata* f. *platani* by river water]. *European Journal of Forest Pathology* **21**, 168–171.

Grosclaude C, Olivier R, Romiti C (1993) Chancre colore du platane. Transmission et survie hypogees de l'agent responsible [Canker stain of plane. Transmission and hypogeal survival of the agent responsible]. *Phytoma – La Defense des Vegetaux* **455**, 57–59.

Gugliuzzo A, Gusella G, Leonardi GR, Costanzo MB, Ricupero M, Rassati D *et al*. (2023) From a cause of rapid fig tree dieback to a new threat to mango production: the invasive bark beetle *Cryphalus dilutus* Eichhoff (Coleoptera: Curculionidae, Scolytinae) and its associated fungi found on mango trees in Europe. *EPPO Bulletin* **53**, 663–670. Available from: https://doi.org/10.1111/epp.12956

Habib W, Carlucci M, Manco L, Altamura G, Delle Donne AG, Nigro F (2023) First report of *Ceratocystis ficicola* causing wilt disease on common fig (*Ficus carica*) in Italy. *Plant Disease* **107** (10), 3287. https://doi.org/10.1094/PDIS-03-23-0464-PDN

Habib W, Cavalieri V, Carlucci M, Dongiovanni C, Nigro F (2022) A new disease complex threatening fig (*Ficus carica* L.) in Southern Italy. 16th Congress of the Mediterranean Phytopathological Union, 4–8 April, 2022, Limassol, Cyprus.

Happ GM, Happ CM, Barras SJ (1971) Fine structure of the prothoracic mycangium, a chamber for the culture of symbiotic fungi, in the southern pine beetle, *Dendroctonus frontalis*. *Tissue and Cell* **3**, 295–308.

Harrington TC (2013) Ceratocystis diseases. In: Infectious Forest Diseases (eds. P Gonthier and G Nicolotti), CABI International, Wallingford, UK.

Hirota K, Kato K, Miyagawa T (1984) Chemical control of *Ceratocystis* canker in fig. *Research Bulletin of the Aichi-ken Agricultural Research Center* **16**, 211–218.

Hosomi A (2019) Growth and fruit production of 'Masui Dauphine' Figs (*Ficus carica* L.) grafted on rootstock varieties resistant to Ceratocystis canker. *Hort. Res.* (Japan) **18**(2), 85–191.

Hosomi A, Miwa Y, Furukawa M, Kawaradani M (2012) Growth of fig varieties resistant to Ceratocystis canker following infection with *Ceratocystis fimbriata. J. Japan. Soc. Hort. Sci*. **81**(2), 159–165.

Hosomi A, Miwa Y, Isobe T (2015) Choice of cuttings and scions for raising fig (*Ficus carica* L.) nursery stocks by softwood grafting. *Hort. Res*. (Japan) **14**(2), 97–203. (in Japanese, with English summary)

Hssaini L, Razouk R, Fadlaoui A (2023) Figs in Morocco: diversity patterns, valorization pathways and value chain resilience. In. Fig (*Ficus carica*): Production, Processing, and Properties (eds. Mohamed Fawzy Ramadan), Springer, USA.

Hughes MA, Juzwik J, Harrington TC, Keith LM (2020) Pathogenicity, symptom development, and colonization of metrosideros polymorpha by *Ceratocystis lukuohia*. *Plant Disease*, **104**, 2233–2241.

IPPC Secretariat (2023) Glossary of phytosanitary terms. International Standard for Phytosanitary Measures No. 5. Rome. FAO on behalf of the Secretariat of the International Plant Protection Convention. https://www.ippc.int/en/publications/622/

Jiang ZR, Kinoshita S, Sasaki O, Cognato AI, Kajimura H (2019) Non-destructive observation of the mycangia of *Euwallacea interjectus* (Blandford) (Coleoptera: Curculionidae: Scolytinae) using X-ray computed tomography. *Entomological Science* **22**, 173–181. https://doi.org/10.1111/ens.12353

Jiang ZR, Masuya H, Kajimura H (2021) Novel symbiotic association between *Euwallacea* ambrosia beetle and *Fusarium* fungus on fig trees in Japan. *Frontiers in Microbiology* **12**, 725210. https://doi.org/10.3389/fmicb.2021.725210

Jiang ZR, Morita T, Jikumaru S, Kuroda K, Masuya H, Kajimura H (2022) The role of mycangial fungi associated with ambrosia beetles (*Euwallacea interjectus*) in fig wilt disease: dual inoculation of *Fusarium kuroshium* and *Ceratocystis ficicola* can bring fig saplings to early symptom development. *Microorganisms* **10**, 1912. https://doi.org/10.3390/microorganisms10101912

Johnson JJ, Li Y, Mandelshtam MY, Park S, Lin CS, Gao L, Hulcr J (2020) East Asian *Cryphalus* Erichson (Curculionidae, Scolytinae): new species, new synonymy and redescriptions of species. *Zookeys*, **995**, 15–66.

Kajii C, Morita T, Jikumaru S, Kajimura H, Yamaoka Y, Kuroda K (2013) Xylem dysfunction in *Ficus carica* infected with wilt fungus *Ceratocystis ficicola* and the role of the vector beetle *Euwallacea interjectus*. *International Association of Wood Anatomists Journal* **34**, 301–312. https://doi.org/10.1163/22941932-00000025

Kajitani Y (1995) Simple method with cut shoots for detection of fig Ceratocystis cancer pathogen, *Ceratocystis fimbriata* from soil in orchards. *Ann. Phytopathol. Soc. Jpn*. **61** (3), 229 https://www.jstage.jst.go.jp/article/jjphytopath1918/61/3/61_3_210/_pdf/-char/en

Kajitani Y (1996) The possibility of transmission of fig Ceratocystis canker disease by an ambrosia beetle (*Xyleborus interjectus* Eichhoff). *Ann. Phytopathol. Soc. Jpn.* **62**, 275. (abstract, in Japanese)

Kajitani Y (2017) Infection strategies of pathogens observed in fig wilt disease and grapevine swelling arm. *Plant-Pathog. Fungi Conf*. **17**, 9–20.

Kajitani Y, Kanematsu S (1997) PCR-RFLP analysis of the rDNA ITS region of *Ceratocystis fimbriata* isolated from fig and sweet potato. *Ann. Phytopathol. Soc. Jpn.* **63**, 208. (abstract, in Japanese)

Kajitani Y, Kudo A (1993) Difference of *Ceratocystis fimbriata* isolated from fig and sweet potato. *Ann. Phytopathol. Soc. Jpn*. **59**, 290. (abstract, in Japanese)

Kajitani Y, Masuya H (2011) *Ceratocystis ficicola* sp. nov., a causal fungus of fig canker in Japan. *Mycoscience* **52**, 349–353.

Kajitani Y, Tsutsumi T, Yamada K (1992) Occurrence of Ceratocystis canker of fig caused by *Ceratocystis fimbriata* Ellis et Halsted in Fukuoka prefecture. *Ann. Phytopathol. Soc. Jpn.* **58**, 111–112 (abstract, in Japanese)

Kajitani Y (1999). The dispersal period of the *Xyleborus interjectus* (Coleoptera, Scolytidae), a vector of the fig Ceratocystis canker, and the organ carrying the causal fungus. *Ann. Phytopathol. Soc. Jpn*. **65**, 377. (in Japanese)

Kamimori M, Isobe T, Yakushiji H (2022) Evaluation of Ceratocystis canker resistance, vegetative growth, and fruit production of ‘Masui Dauphine’ Fig (*Ficus carica*) grafted on ‘Reikodai 1 go’ BC1 of an interspecific hybridization of *F. carica* and *F. erecta. The Horticulture Journal* **91**(3), 337–344. (in Japanese, with English summary)

Kato K, Hirota K, Miyagawa T (1982) A new disease, Ceratocystis canker of fig caused by *Ceratocystis fimbriata* Ellis et Halsted. *Plant Prot* **36**, 55–59 (in Japanese)

Kato K, Hirota K, Miyagawa T, Yokoyama T (1981) Fig canker disease. *Ann Phytopathol Soc Jpn* **47**, 373–374 (abstract, in Japanese)

Kato K, Miyagawa T (1980) Fig canker disease. Ann. Phytopathol. Soc. Jpn. **46**, 97–98 (abstract, in Japanese)

Khatib S, Vaya J (2010) Fig, carob, pistachio, and health. In: Bioactive foods in promoting health. 245–263.

Kile GA (1993) Plant diseases caused by species of *Ceratocystis* sensu stricto and *Chalara*. In: *Ceratocystis* and *Ophiostoma*, Taxonomy, Ecology and Pathogenicity. Eds MJ Wingfield, KA Seifert and JF Webber, APS Press, Minnesota.

Kuroda K (2013) Collaboration of wilt pathogen and vector beetle successfully induces extensive xylem dysfunction and wilt symptom. The 8th Pacific Regional Wood Anatomy Conference, 17–21 October 2013, Nanjing Forestry University, China.

https://www.researchgate.net/publication/257654295_Collaboration_of_wilt_pathogen_and_vector_beetle_successfully_induces_extensive_xylem_dysfunction_and_wilt_symptom

Liu FF, Barnes I, Wingfield JRM, Chen SF (2017) Molecular phylogenetics and microsatellite analysis reveal a new pathogenic *Ceratocystis* species in the Asian-Australian clade. *Plant Pathology* **67**, 1097–1113.

Luchi N, Ghelardini L, Belbarhri L, Quartier M, Santini A (2013) Rapid detection of *Ceratocystis platani* inoculum by quantitative Real-Time PCR assay. *Applied and Environmental Microbiology* **79**, 5394–5404.

Manual of the alien plants of Belgium (2023) https://alienplantsbelgium.myspecies.info/content/ficus-carica

Marincowitz S, Barnes I, de Beer ZW, Wingfield MJ (2020) Epitypification of *Ceratocystis fimbriata*. *Fungal Syst Evol.* **6**, 289 –298. doi: 10.3114/fuse.2020.06.14

Mellal MK, Khelifa R, Chelli A, Djouadi N, Madani K (2023) Combined effects of climate and pests on fig (*Ficus carica* L.) yield in a mediterranean region: implications for sustainable agricultural strategies. *Sustainability* **15**, 5820. https://doi.org/10.3390/su15075820

Miwa Y, Hosomi A, Ishii T (2014) Lesion spreading of Ceratocystis canker on 'Masui Dauphine' fig trees. *International Journal of Agricultural Policy and Research* **2**(2), 55–06.

Morita T, Hara H, Jikumaru S (2015) Estimation of initial infection period in fig cuttings planted in fig orchard contaminated with *Ceratocystis ficicola. Ann. Rept. Kansai Pl. Prot*. **57**, 87–90.

Morita T, Hara H, Mise D, Jikumaru S (2012) A case study of Ceratocystis canker epidemic in relation with *Euwallacea interjectus* infestation. *Ann. Rept. Kansai Pl. Prot*. **54**, 29–34.

Morita T, Hara T, Nakano M, Jikumaru S (2013) Detection of fig stain blight fungus from soil using branch cutting method. *Ann. Rept. Kansai Pl. Prot*. **55**, 71–75.

Morita T, Jikumaru S, Kuroda K (2016) Disease development in *Ficus carica* plants after inoculation with *Ceratocystis ficicola*. (1) Relationship between xylem dysfunction and wilt symptoms. *Japanese Journal of Phytopathology* **82**, 301–309. https://doi.org/10.3186/jjphytopath.82.301 (In Japanese with English summary)

Morita T, Jikumaru S, Yakushiji H (2020) Evaluation of Ceratocystis canker resistance between BC1, interspecific hybrids of *Ficus carica* and *F. erecta*, and existing resistant fig varieties, *F. carica*, in relation to infection via soil. *Ann. Report Kansai Pl Prot*. **62**, 149–152. (in Japanese, with English summary)

Morita T, Mise D, Jikumaru S (2018) Observation of external and internal symptoms in fig cultivar 'Houraishi' planted in soil contaminated with *Ceratocystis ficicola*. *Bulletin of the Hiroshima Prefectural Technology Research Institute Agricultural Technology Research Center* **92**, 1–9. (In Japanese with English summary)

Morita T, Jikumaru S (2018) Evaluation of soil-drench control system against Ceratocystis canker of fig with fungicide available up to the day before harvesting. *Ann. Rept. Kansai Pl. Prot*. **60**, 77–80. (in Japanese, with English summary)

Morita T, Jikumaru S, Sugawa S, Shirakami N, Yakushiji H (2021) Evaluation of resistance to Ceratocystis canker in a BC1 population line from interspecific hybridization of fig (*Ficus carica*) and *F. erecta* 'Reikoudai 1 gou': effects of soil or wound inoculation with *Ceratocystis ficicola* on cuttings. *Jpn. J. Phytopathol.* **87**, 76–79. (in Japanese, with English summary)

Nasution A, Glen M, Beadle C, Mohammed C (2019) Ceratocystis wilt and canker – a disease that compromises the growing of commercial Acacia-based plantations in the tropics. *Australian Forestry* **82**, 80–93.

National Center for Biotechnology Information (2023) https://www.ncbi.nlm.nih.gov/ (accessed on 21.11.2023).

Nitta H, Morita T, Wakasaki Y, Kakogawa K (2005) Relationship between Ceratocystis canker and ambrosia beetle in fig orchard. *Ann. Rep. Kansai. Plant Prot.* **47**, 95–98. (in Japanese)

Nosir W (2023) Cultivars and agriculture practice of fig (*Ficus carica*). In: MF Ramadan (ed.), Fig (*Ficus carica*): Production, Processing, and Properties. Springer, Cham. P. 215–246. https://doi.org/10.1007/978-3-031-16493-4_9

POWO (2023). Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://www.plantsoftheworldonline.org/ Retrieved 20 December 2023.

Ramadan MF (2023) Introduction to fit (*Ficus carica*): production, processing and properties. In: MF Ramadan (ed.), Fig (*Ficus carica*): Production, Processing, and Properties. Springer, Cham. P. 1–8.

Saranya R (2021) *Ceratocystis fimbriata* – A threatening pathogen. *Agriculture and Food: E-Newsletter* **3**(11), 91–93. https://krishi.icar.gov.in/jspui/bitstream/123456789/70260/1/popular%20art.cera.pdf

Schrader G, MacLeod A, Mittinty M, Brunel S, Kaminski K, Kehlenbeck H, Petter F, Baker R (2010) Enhancements of pest risk analysis techniques. *EPPO Bulletin* **40**, 107–120. https://doi.org/10.1111/j.1365-2338.2009.02360.x

Shimizu S, Miyoshi T, Ochi M, Tachibana Y (1999) Occurrence of fig Ceratocystis canker in Ehime Prefecture and its control by thiophanate-methyl triflumizole fungicide. *Bull. Ehime Fruit Tree Exp. Stn.* **13**, 27–35 (in Japanese with English summary)

Shirakami N, Morita T, Jikumaru S, Sugawa S, Yakushiji H (2022). Quantitative PCR to determine density of *Ceratocystis ficicola* and understand resistance of BC1 line Reikodai 1 go derived from hybridization between common fig, *Ficus carica*, and wild fig, *F. erecta*. *Jpn. J. Phytopathol*. **88**, 91–97.

Shirasawa K, Yakushiji H, Nishimura R, Morita T, Jikumaru S, Ikegami H, Toyoda A, Hirakawa H, Isobe S (2020) The *Ficus erecta* genome aids *Ceratocystis* canker resistance breeding in common fig (*F. carica*). *The Plant Journal* **102**, 1313–1322. https://doi.org/10.1111/tpj.14703

Soulioti N (2022) Contribution to the study of invasive phytopathogenic species ascomycete *Ceratocystis* in Greece. Post Graduate Thesis, Department of Biology, National University of Athens, Greece. (In Greek).

Stahr M, Quesada-Ocampo M (2020) Assessing the role of temperature, inoculum density, and wounding on disease progression of the fungal pathogen *Ceratocystis fimbriata* causing black rot in sweetpotato. *Plant Disease* **104**, 930–937.

Sumida S, Kajii C, Morita T, Kuroda K (2016a) Disease development in *Ficus carica* seedlings after inoculation with *Ceratocystis ficicola*. (2) Microscopic analysis of the host-pathogen interaction and internal symptoms. *Japanese Journal of Phytopathology* **82**, 310–317 (In Japanese with English summary). https://doi.org/10.3186/jjphytopath.82.310

Sumida S, Morita T, Jikumaru S, Kuroda K (2015) An anatomical study on the disease development process of wilt disease caused by inoculation with *Ceratocystis ficicola*. *Tree and Forest Health* **19**, 96–97.

Sumida S, Morita T, Kuroda K (2016b) Invasion strategy of *Ceratocystis ficicola* from soil to host (*Ficus carica*). *Tree and Forest Health* **20**, 30–31. (in Japanese)

Togawa M, Masui S, Nomura A, Masui H (1999) Occurrence and control of stem rot on fig. *Bull. Shizuoka Citrus Exp. Stn.* **28**, 51–62. . (in Japanese, with English summary)

Tsopelas P, Santini A, Wingfield MJ, De Beer W (2017) Canker stain: A lethal disease destroying iconic plane trees. *Plant Disease* **101**, 645–658. https://doi. org/10.1094/PDIS-09–16-1235-FE

Tsopelas P, Soulioti N, Wingfield MJ, Barnes I, Marincowitz S, Tjamos EC, Paplomatas EJ (2021) *Ceratocystis ficicola* causing a serious disease of *Ficus carica* in Greece. *Phytopathologia Mediterranea* **60**(2), 337–349. https://doi.org/10.36253/phyto-12794

Van Wyk M, Al Adawi AO, Khan IA, Deadman ML, Al Jahwari AA, Wingfield BD, Ploetz R, Wingfield MJ (2007) *Ceratocystis manginecans* sp. nov., causal agent of a destructive mango wilt disease in Oman and Pakistan. *Fungal Diversity* **27**, 213–230.

Vigouroux A, Stojadinovic B (1990) Possibilites d'infection du platane pour *Ceratocystis fimbriata* f. *platani* apres contamination de l'eau ou se developpent des racines blesses [Possibilities of the infection of plane by *Ceratocystis fimbriata* f. *platani* after contamination by water or the development of wounded roots]. *European Journal of Forest Pathology* **20**, 118–121.

Yakushiji H, Morita T, Jikumaru S (2019) Ceratocystis canker resistance in BC1 populations of interspecific hybridization of fig (*Ficus carica*) and *F. erecta*. *Scientia Horticulturae* **252**, 71–76, https://doi.org/10.1016/j.scienta.2019.03.039

Yakushiji H, Morita T, Jikumaru S, Ikegami H, Azuma A, Koshita Y (2012) Interspecific hybridization of fig (*Ficus carica* L.) and *Ficus erecta* Thunb., a source of Ceratocystis canker resistance. *Euphytica* **183**, 39–47.

Yuceer C, Hsu CY, Erbilgin N, Klepzig KD (2011) Ultrastructure of the mycangium of the southern pine beetle, *Dendroctonus frontalis* (Coleoptera: Curculionidae, Scolytinae): complex morphology for complex interactions. *Acta Zoologica* **92**, 216–224.

Annex 1. Evaluation of possible phytosanitary measures for the main identified pathways, using EPPO Standard PM 5/3

The table below summarizes the consideration of possible measures for the pathways 'Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica*' (based on EPPO Standard PM 5/3).

When a measure is considered appropriate, it is noted "yes", or "yes, in combination" if it should be combined with other measures in a systems approach. "No" indicate that a measure is not considered appropriate. A short justification is included.

Option	**Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica***
Existing measures in the PRA area	Partly. For countries of the European Union, it is prohibited to introduce plants for planting, other than seeds, *in vitro* material and naturally artificially dwarfed woody plants for planting of *Ficus carica* L. from third countries other than from Israel (EU, Implementing Regulation 2021/1936; EU, 2021). For the United Kingdom. It is prohibited to introduce *F. carica* plants for planting pending risk assessment, with the exception of EU Member States, Liechtenstein and Switzerland (regulated and notifiable; www.gov.uk). No information on the requirements of other non-EU EPPO countries has been found. Special requirements for bonsai plants, as set out in EU Implementing Regulation 2019/2072 (EU, 2019), may act to mitigate the risk. The above measures do not cover the entry of *F. carica* to all countries in the EPPO region. Additionally, there are no measures (except a plant passport) preventing the internal movement of *F. carica* between countries of the EU. A plant passport does not specify requirements which may play a role to prevent the propagation of *F. carica* with *C. ficicola*. .
Options at the place of production	
Inspection at place of production	**Yes, in combination*** (for measures marked with '*', see after the table). Visual examination may detect symptoms on the trunk or branches of plants (i.e. cankers), however, it may still be difficult for small microscopic symptoms. Infected plants can remain asymptomatic up to three years after infection. Plants may be traded before symptoms become evident. Inspection at the place of production is unlikely to reliably detect infected plants.
Testing at place of production	**Yes, in combination*.**

Option	Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica*
	Methods have been developed for the detection of *C. ficicola* in soil and in wood. To-date, these methods have not been validated (see Section 2.12). There is no evidence that the methods for detection on wood material work for asymptomatic plants. Isolation can be achieved on selective media.
Treatment of crop	No. There are no curative treatments for this pest. Application of chemical fungicides to the soil may prevent infection by the pest. However, it is costly and time consuming (six times per year). Growing plants in pots with soil treatment (e.g. heat treated or fungicide application). Treatment of above ground parts of the plants with insecticide may prevent infection by ambrosia or bark beetles.
Resistant cultivars	No. BC1 line Reikodai 1 gou highly resistant cultivars have been developed in Japan. Based on the information from the literature and expert opinion, the EWG consider there are no truly resistant (immune) cultivars.
Growing under physical isolation	**Yes.** Plants for planting could be grown under protected conditions with sufficient measures to exclude the pest, following EPPO Standard PM5/8(1) *Guidelines on the phytosanitary measure 'Plants grown under physical isolation'* (EPPO, 2016). Specific requirements would be required for soil or other growing media, e.g. treated in an appropriate way (heat treatment or with fungicide).
Specified age of plant, growth stage or time of year of harvest	No. It is not possible to define at what period a commodity will be infested.
Produced in a certification scheme	**Yes.** *C. ficicola* could be included into an established certification scheme for *F. carica*. Tests for *C. ficicola* should be required in the certification scheme and validated. . Good practices should be applied. The production should be performed under strict hygiene measures, and in appropriate isolation conditions similarly to the production in a pest-free area, pest free place/site of production, pest free production site following EPPO Standard PM 5/8 '*Plants grown under complete physical isolation*' (see more information in these respective options).
Pest freedom of the crop	See related options already analysed in the table. Spores can be present in the soil which can infect the plants for planting. In EPPO Standard PM 5/3, 'pest freedom of the crop' is recommended for pests having a 'very low' rate of natural spread. Several options related to pest freedom of the crop are reviewed in this table under: - Treatment of crop

Option	Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica*
	- Resistant cultivars - Growing under physical isolation - Specified age of plant, growth stage or time of year of harvest - Production in a certification scheme.
Pest free production site (PFPS)	**Yes**, if grown under physical isolation, see above. To establish and maintain the PFPS, soil should be tested at the PFPS 1 year prior to establishment of the PFPS and continued every year during the growing period of the host, and again at the time of harvest. Specific surveys should also be carried out in the vicinity to demonstrate pest freedom from *C. ficicola* in accordance with relevant ISPMs. PFPS should be subjected annually to inspections including its immediate vicinity carried out at the most appropriate times of the year to detect the presence of the pest and a representative sample of the plants should have been subjected to testing for the presence of the pest at appropriate times of the year. Inspections should be carried out for ambrosia beetles and insecticides should be applied against ambrosia beetles throughout the growing season if needed. There should be restrictions on the movement of host material and soil (originating from areas where the pest is known to be present) into the PFPS, and into the area surrounding the PFPS, especially the area between the PFPS and the closest area of known infestation. Additionally, equipment, machinery etc. should be restricted which originates from areas where the pest is known to occur into the PFPS. Strict hygiene measures should be taken to guarantee a PFPS.
Pest free place of production (PFPP)	**Yes.** As recommended by the EPPO Panel on Phytosanitary Measures, the choice between PFPP and PFPS is a decision to be taken by the NPPO based on the operational capacities of the producers and biological elements. As for PFPS, if fulfilled by all the individual sites of the place of production.
Pest free area	**Yes.** There are areas free from the pest in Greece, Italy, and Japan. Area established by NPPO in according to ISPMs 4 and 29. To establish and maintain the PFA (ISPM 4, ISPM 29), a general surveillance in the area prior to establishment of the PFA and continued every year may be sufficient.

Option	Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica*
	• In specific cases, specific surveillance should also be carried out in the zone between the PFA and known infestation area to demonstrate pest freedom. The detection surveys to establish and maintain the PFA should be targeted for the pest and should be based on appropriate combination of visual examination and testing of host plants and soil. • There should be restrictions on the movement of host material, soil associated with hosts and equipment used (originating from areas where the pest is known to be present) into the PFA, and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation.
Options after harvest, at pre-clearance or during transport	
Inspection of consignment	**Yes, in combination*.** Pest is difficult to detect, asymptomatic in the host for up to three years.
Testing of commodity	**Yes, in combination*.** Same as testing at place of production.
Treatment of the consignment	No. No specific measures for treatment of the fungus if present within the host. Treatment would not guarantee the absence of the pest.
Pest only on certain parts of plant/plant product, which can be removed	No. The pest can be present in the xylem of the host and can remain asymptomatic inside the commodity.
Prevention of infestation by packing/handling method	**Yes in combination*.** Precautions should be taken to make sure that the commodities are not infested. Packing should prevent reinfestation during storage and transport
Options that can be implemented after entry of consignments	
Post-entry quarantine	**Yes.** It could be possible by inspection and testing for at least 3 growing season (see PFPS). In the framework of a bilateral agreement.
Limited distribution of consignments in time and/or space or limited use	No. It is not possible to define precisely the areas and times where/when the pest is not likely to establish, and it may also establish under protected conditions.
Surveillance and	No.

Option	Plants for planting (except seeds, pollen, tissue cultures) of *Ficus carica*
eradication in the importing country	Detecting the pest at an early stage to enable eradication may be difficult to achieve.

*The individual measures identified above as 'Yes, in combination' were:

Host plants for planting
Inspection at place of production
Testing at place of production
Inspection of consignments
Testing of consignments
Prevention of infection of packaging material

Any combinations from this table would not sufficiently mitigate the risk.

Other possible combinations:
No other possible combinations were available that sufficiently mitigates the risk.

Annex 2. Morphological description

A description from Kajitani and Masuya (2011):

Colonies greenish brown in color. Mycelium aerial. Hyphae smooth, not constricted at the septum. Ascomatal bases pale brown to black, globose to subglobose, 280–640 µm wide, ascomatal necks blackish brown to black becoming paler toward the apices, 890–2,460 µm long, 65–110 µm wide at the base, 27–43 µm wide at the apex. Ostiolar hyphae divergent, hyaline, 140–300 µm long. Asci not observed. Ascospores hyaline, galeate, aseptate, 6.5–8.0 µm long × 4.0–5.5 µm wide in top view, × 3.0–4.5 µm high in side view, accumulating in buff-yellow mucilaginous masses at the apices of the ascomatal necks.

Thielaviopsis anamorph: Endoconidiophores occurring singly on mycelium, hyaline to pale brown, tapering toward the apices, 40–133 µm long, 2–4 µm wide at bases. Phialides cylindrical or slightly lageniform, 20–42 µm long, 2–4 µm wide at bases. Endoconidia hyaline to brown, aseptate, cylindrical, 5.0–9.5 × 4.5–8.0 µm, sometimes remaining in chains. Aleurioconidia brown, aseptate, subglobose, 7.5–16.0 × 7.0–12.5 µm.

C. ficicola is characterized by extensively large perithecia. Other species in the *C. fimbriata* s. l. have similar morphology and are difficult to distinguish from each other. However, *C. ficicola* is easily distinguished from other species in this complex by its perithecial size.

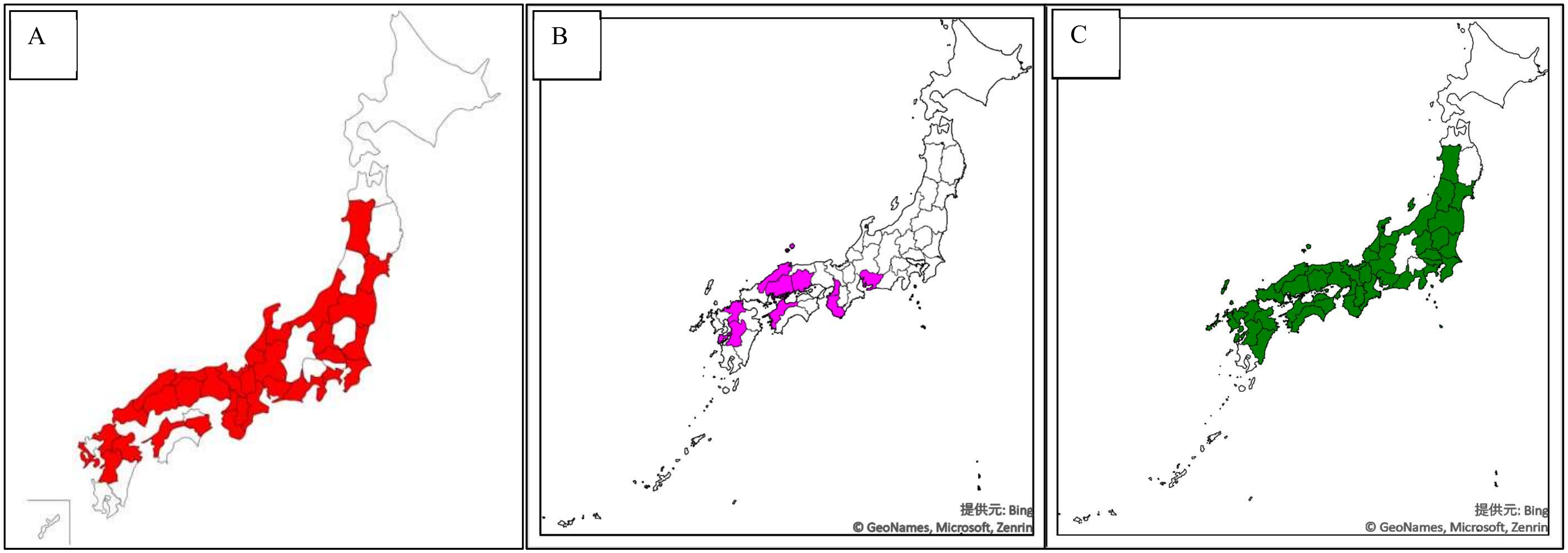
The anamorphic characteristics of *C. ficicola* are almost the same as those of other species of *C. fimbriata* s. l., but *C. ficicola* does not have apparent doliiform conidia, which are often seen on many other species of *C. fimbriata* s. l., excepting *C. fimbriata* s. str. This characteristic, together with the size of perithecia, helps with identification of *C. ficicola* by morphology.

A description from Tsopelas *et al*. (2021):

Black ascomata were observed after 7–10 d incubation on V8A medium, and were partially embedded in the agar. These measured 400–600 µm diam. and had globose bases and long necks (1 150–2 200 µm long). They had ostiolar hyphae at the tips of the necks which were 180–300 µm long. Ascospores exuding from the tips of the ascomata necks formed sticky masses of creamy colour. Ascospores were one-celled, ellipsoidal in top view, measured 5–7 × 4–5 µm, with the characteristic "bowler-hat" shape typical of *Ceratocystis* spp. The fungus produced abundant cylindrical endoconidia (12–40 × 4–7 µm) with rounded apices, and these varied slightly as bulged to straight, from less to more round apices. The conidia were extruded in chains from tubular conidiogenous cells. Aleurioconidia were formed singly or in short chains on short conidiophores, and these were ovoid to subglobose (9–13 × 7–12 µm), pigmented and thick-walled. Doliform endoconidia were not observed.

Morphological characteristics of the Greek isolates were identical to those of the Japanese isolate (exholotype MAFF 625119 = CMW 38543), except that the dimensions of the endoconidia were different. The Japanese isolate had cylindrical endoconidia with dimensions of 5–9.5 × 4.5–8 µm, whereas those made in the present study were 12–40 × 4–7 µm.

Annex 3. Maps from Japan



(A) Occurrence of *Ceratocystis ficicola* in Japan (red shading) (Kajitani, 2017; Y. Kajitani, 2023, pers. comm.), (B) Records of *Ficus carica* attacked by *Euwallacea interjectus* in Japan (H. Kajimura, 2023, pers. comm.; Jikumaru & Morita (unpubl.), (C) Economic cultivation of *F. carica* in Japan (Ministry of Agriculture, Forestry and Fisheries of Japan, 2020).

Annex 4. A summary of studies aimed at finding resistant varieties of fig tree

Rootstock (cultivars)	Scions (cultivars)	Comments	Main conclusions of the studies	References
‘Celeste’, ‘Boldido Negra’, ‘Ischia Black’ and ‘Negronne’	‘Masui Dauphine’	- studied potential of 4 varieties as disease-resistant rootstock for ‘Masui Dauphine’; - inoculation did not kill any trees and did not reduce root respiration, except with an unreasonable amount of inoculum; - no significant reduction in the weights of leaves, shoots or roots was observed except for ‘Celeste’; - trees of the 4 varieties tested showed lower mortality and most survived for 5 years; - no year-by-year reduction in scion growth was observed for any rootstock variety.	- the varieties tested are not truly resistant, but are horizontally resistant* to the pest; - these rootstocks are expected to maintain the scion ‘Masui Dauphine’ despite some continuing damage by disease; - of the varieties tested, ‘Negronne’ is the most resistant.	Hosomi *et al.* (2012) [note that the name *C. fimbriata* is used for the fungus in this paper, but it is most likely *C. ficicola*]
‘Ischia Black’ and ‘Negronne’	‘Masui Dauphine’	- the cuttings collected from the basal position leafed later but rooted earlier, and achieved their required shoot length (0.3 m) earlier than those collected from the apical position; - the early grafting improved the grafting success rate.	- the proportion of surviving grafted nursery stock was higher when using the immature portion of a ‘Masui Dauphine’ scion shoot than a semi-mature portion.	Hosomi *et al.* (2015)
‘Celeste’ (‘Malta’), ‘Ischia Black,’ ‘Negronne’ (‘Bordeaux’), ‘Kibaru’ and ‘Zidi’	‘Masui Dauphine’ (‘San Piero’)	- the characteristics of fruit set, maturation date, and fruit qualities on these rootstocks were similar to those of the own-rooted trees.	- none of the rootstock varieties resistant to Ceratocystis canker disease had a clear influence on fruit production of the scion ‘Masui Dauphine’; - among these varieties, ‘Negronne’ and ‘Kibaru’ are recommended rootstocks in terms of disease resistance.	Hosomi (2019)
BC1 (backcross hybridizations) between four common figs (seed parent) and F1 caprifig type (pollen parent)		- in a wound inoculation experiment using cuttings from 4 BC1 individuals identified as being disease-resistant, all examined lines were healthy and unwithered 100 days after inoculation.	- *F. erecta* and F1 (*F. carica* × *F. erecta*) are extremely resistant; - *F. erecta* is not practical as a rootstock due to extremely low grafting compatibility with *F. carica*;	Yakushiji *et al.* (2019)

Rootstock (cultivars)	Scions (cultivars)	Comments	Main conclusions of the studies	References
			- F1 hybrids are unusable as a rootstock because of a root disorder; - resistance in *F. erecta* is controlled by a single dominant gene; - BC1 progeny exhibited sufficient graft compatibility with fig, indicating that BC1 would be a practical fig rootstock source.	
Three BC1 lines and 'Celeste'	'Houraishi' and 'Masui Dauphine'	- infection and mortality occurred on 86.1 % and 87 % of the own-rooted 'Houraishi' and 'Masui Dauphine' cuttings, respectively; - the infection rate on 'Celeste' rootstock was 41.7 %, but mortality was not observed; - *C. ficicola* infection was restricted within the roots of 'Celeste'; - the disease was not detected in cuttings with BC1 rootstock;	- BC1 is more resistant to infection of *C. ficicola* via soil than existing resistant varieties like 'Celeste'	Morita *et al*. (2020)
'Reikoudai 1 gou' line, *F. erecta*, cultivated fig varieties and varieties considered resistant		- after 180 days, 64–100 % of cultivated figs and existing varieties considered resistant were dead; none of'Reikoudai 1 gou' including wound-inoculated, or *F. erecta* were dead.	- resistance of 'Reikoudai 1 gou' is equivalent to that of *F. erecta* regardless of inoculation method.	Morita *et al*. (2021)
'Reikodai 1 go' (BC1 from interspecific hybridization of *F. carica* and *F. erecta*)	'Masui Dauphine'	- soil inoculation with *C. ficicola* (9 times in 3 years) resulted in death, or inhibited growth, of own-rooted trees; - inoculated 'Reikodai 1 go'-grafted trees revealed no growth inhibition and had growth similar to those of non-inoculated own-rooted and non-inoculated 'Reikodai 1 go'-grafted trees; - use of 'Reikodai 1 go' as a rootstock is unlikely to cause considerable problems in the fruit production of 'Masui Dauphine' fig trees.	- no significant differences in the initial growth of the shoots (1st year of planting) was observed between 'Reikodai 1 go'-grafted and own-rooted trees; - 'Reikodai 1 go'-grafted trees demonstrated a tendency towards scion overgrowth; - 'Reikodai 1 go'-grafted trees were highly resistant to soil infestation with *C ficicola.*	Kamimori *et al*. (2022)

Rootstock (cultivars)	Scions (cultivars)	Comments	Main conclusions of the studies	References
Reikodai 1 go (BC1 from interspecific hybridization of *F. carica* and *F. erecta*) and Houraishi		- the amount of DNA of *C. ficicola* was limited in Reikodai 1 go cuttings relative to that in Houraishi; - by 29 days, all Houraishi cuttings were dead, but all Reikodai 1 go cuttings were still alive after 180 days.	- the resistance of Reikodai 1 go prevents the migration and propagation of the *C. ficicola* pathogen.	Shirakami *et al*. (2022)

* In genetics, the term horizontal resistance was first used by J. E. Vanderplank to describe many-gene resistance, which is sometimes also called generalized resistance. This contrasts with the term vertical resistance which was used to describe single-gene resistance.

Annex 5. Popular *Ficus carica* cultivars in Mediterranean countries of the EPPO region (mostly based on Nosir, 2023, and references within)

Algeria: ‘Kalamon’, ‘Kalamatiani Evias’ and about 40 others (Nosir, 2023).

Cyprus: ’Vazanata’, ’Vasilika’, ’Smyrneika’, ’Vardika’, ’Kadota’, ’Napolitana negra’, ’Progontto Blanco’, ’Gentile Bianco’ (Nosir, 2023).

Egypt: ‘DiRedo’, ‘Conadria’, ‘Sultani’, ‘Black Mission’ (Nosir, 2023).

France: ‘Bellone Noire’, ‘Bellone Grise’, ‘Grise de Tarascon’, ‘Violette de Solliès’, ‘Grise-Saint-Jean’, ‘Marseillaise’ (The Provence Holidays, 2023); ‘Ronde de Bordeaux’, ‘Smith’ (= ‘John Smith’), ‘Violette de Bordeaux’ (= ‘Beer's Black’, ‘Negronne’, ‘Little Miss Figgy’) (Raddi, 2023).

Greece: ‘Kymis’, ‘Dauphine’ (similar to ‘Masui Dauphine’) (Nosir, 2023).

Italy: ‘Dottato’ (= ‘Ottato’, ‘Uttato’, ‘Ortata’, ‘Fico Bianco’, ‘Kadota’) (Nosir, 2023).

Israel: ‘Brown Turkey’, ‘Ice Crystal’, ‘Jordan’, ‘Kadota’, ‘Nazareth’, ‘Penashe’, ‘Switzerland’ (EFSA PLH Panel, 2021).

Morocco: ‘El-quoti lbied’, ‘Ghani’, ‘Chaari’, ‘Fassi’, ‘Ounq Hmam’, ‘Nabout’, ‘Ghoudan’, ‘Zerqui,’ ‘Sbeti’, ‘Tabli’, ‘Lamtal’, ‘Mssari’, ‘Arguil’, ‘Chaari’, ‘Jaadi’ (Nosir, 2023).

Spain: ‘Colar’, ‘Super-Fig’, ‘Cuello de Dama Negro’, ‘San Antonio’, ‘Nazaret’, ‘Tiberio’, ‘Carballar Negra’, ‘Moscatel’ (Nosir, 2023).

Tunisia: ‘Bither’, ‘Bither besbessi’, ‘Bidhi’, ‘Zidi’, ‘Kahli’, ‘Soltani’, ‘Bouhouli’, ‘Wahchi’ (Nosir, 2023).

Türkiye: ‘Sarilop’, ‘Bursa Siyahi’, ‘Yesilguz’, ‘Bardakci’, ‘Sultan Selim’, ‘Karabakunva’, ‘Beyaz Orak’ (Nosir, 2023).

Annex 6. Data on commercial fig production in the EPPO region

Table 1. Fig fruit production in EPPO countries (t) (2017–2021; FAO, 2023)

Country	2017	2018	2019	2020	2021
Albania	20077	24448	22024	21889	24095
Algeria	128684	109214	114092	116143	107266
Armenia	909	1227	1234	1713	1606
Azerbaijan	9263	11215	12074	12266	12620
Bosnia and Herzegovina	678	894	980	1005	939
Croatia	923	800	810	790	770
Cyprus	2948	1340	1600	1670	1810
France	3718	3340	3340	3340	6440
Greece	23591	16010	19730	19840	7780
Israel	2390	2414	2387	2381	2356
Italy	11363	10650	11830	12180	12760
Jordan	556	645	641	655	591.45
Malta	59	60	30	50	40
Montenegro	3830.02	3842	3872	3849	3825
Morocco	137934	128380	153472	144246	144153
North Macedonia	745	663	626	879	894
Portugal	3402	3740	4610	4410	5000
Slovenia	39	50	80	100	50
Spain	36380	47750	51600	59900	60190
Tajikistan	1218.54	1225	1219	1221	1222
Tunisia	25800	27400	27000	19600	20000
Türkiye	305689	306499	310000	320000	320000
Uzbekistan	20200	21000	24800	30300	32200

Table 2. Fig fruit area harvested in EPPO countries (ha) (2017–2021; FAO, 2023)

Country	2017	2018	2019	2020	2021
Albania	1483	1482	1489	1504	1508
Algeria	40932	39356	39438	39026	39065
Armenia	231	239	237	242	238
Azerbaijan	1808	1826	1880	1905	1913
Bosnia and Herzegovina	367	477	537	562	535
Croatia	273	270	420	570	570
Cyprus	163	140	160	170	190
France	428	440	440	440	840
Greece	3720	3770	3990	4400	1140
Israel	131	131	133	127	122
Italy	2336	2230	2150	2060	2070
Jordan	120	121	121	125	118
Malta	26				
Montenegro	1301	1311	1328	1337	1346
Morocco	60533	61498	62969	63131	64431
North Macedonia	45	39	37	52	52
Portugal	4130	4130	3810	3810	3770
Slovenia	13	10	20	20	20
Spain	13564	13980	14600	15720	17160
Tajikistan	307	309	310	309	309
Tunisia	17891	18869	18349	13323	13597
Türkiye	50330	51389	52116	53694	54698
Uzbekistan	728	739	838	985	1264

Annex 7. Köppen-Geiger climate classification (1999–2020) (Beck *et al*., 2023)