

REVIEW ARTICLE

Worldwide potential insect vectors of *Xylella fastidiosa* and assessment of their importance with a focus on Morocco

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Abstract In Morocco, the climate conditions are favorable for the establishment and the spread of *Xylella fastidiosa* (*X.f.*). However, the successful establishment of the bacterium depends on many factors; mainly: bacterial subspecies and sequence type, host plants susceptibility, feeding behavior and transmission efficiency of the insect vectors. Knowledge of the relationship between the bacterium–affected crop agro-ecosystem and potential insect vectors is of crucial importance. In this work, we list the tritrophic interaction *X.f.*-host plants-insect vectors that occur worldwide in order to apply it to the current situation in Morocco and for risk analysis on the bacterium in the country. Two most relevant *X.f.* subspecies of the bacterium (in terms of impact on crops) were considered, namely, subsp. *fastidiosa* and subsp. *pauca*. Based on the international literature and public databases, the majority of the *X.f.*-insect vectors are comprised in two families: Cicadellidae and Aphrophoridae. Among all cicadellid species recorded, a high number had the capacity to transmit *X.f.* to hosts in America while this ability is null for other regions (except *Graphocephala versuta* Say (Hemiptera: Cicadellidae) recorded in Algeria). In Morocco, none of the cicadellid genera reported worldwide as vectors of *X.f.* have been so far reported, whereas many species of spittlebugs and leafhoppers are present. *Philaenus tessellatus* Melichar (Hemiptera: Aphrophoridae) is highly abundant in Morocco and could play a role as potential vector in case the bacterium is introduced in the country. With regard to the *X.f.* hosts, citrus, olive, almond and grapevine, forest agroecosystems and oleander are considered the main susceptible species present in Morocco.

Additional keywords: *Graphocephala versuta*, *Philaenus tessellatus*, spittlebugs, subspecies *fastidiosa*, subspecies *pauca*, *Xylella fastidiosa*, *X.f.* potential vectors

Introduction

Agriculture plays a key role in socio-economics and a significant role in improving the food security situation in Morocco. In the country, approximately the half

area (43%) of arable land is devoted to cereals, which are located in rained zones and grown in rotation with other annual crops (e.g. beans, chickpeas, and lentils). However, olive, citrus, almond, and grapevine are among Morocco's leading agricultural products in terms of size of area and/or value. Other major agricultural crops in the country are mainly, pome and stone fruits, open field vegetables (e.g. tomatoes, potatoes, etc.) and other industrial crops, mainly in commercial greenhouse (e.g. cucumbers, peppers, blueberries, flowers, etc.). These crops are mainly located in the irrigated perimeters. All crops are located, mostly in the Center, western and northern parts of the country. However, many parameters that affect the annual production are needed to be

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taken into account in the near future, mainly technology development, adoption level and climatic conditions often characterized by their variation. In addition to water scarcity and climate change concerns, the disease threat from *Xylella fastidiosa* (*X.f*) (Xanthomonadaceae, Gamma proteobacteria) is maybe one of the most relevant concerns for crops that growers may face in the country.

Xylella fastidiosa is a xylem-restricted pathogenic, gram-negative bacterium, initially restricted to the American continent (Hopkins and Purcell, 2002). The main reported diseases for the bacterium include Olive quick decline syndrome (OQDS), Citrus variegated chlorosis (CVC), Pierce's disease (PD) in grapevine, Almond leaf scorch disease (ALSD) and Oleander leaf scorch disease (OLSD). *Xylella fastidiosa* is divided into three main groups of subspecies with allopatric distribution: *X.f* subsp. *fastidiosa* (*X.f.f*), *X.f* subsp. *multiplex* (*X.f.m*) and *X.f* subsp. *pauca* (*X.f.p*) (Nunney *et al.*, 2012, 2019; Coletta-Filho *et al.*, 2020). This bacterium was firstly identified as *X.f* associated with PD with high impact and devastating consequences on the southern California grape industry (Chang *et al.*, 1993; Galvez *et al.*, 2010; Sanscartier *et al.*, 2012). *Xylella fastidiosa* subsp. *pauca* is also associated with different crops, causing several diseases: CVC is the most devastating disease, showing a high incidence on the citrus industry in Sao Paulo, and affecting almost 100 million of sweet orange trees (Coletta-Filho *et al.*, 2020). In *Medicago sativa* plants, *X.f* infection induces hypersensitive-response-like symptoms (Abou Kubaa *et al.*, 2019). In 2013, this bacterium was first reported in Europe and well characterized as *X.f.p* associated with leaf scorching with severe dieback and desiccation in olive causing OQDS in Apulia region (south of Italy) (Saponari *et al.*, 2013, 2017). A recent study demonstrated the physiological response to *X.f* infections by measurements of stomatal conductance and stem water potential in the infected olive trees (Surano *et al.*, 2022).

Xylella fastidiosa has a wide range of

host plants infecting about 655 plant species (EFSA, 2022). Estimations in EU indicate that *X.f* has the potential of causing a 5.5 billion Euros of annual production loss once it is full spread across the entire EU. This would threaten more than 300.000 jobs across EU currently involved in that production. The economic threat of *X.f* is not limited to producers but should be contextualized as a societal problem (Schneider *et al.*, 2021).

In an open field crop or natural agroecosystems, the natural spread of *X.f* occurs in two main ways: (i) long-range transport of the infected plant (or part of the infected plant) and (ii) local and regional spread which can occur by an insect vector. For local spread, *X.f* is transmitted to host plants by specialized insect vectors belonging to order Hemiptera, suborder Auchenorrhyncha, more specifically spittlebugs (Aphrophoridae), sharpshooter leafhoppers (Cicadellidae, subfamily Cicadellinae), treehoppers (Membracidae) and Cicadas (Cicadidae and Tibicinidae), which feed on xylem sap (Janse and Obradovic 2010). Natural transmission of *X.f* by insects is considered the main factor in local dissemination and appears to be the most critical threat for *X.f* establishment and spread in Europe. When this pathogen overwinters in the xylem of the host plant, the long-distance spread is likely related to the movement of infected plant material (Chatterjee *et al.*, 2008; EFSA, 2018). When the bacterium is introduced into a new environment with well-suited abiotic conditions, it requires the presence of efficient vectors to establish and spread (Ferreles, 2015).

The favorable factors that may cause a high risk of *X.f*-epidemic disease include: the presence of an efficient vector, favorable climatic conditions and the presence of a suitable host plant. This highlights the risks associated with the unintended introduction of organisms, e.g. subspecies of *X.f*, into new regions. In the case of the Mediterranean basin countries, particularly Morocco, they are at high risk for the arrival and establishment of this bacterium (Frem *et al.*, 2020). Knowledge of potential insect vectors in association with the disease produced in the

host crops is of crucial importance for discovering emergent pathogens. The potential insect vectors of *X.f* around the world have been reviewed, except for North Africa (Cornara *et al.*, 2019; Di Serio *et al.*, 2019). In North America and South America, sharp-shooter species are considered the main vectors of *X.f* that cause several serious diseases like PD on grapevine and CVC on citrus. In citrus orchards affected by CVC disease in Argentina, eleven leafhopper and treehopper species were tested positive for *X.f* by molecular assays (Dellap *et al.*, 2016). In Italy, three spittlebugs, *Philaenus spumarius* (Linnaeus), *Philaenus italosignus* Drosopoulos & Remane, and *Neophilaenus campestris* Fallén (Hemiptera: Aphrophoridae) demonstrated the ability to transmit *X.f* in the field (Cavaliere *et al.*, 2019; Panzavolta *et al.*, 2019). However, the two widespread species in Italy and other southern European countries are *P. spumarius* and *N. campestris* (Lopes *et al.*, 2014; Morente *et al.*, 2018; Thanou *et al.*, 2018; Tsagkarakis *et al.*, 2018; Bodino *et al.*, 2019; Theodorou *et al.*, 2021), in which *P. spumarius* alone is the main vector associated with OQDS in olive orchards in the south of Italy (Saponari *et al.*, 2017). Moreover, a recent survey conducted in Basilicata Region, Italy demonstrated that a *P. spumarius*, *N. campestris*, *Lepyronia coleoptrata* Linnaeus (Hemiptera: Aphrophoridae) and *Cicadella viridis* (Linnaeus) (Hemiptera: Cicadellidae) were the potential vectors of *X.f* captured in that region (Trotta *et al.*, 2021). A recent review describes control attempts and current management of *X.f* in olive, including control of the vector *P. spumarius* (Morelli *et al.*, 2021). In addition, subspecies of *X.f* have been well described considering plant diseases and sequence type, but limited data is available on subspecies of *X.f*, hosts and insect vector interrelationships.

In Morocco, *X.f* is considered a quarantine pest and since 2016, there has been a crop-agroecosystems insurance program to help producers in coping with the risk related to the national *X.f* (ONSSA, 2016; Afechtal *et al.*, 2018). Up to 2022, the bacterium has not been detected in Morocco, thus

the country remained *X.f*-free (El Handi *et al.*, 2022). However, limited data is available on the relationship between worldwide potential insect vectors and plant heritage in North Africa, particularly in Morocco. The ability to carry out rational control strategies against *X.f* depends mainly on the knowledge and analysis of the risk assessment of worldwide potential insect vectors in the context of Moroccan crop agro-ecosystems. This study aims to give recent data and analyze the threat of the occurrence and interaction between the potential insect vectors with *X.f* around the world, including America, Europe, Asia and North Africa, in comparison with Morocco. This may provide promising prospects on how we could manage the bacterium-affected crop agro-ecosystem threat in Morocco.

Materials and Methods

1. Literature search

Available information on the main potential insect vectors of *X.f* associated with different plant species, including crops worldwide were retrieved upon the consultation of public databases ZENODO (i.e. <https://zenodo.org/record/3775537#.YitG-GXrMKUI>) and through a literature search of articles published from 90's to 2022. For this, we used databases of EFSA (<https://www.efsa.europa.eu/en/efsajournal/pub/5736>), EPPO (www.eppo.org), Scopus (www.scopus.com), Springer (<https://link.springer.com>) and Google Scholar (<https://scholar.google.com>).

2. Data analysis

Global species distribution was divided into five main areas: America (North America and South America), Europe, Asia, and North Africa and for comparison Morocco (including the data previously collected in Morocco). The collected data were summarized as a data matrix including the following generated variables:

- Insect species belonging to the Cicadomorpha infraorder were categorized as:

- a) main vector: the insect can transmit the bacterium to the plant in the natural conditions and induce disease that results with symptoms on the plant or the tree after infection, in situ, b) competent vector: the insect can transmit the bacterium to the plant and may induce symptoms on the plant or the tree after infection only in semi-field and laboratory conditions, c) potential insect vector: insect may be able to acquire and/or to transmit the bacterium.
- *Phylogeny diagram* of all recorded species groups.
 - *Host plants*: the main host plants of vector or potential vector insects; monocotyledonous and dicotyledonous in ground cover and shrub tree crops.
 - *Acquisition (Acq)*: number of the potential insect vector individuals that are able to acquire the bacterium from *X.f*-symptomatic plant divided by the total number of all specimens tested. Under laboratory conditions with three levels: *Acq-lab*: the insect acquires the bacterium; *Acq-no lab*: the insect does not acquire the bacterium and *Acq-un lab*: unknown information or no available data on insect acquisition. Under field conditions: *Acq-field*: the insect acquires the bacterium; *Acq-no field*: the insect does not acquire the bacterium; and *Acq-un field*: unknown information or no available data.
 - *Transmission (Tra)*: number of the potential insect vector individuals that are able to transmit *X.f* in the plant after acquiring the bacterium divided by the total number of individuals tested. Under laboratory conditions: *Tra-lab*: the insect can transmit the bacterium; *Tra-no lab*: the insect cannot transmit the bacterium; and *Tra-un lab*: unknown information or no available data. Under field conditions: *Tra-field*: the insect can transmit the bacterium; *Tra-no field*: the insect cannot transmit the bacterium and *Tra-un field*: unknown information or no available data.
 - *Nature of X.f subspecies transmission*: the subspecies *X.f* transmitted by the potential insect vector.

For some variables (e.g., species categorized, *Acq*, *Tr*), the number was determined and a percentage was calculated as the number of species reported for the parameter over the total number reported in the region. The data collected from these variables' determination, were used to generate graphs.

Results

In this study, a total of 218 species of Cicadomorpha were recorded as potential insect vectors of *X.f*, worldwide (Table S1). Intraorder, subfamilies, families and genera of these species, ordered phylogenetically are given in Figure 1. The largest numbers of genera were found to belong to four families Cicadellidae (40 genera, 79 species), Aphrophoridae (9 genera, 38 species), Membracidae (16 genera, 27 species), and Tibicinidae (8 genera, 47 species). The number of genera does not exceed two for other families. In Morocco, only 6 *X.f* potential insect vectors were recorded. The highest number (70) of *X.f* potential insect vectors belonging to Cicadellidae was identified in the America compared to Europe (7) and other areas (<5). However, the number of Aphrophoridae species recorded was higher in Europe (29) than in America (9), Asia (6), North Africa (9), and Morocco (6). The numbers of known potential insect vectors of *X.f* with the capacity to acquire and transmit the bacterium are provided in Figures 2 and 3. Among all identified *X.f*-potential insect vectors, only four families contain high numbers of species that have the capacity to acquire and to transmit the bacterium from the infected plant: Cicadellidae, Aphrophoridae, Clastopteridae and Membracidae. In terms of species able to acquire and transmit *X.f*, numbers were higher in America compared to the other areas: for cicadellids (51 and 43, respectively) and for membracids (13 and 2, respectively). These numbers were variables for Aphrophoridae (1 and 5) and for Clastopteridae (4 and 1).

Regarding the capacity to acquire *X.f*,

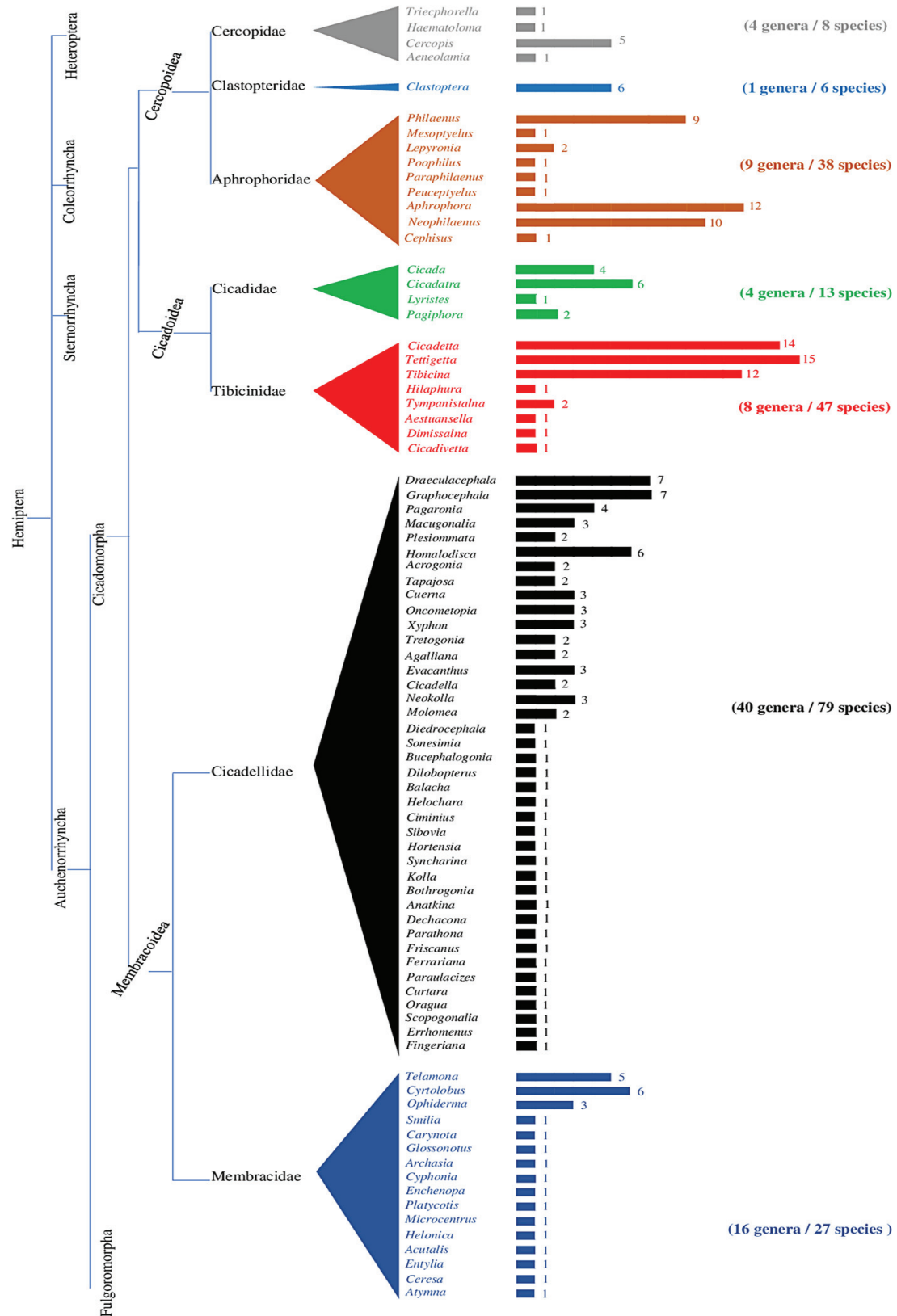


Figure 1. List of worldwide potential insect vectors of *Xylella fastidiosa*: infraorder, subfamilies, families and genera ordered phylogenetically, in America, Europe, Asia, North Africa and for comparison with Morocco. Histogram with number of potential insect vectors of *X.f* for each family.

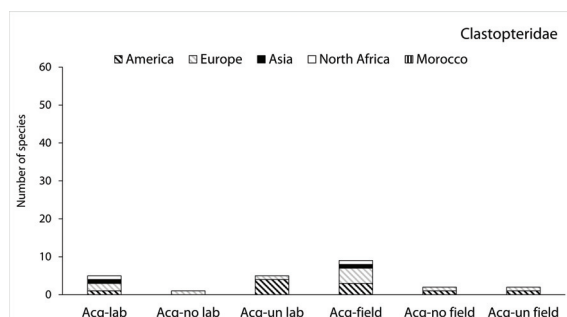
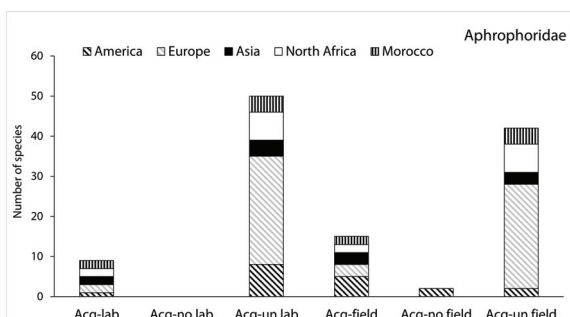
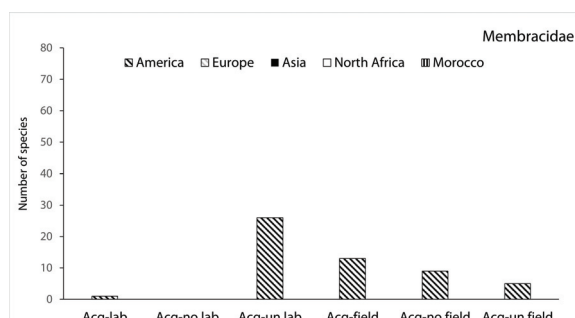
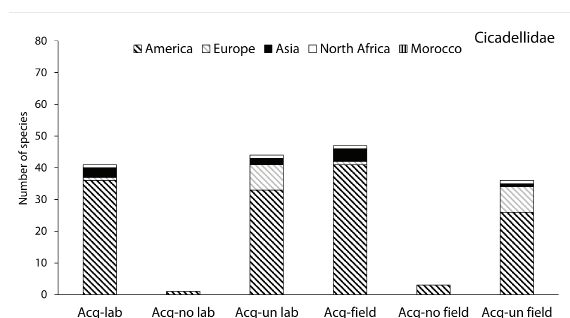


Figure 2a. Worldwide potential insect vectors of *Xylella fastidiosa*: Number of known species that able to acquire bacterium in the field and in the laboratory in America, Europe, Asia and North Africa and for comparison with Morocco. (Acq) Acquisition, (Tra) Transmission; (lab) laboratory, (un) unknown, (no) cannot.

Figure 2b. Worldwide potential insect vectors of *Xylella fastidiosa*: Number of known species that able to acquire bacterium in the field and in the laboratory in America, Europe, Asia and North Africa and for comparison with Morocco. (Acq) Acquisition, (Tra) Transmission; (lab) laboratory, (un) unknown, (no) cannot.

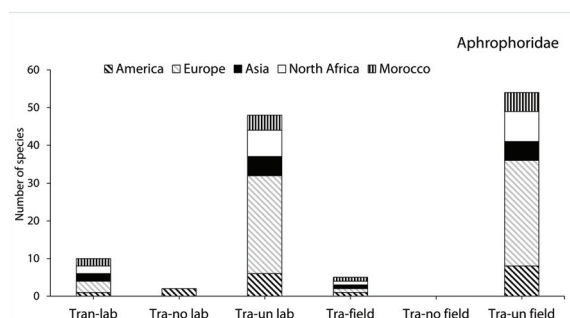
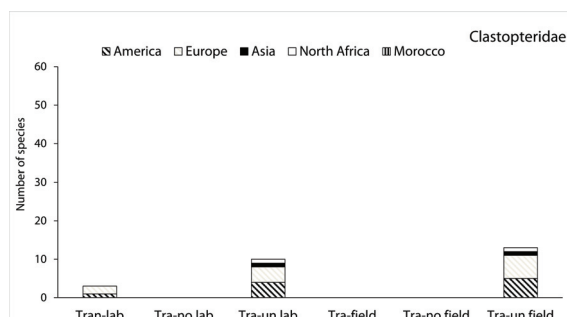
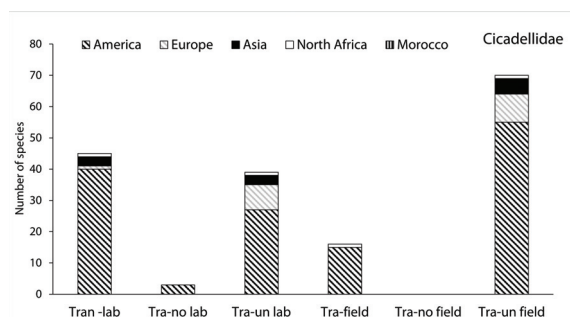


Figure 3b. Worldwide insect vectors of *Xylella fastidiosa*: Number of known species that able to transmit the bacterium in the field and in the laboratory in America, Europe, Asia and North Africa and for comparison with Morocco. (Acq) Acquisition, (Tra) Transmission; (lab) laboratory, (un) unknown, (no) cannot.

Figure 3a. Worldwide insect vectors of *Xylella fastidiosa*: Number of known species that able to transmit the bacterium in the field and in the laboratory in America, Europe, Asia and North Africa and for comparison with Morocco. (Acq) Acquisition, (Tra) Transmission; (lab) laboratory, (un) unknown, (no) cannot.

the cicadellids species number was higher in America compared to other areas, in the laboratory (36) and in the field (41). This number does not exceed two in laboratory conditions in Asia and one for North Africa. Among all cicadellid species, we identified a high number of species that able to transmit *X.f* to the host in America with 40

and 15 species under laboratory conditions and in the field, respectively. This number was 2 for Asia under laboratory conditions and one for North Africa. For aphrophorid species, the number of species that able to acquire *X.f* was very low in America (5) and Europe (3) either in the laboratory or in the field. This number does not exceed two in other areas. Even in America, among all aphrophorids, the number of species that able to transmit *X.f* ranged from two to five under laboratory conditions. However, only one species has the capacity to transmit this bacterium in the field in each region. About 50% of all cicadellid species have no information related to their capacity to acquire and transmit *X.f*. In America, two Membracidae species can acquire *X.f* while only one species transmits the bacterium to crops. Many species with unknown information related to their capacity to acquire and transmit *X.f* were recorded. Few data has been reported on the tritrophic interaction *X.f*-host plant-insect vector, provided in Table S2.

Discussion

Xylella fastidiosa remains a major disease because it threatens natural areas and the horticultural, agricultural, and forestry sectors as a recognized agent of many serious and economically important diseases of crops and landscape plants (Almeida *et al.*, 2014). Morocco is among the Mediterranean countries of high risk for arrival, establishment, and spread of this bacterium (Afechtal *et al.*, 2018; Frem *et al.*, 2020). The most economically known insect-borne diseases (e.g. OQDS) in Europe from Cicadomorpha, particularly *P. spumarius*, are linked to the bacterium *X.f* (Saponari *et al.*, 2017). High numbers of *X.f*-potential insect vectors were identified for only two families; Cicadellidae and Aphrophoridae. For comparison, only six aphrophorids were recorded for Morocco.

Cicadellid species were the main vector of *X.f* in America. Twelve leafhopper species are known to be vectors of CVC in Bra-

zil (Lopes, 1996; Gravena *et al.*, 1998; Parra *et al.*, 2003) and nine are the most important sharpshooter vectors of *X.f* to economically important crops in North America (Cornara *et al.*, 2019). Most Cicadellinae species have shown the ability to acquire and transmit *X.f* because of their xylem-fluid feeding habit (Redak *et al.*, 2004). The most important one, *C. viridis*, was reported by current studies in Europe (Bodino *et al.*, 2022; Rodrigues *et al.*, 2023). The last survey carried out in Morocco showed that none of the Cicadellid genera (e.g. *Cicadella*, *Evacanthus* and *Graphocephala* genera) has been reported as potential vectors of *X.f* were found in Morocco (Haddad *et al.*, 2021). However, it is most important to notice the presence of *G. versuta* during the survey carried out in Algeria between September 2013 and April 2014 (Boulaouad *et al.*, 2022). This cicadellid is a vector of *X.f* in USA (Janse and obradovic, 2010). Some specialized phloem feeders such as leafhoppers, can come into contact with xylem vessels and become infected (El Beaino *et al.*, 2014), however, we cannot consider them as a potential insect vectors, since no current studies have clarified their transmission of the bacterium. This is the case of the American grapevine leafhopper, *Scaphoideus titanus* Ball (Hemiptera: Cicadellidae), which is a specialist of *Vitis spp.* and a true mixed xylem/phloem-feeder (Chuche *et al.*, 2017).

Few aphrophorid species are able to acquire *X.f*, however, under field conditions; only one aphrophorid species has the capacity to transmit this bacterium. In America, 12,880 insect specimens were collected in pin, red oaks in New Jersey, 1.7% were Aphrophoridae and Clastopteridae, and only four spittlebug species DNA tested positive for *X.f* (Zhang *et al.*, 2011). However, in Europe, *P. spumarius* is the only important insect vector involved in the ongoing *X. fastidiosa* outbreak in olive groves in Italy (Saponari *et al.*, 2017; Cornara *et al.*, 2019). A recent survey of potential insect vectors in Morocco was carried out by Haddad *et al.* (2021) where only two main *X.f* potential insect vectors were recorded, *P. tessellatus* and *N. campestris* (Hemiptera: Aphrophoridae).

According to these authors, *P. spumarius* was not found. They suggest that *P. tessellatus* should be considered as the main potential insect vector of *X.f* in the country. According to Greco et al. (2021), in areas where the bacterium is not yet present, a qualitative-quantitative study on the entomofauna is important for the timely identification of potential vectors and for developing effective control strategies.

In America, two Membracidae species can acquire *X.f* but only one species transmits the bacterium to plant. In CVC-affected citrus agroecosystems in Argentina; two Membracidae species *Cyphonia clavigera* (Fabricius) and *Entylia carinata* (Forster) were tested positive for *X.f* (Dellape et al., 2016). However, in transmission trials, only *C. clavigera* successfully transmitted *X.f* to plants. In addition, under field around the pin and red oaks leaf scorch-affected agroecosystem in New Jersey (USA), eleven treehopper species DNA tested, were positive for *X.f* (Zhang et al., 2011).

The Cicadidae are xylem-sap feeders, and so at least in theory they are candidate vectors of *X.f*. However, few studies have been conducted on the ability to transmit the bacterium (Paiao et al., 2002; Krell et al., 2007). Recently, Cornara et al. (2020) showed that no successful transmission of *X.f* occurred using *Platypedia minor* Uhler and *Cicada orni* Linnaeus (Hemiptera: Cicadidae), infesting grapevine and olive plants. A study by Mesmin et al. (2023) showed similar results in Corsica (France). In Tunisia, four potential *X.f* vectors were identified recently: namely *N. campestris*, *N. lineatus*, *P. tessellatus* and *P. maghresignus* Drosopoulos & Remane (Boukhris-Bouhachem et al., 2022). A new study showed similar results for spittlebugs community in European olive and grapevine (Antonatos et al., 2021; Bodino et al., 2020; 2021a, b; Rodrigues et al., 2023). In Morocco, many species with unknown information related to their capacity to acquire and transmit *X.f* were identified. The lack of information is due to the limited trials worldwide on *X.f*-potential insect vectors. Thus, there is a serious necessity to make supplementa-

ry surveys to get new data in the country, as well as in North Africa.

Several pathogenic variants of the bacterium have been described and categorized by subspecies. Six subspecies are reported for *X.f*; worldwide (Schaad et al., 2004; Schuenzel et al., 2005; Randall et al., 2009; Nunney et al., 2014): *X.f* subsp. *fastidiosa*, *X.f* subsp. *multiplex*, *X.f* subsp. *sandy*, *X.f* subsp. *pauca*, *X.f* subsp. *tashke* which was isolated from the ornamental tree *Chitalpa tashkentensis* (Randall et al., 2009) and finally, *X.f* subsp. *morus* that infects *Morus* spp. (Nunney et al., 2014, 2019). Together, these subspecies of *X.f* have been reported to cause diseases after infection on more than 655 plant species belonging to 293 genera and 88 botanic families (EFSA, 2022). However, only two of subspecies are of worldwide important and most economically devastating; *X.f* subsp. *fastidiosa* which cause PD in grapevine in North America and *X.f* subsp. *pauca* which causes CVC and OQDS in South America and in Europe, respectively (Parra et al., 2003; Dellape et al., 2016; Saponari et al., 2017). The other subspecies are associated with low economic damage.

The spread of the bacterium to forest areas could lead to an impact on oaks, elms, maples, and other tree species known to be affected in North America (EFSA, 2020; Desprez-Loustau et al., 2021). Most researches have shown no specificity of insect vector transmission for different bacteria genotypes and strains (Almeida and Nunney, 2015; Esteves et al., 2019; Coletta-Filho et al., 2020). Except for the two tritrophic interactions (*X.f* subsp. *pauca*-olive-*P. spumarius* and *X.f* subsp. *fastidiosa*-grapevine-sharphopper), little specific data are available on transmitted *X.f* subspecies by a confirmed insect vector. This is the case of ALSD in California, which is caused by the interactions of two types of sequence of *X.f* subspecies; subsp. *fastidiosa* (ST1) and subsp. *multiplex* (ST81) (Olmo et al., 2021). The same authors reported that, to date, ALSD affects over 81% of almond trees and PD was widespread in vineyards across Mallorca. However, no available data was recorded on the role of the potential vec-

tor of this bacterium. In addition, all knowledge on Apulian OQDS outbreak should not be generalized and applied to other pathosystems, since *Xylella-pathosystems* should be treated on a case-by-case basis (Desprez-Loustau *et al.*, 2021).

In Morocco, citrus, olive, almond, grapevine, the forest agroecosystem and oleander which is the main ornamental plant in the country, are identified as at high risk to be host plants of the bacterium. While *P. tessellatus* has not been tested for acquisition and transmission efficiency on any crop, its occurrence at high abundance suggest that it could be the main potential vector of *X.f* in Morocco once the latter introduced. In addition, taking into account all data which implies the role of *P. tessellatus* in the potential epidemiology of *X.f* in Mediterranean region and particularly in Morocco, it will be essential to conduct trials to assess the role of this spittlebug, as an insect vector, in the spread of different subspecies of *X.f* in to the main crop agroecosystems, e.g. citrus, olive, almond grapevine, forest system and oleander.

Conclusions

Knowledge of relationships between *X.f* subspecies and the worldwide potential insect vectors is of crucial importance to understand the risk of introduction and spread of the bacterium in new regions and countries such as in Morocco. The emergence of serious diseases associated with *X.f* in different EU countries and its easy spread to other countries in the Mediterranean region, represents a serious threat to all potential host species in each country. Furthermore, the favorite climatic conditions for *X.f* in Morocco, suggest that the bacterium will find a suitable environment for successful establishment. The present work highlights the main reported diseases caused by *X.f*, the associated subspecies, affected crops and the typical symptoms. According to the available data in the literature, *P. tessellatus* should be considered as the main potential insect vec-

tor of *X.f* in Morocco. While no data is available on the acquisition and transmission efficiency of *P. tessellatus* to any crop, this insect which is already associated with several susceptible crops in Morocco could play a major role in fast spread of *X.f* once introduced in Morocco. Indeed, it is of crucial importance to notice the presence of *G. versuta* in Algeria. There is a great need to carry out supplementary surveys on potential insect vectors of this bacterium. In addition, there is an urgent need to have the scientific tools to detect quickly the occurrence of this bacterium in the first bacteria inoculums that could be introduced in the near future.

Supplementary Material

Table S1. List of worldwide, families, genera, occurrence, acquisition and transmission of *X.f*, disease transmitted and host plants, vector, competent and potential vector of *X.f*, including America (AM), Europe (EU), Asia (AS), North Africa (NA) and Morocco (MO). Lab: Laboratory.

Table S2. Worldwide tritrophic interaction subspecies of *X.f*-host plant-insect vector.

Conflicts of Interest

The authors declare no conflict of interest.

This research received no external funding. We used the support provided by the Regional Agricultural Research Center of Kenitra (INRA-Morocco). The authors wish to express their gratitude to Dr. Maria Saponari (Institute for Sustainable Plant Protection, Bari, Italy) and Dr. Vinton Thompson (American Museum of Natural History, New York, USA) for their valuable comments and suggestions to improve the quality of the paper.

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Received: 3 June 2023; Accepted: 19 December 2023

ΑΡΘΡΟ ΑΝΑΣΚΟΠΗΣΗΣ

Έντομα δυνητικοί φορείς του βακτηρίου *Xylella fastidiosa* παγκοσμίως και αξιολόγηση της σημασίας τους με έμφαση στο Μαρόκο

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Περίληψη Στο Μαρόκο οι κλιματικές συνθήκες είναι ευνοϊκές για την εγκατάσταση και εξάπλωση του φυτοπαθογόνου βακτηρίου *Xylella fastidiosa* (X.f). Ωστόσο, η επιτυχής εγκατάσταση του βακτηρίου εξαρτάται από πολλούς παράγοντες και κυρίως: τα υποείδη του βακτηρίου και τον τύπο αλληλουχίας, την ευαισθησία των φυτών-ξενιστών, τη διατροφική συμπεριφορά και την αποτελεσματικότητα μετάδοσης από τα έντομα-φορείς. Η γνώση της σχέσης μεταξύ του αγρο-οικοσυστήματος των καλλιεργειών που προσβάλλονται από το βακτήριο και των πιθανών εντόμων-φορέων είναι ιδιαίτερης σημασίας. Σε αυτήν την εργασία, παραθέτουμε τις τριτροφικές αλληλεπιδράσεις X.f – φυτά ξενιστές – έντομα φορείς, οι οποίες εμφανίζονται παγκοσμίως, με στόχο την αξιοποίησή τους στην τρέχουσα κατάσταση στο Μαρόκο και για την ανάλυση κινδύνου για το βακτήριο στη χώρα. Εξετάστηκαν δύο πιο σχετικά υποείδη X.f του βακτηρίου (όσον αφορά τις επιπτώσεις στις καλλιέργειες), συγκεκριμένα, το υποείδος *fastidiosa* και το υποείδος *rauca*. Με βάση τη διεθνή βιβλιογραφία και τις δημόσιες βάσεις δεδομένων, η πλειονότητα των εντόμων-φορέων του X.f ανήκει σε δύο οικογένειες: Cicadellidae και Aphrophoridae. Μεταξύ όλων των ειδών Cicadellidae που καταγράφηκαν, ένας μεγάλος αριθμός είχε την ικανότητα να μεταδώσει το X.f σε φυτά-ξενιστές στην Αμερική, ενώ αυτή η ικανότητα είναι μηδενική για άλλες περιοχές (εκτός από το *Graphocephala versuta* Say (Hemiptera: Cicadellidae) που καταγράφηκε στην Αλγερία). Στο Μαρόκο, κανένα από τα γένη της οικογένειας Cicadellidae που έχουν αναφερθεί παγκοσμίως ως φορείς του X.f, δεν έχει αναφερθεί μέχρι στιγμής ενώ υπάρχουν πολλά είδη Cicadellidae και Aphrophoridae. Το είδος *Philaenus tessellatus* Melichar (Hemiptera: Aphrophoridae) είναι σε μεγάλη αφθονία στο Μαρόκο και θα μπορούσε να παίξει ρόλο ως δυνητικός φορέας σε περίπτωση που το βακτήριο εισαχθεί στη χώρα. Όσον αφορά τους δυνητικούς ξενιστές του X.f στο Μαρόκο θεωρούνται τα εσπεριδοειδή, η ελιά, η αμυγδαλιά, το αμπέλι, τα δασικά αγροοικοσυστήματα και η πικροδάφνη.

Hellenic Plant Protection Journal **17**: 1-30, 2024

Supplementary material

Table S1. List of worldwide, families, genera, occurrence, acquisition and transmission of *X.f.* disease transmitted and host plants, of confirmed vector, competent and potential vector of *X.f.* including America (AM), Europe (EU), Asia (AS), North Africa (NA) and Morocco (MO). Lab: Laboratory.

uk: Unknown; AD: Alfalfa dwarf; PD: Pierce's disease; PP: Phony peach; ALS: Almond Leaf Scorch; BLS: Bacterial leaf scorch; PPD: Phony peach disease; OLS, Oleander leaf scorch; CVC: Citrus variegated chlorosis; CLS: Coffee leaf scorch; PLS: Plum leaf scald; QQDS: Olive quick decline syndrome.

Family/genus/species		Occurrence				Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
		AM	EU	AS	NA	MO	Lab	field	Lab	field		
Cicadellidae	<i>Draeculacephala</i>	+	-	-	-	-	Yes	Yes	uk	uk	uk	Zhang <i>et al.</i> 2011
		+	-	-	-	-	no	yes	uk	uk	unknown	Mitchell <i>et al.</i> 2009; Overall & Rebek 2015
		+	-	-	-	-	yes	yes	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	-	uk	yes	Yes	uk	unknown	Redak <i>et al.</i> 2004
		+	-	-	-	-	uk	yes	yes	uk	unknown	Redak <i>et al.</i> 2004
		+	-	-	-	-	uk	yes	no	uk	unknown	Redak <i>et al.</i> 2004
		+	-	-	-	-	yes	yes	yes	yes	unknown	Redak <i>et al.</i> 2004; Overall & Rebek 2017; Cornara <i>et al.</i> 2019
		+	-	-	-	-	yes	yes	yes	yes	unknown	Redak <i>et al.</i> 2004; Daugherty <i>et al.</i> 2011; Overall & Rebek 2017; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004; Daugherty <i>et al.</i> 2011; Overall & Rebek 2017; Cornara <i>et al.</i> 2019
		+	-	-	-	-	uk	yes	uk	uk	unknown	Redak <i>et al.</i> 2004
		+	-	-	-	-	uk	yes	yes	yes	unknown	Redak <i>et al.</i> 2004
	<i>Graphocephala</i>	+	-	-	-	-	uk	uk	uk	uk	unknown	Redak <i>et al.</i> 2004; Overall & Rebek 2017; Cornara <i>et al.</i> 2019
		+	-	-	-	-	yes	yes	uk	uk	Blackberry, forsythia, cheese wood, cup plant, whole leaf rosinweed, rose, thistle, milkweed, goldenrod, and fragrant sumac	Zhang <i>et al.</i> 2011; Overall & Rebek 2015; Overall <i>et al.</i> 2017
		+	-	-	+	-	yes	yes	yes	yes	Ragweed, sunflower, okra, plum, and blackberry	Redak <i>et al.</i> 2004; Mitchell <i>et al.</i> 2009; Zhang <i>et al.</i> 2011; Cornara <i>et al.</i> 2019; Boulaouad <i>et al.</i> 2022
		+	-	-	-	-	uk	yes	uk	yes	Willow, poplar, broad-leaved milkweed, and great ragweed	Redak <i>et al.</i> 2004; Overall & Rebek 2015; Overall <i>et al.</i> 2017
		+	-	-	-	-	yes	yes	yes	uk	unknown	Redak <i>et al.</i> 2004
		+	+	-	-	-	uk	uk	uk	uk	woody plants: <i>Acer platanoides</i> , <i>Azalea spp.</i> , <i>Forsythia spp.</i> , <i>Hedera helix</i> , <i>Ilex aquifolium</i> , <i>Platanus sp.</i> , <i>Pyris japonica</i> , <i>Robina pseudoacacia</i> , <i>Rumex acetosa</i> , <i>Tilia spp.</i>	Olthoff, 1986; Sergel 1987; Tóth <i>et al.</i> 2017

Family/genus/species		Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References	
		AM	EU	AS	NA	MO	Lab	field	Lab	field				
<i>Pagaronia</i>	<i>P. confusa</i> Oman, 1938 <i>P. furcata</i> Oman, 1938 <i>P. tredecimpunctata</i> Ball, 1902 <i>P. triunata</i> Bal, 1902	+	-	-	-	-	yes	uk	yes	uk	PD	unknown	Redak <i>et al.</i> 2004; EFSA, 2019	
		+	-	-	-	-	uk	uk	uk	uk	PD	unknown	EFSA, 2019	
		+	-	-	-	-	uk	uk	uk	uk	PD/AD	unknown	Redak <i>et al.</i> 2004; EFSA, 2019	
		+	-	-	-	-	uk	uk	uk	uk	PD/AD	unknown	Redak <i>et al.</i> 2004; EFSA, 2019	
<i>Macugonalia</i>	<i>M. cavifrons</i> St al, 1862 <i>M. sobrina</i> Stål, 1862 <i>M. leucomelas</i> Walker, 1851 <i>P. corniculata</i> Young, 1977	+	-	-	-	-	yes	uk	yes	uk	PLS/CVC	<i>Citrus sinensis</i> (L.) Obs., <i>Citrus unshiu</i> Marc.	Dellape <i>et al.</i> 2013; 2016; Esteves <i>et al.</i> 2019; Müller <i>et al.</i> 2021	
		+	-	-	-	-	uk	uk	uk	uk	uk	uk	unknown	Dellape <i>et al.</i> 2016
		+	-	-	-	-	yes	yes	yes	yes	uk	CVC/PLS	unknown	Redak <i>et al.</i> 2004; Cornara <i>et al.</i> 2019; Esteves <i>et al.</i> 2019; Müller <i>et al.</i> 2021
		+	-	-	-	-	yes	yes	yes	yes	uk	CVC	unknown	Dellape <i>et al.</i> 2016; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004
<i>Plesiommata</i>	<i>P. mollicella</i> Fowler, 1900						uk	yes	yes	yes	CVC	<i>Zea mays</i> L. (Poaceae), <i>Triticum aestivum</i> L. (Poaceae), <i>Avena sativa</i> L. (Poaceae) <i>malezas asociadas</i> , <i>Sorghum vulgare</i> (Poaceae), <i>Oriza sativa</i> L. (Poaceae), <i>Brassica</i> sp. (Brassicaceae), <i>Lycopersicon</i> sp. (Solanaceae), <i>Solanum</i> sp. (Solanaceae), <i>Citrus sinensis</i> Osb. (Rutaceae) <i>malezas asociadas</i> , <i>C. reticulata</i> (Rutaceae), <i>Andropogon gayanus</i> Kunth (Poaceae), <i>Carica papaya</i> L. (Caricaceae), <i>Vaccinium corymbosum</i> L. (Ericaceae)	unknown	Dellape <i>et al.</i> 2016
							uk	yes	yes	yes	uk	CVC		
							uk	yes	yes	yes	uk	CVC		
							uk	yes	yes	yes	uk	CVC		
<i>Homalodisca</i>	<i>H. spottii</i> Takiya, Cavichioli & McKamey, 2006 <i>H. vitripennis</i> Germar, 1821	+	-	-	-	-	uk	yes	uk	yes	CVC	unknown	Ringenberg <i>et al.</i> 2014; Takiya <i>et al.</i> 2006	
		+	-	-	-	-	yes	yes	yes	yes	PD/PPD/ALS/OLS/BLS/CVC	Johnsongrass, sunflower, hollyhock, okra, lambsquarters, cotton, corn, cowpeas, oak, ash, silk tree, crapemyrtle, elderberry and peach	Redak <i>et al.</i> 2004; Overall & Rebek 2015; Overall <i>et al.</i> 2017; Daugherty <i>et al.</i> 2011; Krugner <i>et al.</i> 2012; Mitchell <i>et al.</i> 2009; Almeida <i>et al.</i> 2005; Sanderlin & Melanson 2010; Cornara <i>et al.</i> 2019	
		+	-	-	-	-	uk	yes	no	uk	PD/AD	unknown	Redak <i>et al.</i> 2004	
		+	-	-	-	-	yes	uk	yes	uk	uk	unknown	Daugherty <i>et al.</i> 2011	
<i>Acrogonia</i>	<i>H. liturata</i> Ball, 1901 <i>H. lacerta</i> Fowler, 1899 <i>H. ignorata</i> Melichar, 1924 <i>H. insolita</i> Walker, 1858 <i>A. virescens</i> Metcalf, 1949 <i>A. citrina</i> Marucci & Cavichioli, 2002	+	-	-	-	-	yes	yes	yes	yes	CVC/CLS	unknown	Redak <i>et al.</i> 2004; Marucci <i>et al.</i> 2008; Yamamoto <i>et al.</i> 2002	
		+	-	-	-	-	yes	yes	yes	yes	PD/PP/BLS	Texas millet, Johnsongrass and crabgrass; southern sandbur	Redak <i>et al.</i> 2004; Cornara <i>et al.</i> 2019; Overall & Rebek 2017; Sanderlin & Melanson 2010	
		+	-	-	-	-	yes	uk	yes	yes	CVC	unknown	Dellape <i>et al.</i> 2016 Redak <i>et al.</i> 2004	
		+	-	-	-	-	yes	uk	yes	yes	CVC	unknown	Redak <i>et al.</i> 2004; Cornara <i>et al.</i> 2019	

Family/genus/species	Occurrence				Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field		
<i>Tapajosa</i>	+	-	-	-	-	yes	yes	yes	uk	<i>Citrus sinensis</i> (L.) Obs. and <i>C. Unshiu</i> Marc.	Dellape <i>et al.</i> 2013, 2016
<i>Guerna</i>	+	+	-	-	-	uk	uk	uk	uk	unknown	Ringenberg <i>et al.</i> 2014
	+	-	-	-	-	yes	yes	yes	yes	Bermudagrass, crabgrass, Johnsongrass, Texas millet, cotton, cowpea, sunflower, ragweed, and young peach tree	Overall & Rebek 2015; Overall <i>et al.</i> 2017; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004; Sanderlin & Melanson 2010
<i>Oncometopia</i>	+	-	-	-	-	uk	yes	yes	uk	unknown	Redak <i>et al.</i> 2004.
	+	-	-	-	-	uk	yes	yes	uk	unknown	Redak <i>et al.</i> 2004
<i>Oncometopia</i>	+	-	-	-	-	yes	yes	yes	yes	Ash, honeysuckle, Chickasaw plum, redbud, silktree, blackberry, septic weed, Dahlia, Johnsongrass, greenbrier, hibiscus, pokeweed, sunflower, hollyhock, okra, lambsquarters, ragweed, and peach	Overall & Rebek 2015; Zhang <i>et al.</i> 2011; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004
	+	-	-	-	-	yes	yes	yes	yes	Crapemyrtle, Texas millet and Johnson grass	Overall & Rebek 2017; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004.
<i>Xyphon</i>	+	-	-	-	-	yes	uk	yes	uk	unknown	Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004; Marucci <i>et al.</i> 2003
	+	-	-	-	-	uk	yes	yes	yes	Bermudagrass; cotton, cucumber, alfalfa, beebalm, and prickly Russina thistle	Overall & Rebek 2015; Overall <i>et al.</i> 2017 Redak <i>et al.</i> 2004
<i>Tretogonia</i>	+	-	-	-	-	yes	yes	yes	yes	unknown	Redak <i>et al.</i> 2004; Cornara <i>et al.</i> 2019; Overall & Rebek 2017
	+	-	-	-	-	uk	yes	yes	uk	<i>Cynodon</i> sp., <i>Trichostema lanceolatum</i> , <i>Chrysanthamnus</i> sp.	Redak <i>et al.</i> 2004
<i>Agalliana</i>	+	-	-	-	-	uk	uk	uk	uk	unknown	Dmitriev, 2019
	+	-	-	-	-	uk	uk	uk	uk	<i>Citrus sinensis</i> (L.) Obs	Ringenberg <i>et al.</i> 2014
<i>Evacanthus</i>	-	+	-	-	-	uk	uk	uk	uk	Lamiaceae; <i>Urtica</i> sp.; <i>Rubus</i> sp.	Dellape <i>et al.</i> 2013, 2016
	-	+	-	-	-	uk	uk	uk	uk	Asteraceae, <i>Urtica</i> sp., <i>Epilobium</i> sp.; <i>Angelica archangelica</i> ; <i>Mentha aquatica</i>	Dellape <i>et al.</i> 2016
<i>Cicadella</i>	-	+	+	-	-	uk	uk	uk	uk	unknown	Dellape <i>et al.</i> 2016
	-	+	+	-	-	yes	uk	yes	uk	<i>Alnus</i> sp.; Asteraceae; <i>Carex</i> sp.; <i>Corylus avellana</i> ; <i>Crataegus</i> sp.; Ericaceae; Fabaceae; <i>Juncus</i> sp.; Pinus sp.; Poaceae; <i>Primula</i> sp.; <i>Prunus laurocerasus</i> ; <i>Quercus</i> sp.; Renonculaceae; <i>Rubus</i> sp.; <i>Silene</i> sp.; <i>Urtica</i> sp.	EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	<i>Carex</i> sp., <i>Carex lasiocarpa</i> , <i>Carex nigra</i> , <i>Carex vesicaria</i> and others	EFSA, 2013; Mozaffarian, 2018
	-	+	-	-	-	uk	uk	uk	uk		EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk		EFSA, 2013; Nickel & Remane 2002; Mozaffarian & Wilson 2016; Bodino <i>et al.</i> 2022
	-	+	-	-	-	uk	uk	uk	uk		EFSA, 2013, 2015; Nickel & Remane 2002; Malenovsky <i>et al.</i> 2013

Family/genus/species	Occurrence				Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field		
<i>Bucephalagonia</i>	+	-	-	-	-	yes	yes	yes	uk	<i>Citrus senensis</i> Osb (Rutaceae), <i>Vitis vinifera</i> L. <i>Prunus domestica</i> L. (Rosaceae), <i>Coffea</i> sp. (Rubiaceae), <i>Vernonia condensata</i> (Asteraceae), <i>Duranta repens</i> L. (Verbenaceae), <i>Brassicacnapus</i> L. var <i>oleifera</i> (Brassicaceae),	Marucci <i>et al.</i> 2003; Paris <i>et al.</i> 2012; Dellape <i>et al.</i> 2013; Redak <i>et al.</i> 2004; Esteves <i>et al.</i> 2019
<i>Ferraria</i>	+	-	-	-	-	uk	yes	uk	uk	<i>Citrus sinensis</i> (L.) Osb. (Rutaceae), <i>Prunus domestica</i> L.	Redak <i>et al.</i> 2004; Cornara <i>et al.</i> 2019
<i>Diedrocephala</i>	+	-	-	-	-	uk	no	yes	uk	<i>Citrus sinensis</i> (L.) Obs. <i>Citrus unshiu</i> Marc	Dellape <i>et al.</i> 2013, 2016
<i>Sonesimia</i>	+	-	-	-	-	yes	yes	uk	yes	<i>Citrus sinensis</i> (L.) Obs. <i>Citrus unshiu</i> Marc	Dellape <i>et al.</i> 2016; Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004
<i>Dilobopteris</i>	+	-	-	-	-	yes	uk	yes	uk	<i>Citrus sinensis</i> (Rutaceae), <i>Coffea arabica</i> L. (Rubiaceae), <i>Vernonia condensata</i> (Asteraceae), <i>Aloysiavirgata</i> (Verbenaceae), <i>Hibiscus rosa-sinensis</i> (Malvaceae)	Cornara <i>et al.</i> 2019; Redak <i>et al.</i> 2004; Marucci <i>et al.</i> 2008
<i>Balacha</i>	+	-	-	-	-	uk	uk	uk	uk	<i>Eryngium</i> L (Apiaceae)	Dellape <i>et al.</i> 2016
<i>Helochara</i>	+	-	-	-	-	yes	yes	yes	yes	unknown	Redak <i>et al.</i> 2004; Overall & Rebek. 2017
<i>Criminus</i>	+	-	-	-	-	uk	uk	uk	uk	<i>Avena sativa</i> L. (Poaceae)	Dellape <i>et al.</i> 2016
<i>Sibovia</i>	+	-	-	-	-	yes	uk	yes	uk	<i>Zea mays</i> L. (Poaceae), <i>Citrus sinensis</i> Osb. (Rutaceae), <i>Pelargonium hortum</i> L. (Geraniaceae), "malvón", <i>Phaseolus vulgaris</i> L. (Fabaceae), <i>Malva parviflora</i> L. (Malvaceae), <i>Vitis vinifera</i> L. (Vitaceae), <i>Mentha</i> sp. L. (Lamiaceae), <i>Citrus sinensis</i> (L.) Obs. <i>Citrus unshiu</i> Marc	Dellape <i>et al.</i> 2013, 2016; Esteves <i>et al.</i> 2019; Müller <i>et al.</i> 2021
<i>Hortensia</i>	+	-	-	-	-	yes	yes	yes	uk	<i>Sorghum halepense</i> L. (Poaceae), <i>Zea mays</i> L. (Poaceae), <i>Medicago sativa</i> L. (Poaceae), <i>Hordeum vulgare</i> L. (Poaceae), <i>Vigna unguiculata</i> L. (Fabaceae), <i>Panicum barbinum</i> Trin. (Poaceae), <i>Dolichos</i> sp. (Fabaceae), <i>Bidens</i> sp. (Asteraceae), <i>Fragaria</i> sp. (Rosaceae), <i>Crotalaria</i> sp. (Fabaceae), <i>Phaseolus vulgaris</i> L. (Fabaceae), <i>Cynodon</i> sp. (Poaceae), <i>Paspalum</i> sp. (Poaceae), <i>Pennisetum</i> sp. (Arecaceae), <i>Lactuca</i> sp. (Asteraceae), <i>Brassica</i> sp. (Brassicaceae), <i>Carica</i> sp. (Caricaceae), <i>Ipomeas</i> sp. (Convolvulaceae), <i>Sida</i> sp. (Malvaceae), <i>Hibiscus</i> sp. (Malvaceae), <i>Digitaria</i> sp. (Poaceae), <i>Panicum</i> sp. (Poaceae), <i>Cynodon</i> sp. (Poaceae), <i>Eriochloa</i> sp. (Poaceae), <i>Cenchrus</i> sp. (Poaceae), <i>Coffea</i> sp. (Rubiaceae), <i>Lycopersicon</i> sp. (Solanaceae), <i>Capsicum</i> sp.	Dellape <i>et al.</i> 2013, 2016; Ringenberg <i>et al.</i> 2014; Hickel <i>et al.</i> 2001; Paris <i>et al.</i> 2012

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
<i>Syncharina</i>	+	-	-	-	-	uk	uk	Uk	uk	uk	<i>Oryza sativa</i> L. (Poaceae), <i>Sorghum halepense</i> L. (Poaceae), <i>Zea mays</i> L. (Poaceae), <i>Citrus sinensis</i> Osb. (Rutaceae), <i>Hordeum vulgare</i> L. (Poaceae), <i>Medicago sativa</i> L. (Poaceae), <i>Gossypium hirsutum</i> L. (Malvaceae), <i>Cynodon sp.</i> (Poaceae), <i>Triticum aestivum</i> L. (Poaceae), <i>Fragaria sp.</i> (Rosaceae), unknown	Dellape <i>et al.</i> 2016
<i>Kolla</i>	-	-	+	-	-	yes	yes	yes	uk	CVC/PD	unknown	Tuan <i>et al.</i> 2016
<i>Bothrogonia</i>	-	-	+	-	-	yes	yes	yes	uk	CVC/PD	unknown	Tuan <i>et al.</i> 2016
<i>Anatkina</i>	-	-	+	-	-	uk	yes	uk	uk	uk	unknown	Tuan <i>et al.</i> 2016
<i>Dechacona</i>	+	-	-	-	-	yes	yes	yes	yes	CVC/CLS	<i>Citrus sinensis</i> (L.) Osb., <i>Citrus unshiu</i> Marc	Marucci <i>et al.</i> 2008; Redak <i>et al.</i> 2004; Dellape <i>et al.</i> 2013, 2016; Cornara <i>et al.</i> 2019; Esteves <i>et al.</i> 2019 Redak <i>et al.</i> 2004
<i>Parathona</i>	+	-	-	-	-	uk	uk	uk	uk	CVC	unknown	Redak <i>et al.</i> 2004
<i>Friscanus</i>	+	-	-	-	-	uk	yes	yes	uk	PD/AD	unknown	Redak <i>et al.</i> 2004
<i>Molomea</i>	+	-	-	-	-	yes	yes	yes	uk	CVC	<i>Citrus sinensis</i> (L.) Osb., <i>Citrus unshiu</i> Marc.	Dellape <i>et al.</i> 2013
<i>Paraulacizes</i>	+	-	-	-	-	uk	uk	uk	uk	CVC	<i>Citrus sinensis</i> ; <i>Prunus salicina</i> ; <i>Zea mays</i>	Logarzo <i>et al.</i> 2012; Schneider <i>et al.</i> 2017; Dmitriev, 2019; EFSA, 2019
<i>Curtara</i>	+	-	-	-	-	yes	yes	yes	uk	uk	Virginia wildrye, tall thistle, horseweed, thistle, prickly lettuce, wholeleaf rosinweed, and cultivated sorghum	Zhang <i>et al.</i> 2011; Overall & Rebek 2015; Overall <i>et al.</i> 2017
<i>Neokolla</i>	+	-	-	-	-	uk	uk	uk	yes	CVC	<i>Citrus sinensis</i> (L.) Osb., <i>Citrus unshiu</i> Marc	DeCool <i>et al.</i> 2000; Dellape <i>et al.</i> 2013, 2016; Ringenberg <i>et al.</i> 2014 Overall & Rebek 2017.
<i>Scopogonalia</i>	+	-	-	-	-	uk	yes	no	uk	PD	unknown	Redak <i>et al.</i> 2004; EFSA, 2018
<i>Erithomenus</i>	+	-	-	-	-	yes	uk	yes	uk	PD	Willow, poplar and alfalfa	EFSA, 2018
<i>Fingeriana</i>	+	+	-	-	-	uk	yes	uk	uk	uk	<i>Citrus sinensis</i> (L.) Osb. (Rutaceae)	De Coll <i>et al.</i> 2000; Redak <i>et al.</i> 2004
<i>Oragua</i>	+	-	-	-	-	yes	uk	yes	uk	CVC	unknown	Nickel & Remane 2002
<i>Clasteroptera</i>	-	+	-	-	-	yes	yes	yes	uk	CVC	Caipira sweet orange	EFSA, 2018; Yamamoto <i>et al.</i> 2007
<i>Clastopteridae</i>	+	+	-	-	-	yes	yes	yes	uk	CVC	unknown	EFSA, 2018; Lopes & Krugner 2016
	+	+	-	-	-	yes	yes	yes	uk	PD	unknown	Redak <i>et al.</i> 2004; Severin, 1950; EFSA, 2013
	+	+	-	-	-	uk	yes	uk	uk	uk	<i>Corynephorus canescens</i>	Nickel & Remane 2002; Mitchell <i>et al.</i> 2009; EFSA, 2013

Family/genus/species		Occurrence				Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References		
		AM	EU	AS	NA	MO	Lab	field	Lab	field				
Aphrophoridae	<i>C. xanthocephala</i> Germar, 1839 <i>C. achatina</i> Germar, 1839 <i>C. obtusa</i> Say, 1825 <i>C. lineatocolis</i> Stål, 1854	+	+	-	-	-	uk	yes	uk	uk	uk	unknown	Mitchell <i>et al.</i> 2009; EFSA, 2013	
		+	+	-	-	-	yes	uk	yes	uk	BLS	<i>Stipa</i> sp.	Iodos & Kalkandelen 1983; Biedermann 2003; Sanderlin & Melanson 2010	
		+	+	+	+	-	uk	yes	uk	uk	uk	mostly on meadow and Graminae weeds; <i>Nardus stricta</i> , <i>Phragmites</i> , <i>Thuja</i> sp.; <i>Trifolium</i> spp., <i>T. armenicum</i> unknown	Nickel & Remane 2002; Zhang <i>et al.</i> 2011; Mozaffarian & Wilson 2015	
		+	+	-	-	-	uk	no	uk	uk	uk	unknown	Mitchell <i>et al.</i> 2009; EFSA, 2013	
	<i>A. permutata</i> Uhler, 1876 <i>A. angulata</i> Ball, 1899 <i>A. quadrinotata</i> Say, 1831 <i>A. cribrata</i> Walker, 1851 <i>A. alni</i> Fallen, 1805 <i>A. salicina</i> Goeze, 1778 <i>A. corticea</i> Germar, 1821 <i>A. major</i> Uhler, 1896 <i>A. pectoralis</i> Matsumura, 1903 <i>A. costalis</i> Matsumura, 1903 <i>A. similis</i> Lethierry, 1888 <i>A. willemsi</i> Lallemand, 1946	<i>Aphrophora</i>	+	-	-	-	-	uk	yes	no	uk	PD/AD	unknown	Redak <i>et al.</i> 2004;
			+	-	-	-	-	uk	yes	no	uk	PD	unknown	Beal <i>et al.</i> 2021
			+	-	-	-	-	uk	yes	uk	uk	uk	unknown	Redak <i>et al.</i> 2004
			+	-	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
			-	+	+	+	-	uk	uk	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
			-	+	+	+	-	uk	uk	uk	uk	uk	<i>Alnus</i> spp., <i>Amygdalus communis</i> , <i>Betula pendula</i> , <i>Castanea sativa</i> , <i>Cornus mas</i> , <i>Corylus avellana</i> , <i>Cynodon vulgaris</i> , <i>Elaeagnus</i> spp., <i>Fagus sylvatica</i> , <i>Juglans</i> sp., <i>Mespilus germanica</i> , <i>Myrica gale</i> , <i>Oryza sativa</i> , <i>Populus</i> spp., <i>Prunus domestica</i> , <i>P. avium</i> , <i>P. cerasus</i> , <i>Quercus</i> spp., <i>Rubus fruticosus</i> , <i>Rosa</i> sp., <i>Salix</i> sp., <i>Ulmus</i> sp., <i>Urtica</i> sp., <i>Verbascum</i> spp., <i>Vitis vinifera</i> <i>Betula pendula</i> , <i>Robinia pseudoacacia</i> , <i>Rubus fruticosus</i> , <i>Salix</i> spp., sugar beet	Nickel & Remane 2002; EFSA, 2015; Mozaffarian & Wilson 2015; Antonatos <i>et al.</i> 2019
			-	+	+	-	-	uk	uk	uk	uk	uk	Conifers : <i>Arctostaphylos uva-ursi</i> , <i>Cupressus</i> sp., <i>Pinus sylvestris</i> , <i>Pyrus communis</i> , <i>Quercus</i> sp., <i>Verbascum</i> sp.	Antonatos <i>et al.</i> 2019; EFSA, 2015; Nickel & Remane 2002
			-	+	-	-	-	uk	uk	uk	uk	uk	<i>Salix</i> spp., <i>Betula pendula</i>	Antonatos <i>et al.</i> 2019; EFSA, 2013; Nickel & Remane 2002
			-	+	-	-	-	uk	uk	uk	uk	uk	<i>Salix caprea</i> , <i>Salix purpurea</i> and mas Univoltine	Antonatos <i>et al.</i> 2019; EFSA, 2013; Nickel & Remane 2002
			-	+	-	-	-	uk	uk	uk	uk	uk	<i>Salix</i> spp.	EFSA, 2015
			-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
			-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
<i>Philaenus</i>	+	-	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
	-	+	-	+	+	uk	uk	uk	uk	uk	unknown	Remane & Drosopoulos 2001; Drosopoulos <i>et al.</i> 2010
	-	+	-	-	-	uk	uk	uk	uk	uk	wildshrubs and trees; particularly on <i>Quercus</i> spp.	Drosopoulos & Remane 2000
	-	+	-	+	+	uk	uk	uk	uk	uk	unknown	Drosopoulos & Remane 2000; Drosopoulos <i>et al.</i> 2010
	-	+	-	+	+	uk	uk	uk	uk	uk	lily <i>Asphodelus microcarpus</i> and later on shrubs and trees like <i>Quercus</i> and <i>Castanea sativa</i>	Drosopoulos & Remane 2000; EFSA, 2015
	-	+	-	-	-	uk	yes	yes	uk	uk	<i>Asphodelus</i> spp.	Cavalleri <i>et al.</i> 2019; EFSA, 2013 ; Bodino <i>et al.</i> 2020
	+	-	-	-	-	uk	yes	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
	+	+	+	+	+	yes	yes	yes	yes	OQDS/ALS/AD	Mainly dicotyledonous herbs, broadleaves	Schedl, 1988; Redak <i>et al.</i> 2004; Zhang <i>et al.</i> 2011; Cavalleri <i>et al.</i> 2019; Rodrigues <i>et al.</i> 2014; Ben Moussa <i>et al.</i> 2016 ; Bodino <i>et al.</i> 2020
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	+	+	+	yes	yes	yes	uk	uk	Conifers, Graminae, <i>Abies</i> sp., <i>Corylus avelutana</i> , <i>Juncus</i> sp., <i>Medicago sativa</i> , <i>Pinus</i> sp., <i>Pyrus communis</i> , <i>Quercus</i> sp., <i>Rhododendron</i> sp., <i>Ulmus</i> sp., <i>Triticum</i> sp., Zeamays	Lodos & Kalkandelen 1983; Elbeaino <i>et al.</i> 2014; Nickel & Remane 2002; Mozaffarian & Wilson 2015; Ben Moussa <i>et al.</i> 2016; Cavalleri <i>et al.</i> 2019 ; Bodino <i>et al.</i> 2020
<i>Neophilaenus</i>	-	+	+	+	+	uk	uk	uk	uk	uk	mostly on meadow and Graminaeweeds; <i>Nardus stricta</i> , <i>Phragmites</i> , <i>Thuja</i> sp.; <i>Trifolium</i> spp., <i>T. arvense</i>	Mozaffarian & Wilson 2015; Nickel & Remane 2002
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Festuca ovina</i> , <i>Deschampsia flexuosa</i>	Nickel & Remane 2002; EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Festuca ovina</i> sp.	Nickel & Remane 2002; EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Brachypodium pinnatum</i>	Nickel & Remane 2002; EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	Nickel & Remane 2002; EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	Nickel & Remane 2002; EFSA, 2013
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2013

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
	<i>N. minor</i> Kirschbaum, 1868 <i>N. pallidus</i> Haupt, 1917 <i>N. modestus</i> Haupt, 1922 <i>L. quadrangularis</i> Sey, 1825 <i>L. coleoprata</i> Linnaeus, 1758	-	+	-	-	uk	uk	uk	uk	uk	<i>Festuca ovina</i> , <i>Corynephorus canescens</i>	EFSA, 2013; Nickel & Remane, 2002 EFSA, 2013 EFSA, 2015
		-	+	-	-	uk	yes	uk	uk	uk	unknown	
		-	+	-	-	uk	uk	uk	uk	uk	unknown	
		+	-	-	-	uk	uk	uk	uk	BLS	unknown	Redak <i>et al.</i> 2004; Sanderlin & Melanson 2010; Overall & Rebek, 2017
		-	+	+	+	uk	uk	uk	uk	uk	<i>Poa annua</i> , <i>Trifolium repens</i> ; mainly Poaceae, dicotyledonous herbs	Nickel & Remane 2002; Mozaffarian & Wilson 2015; Antonatos <i>et al.</i> 2019; Theodorou <i>et al.</i> 2021
		+	-	-	-	uk	uk	uk	uk	uk	<i>Citrus sinensis</i> (L.) Obs. <i>Citrus unshiu</i> Marc	Dellap <i>et al.</i> 2013
	<i>Cephus</i>	-	+	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	<i>Mesoptylus</i>	-	+	-	-	uk	uk	uk	uk	uk	unknown	
	<i>Poophilus</i>	-	-	+	-	uk	yes	uk	uk	PD	unknown	Tuan <i>et al.</i> 2016; Mozaffarian, 2018
	<i>Peuceptylus</i>	-	+	-	-	uk	uk	uk	uk	uk	unknown	Holzinger <i>et al.</i> 2003
	<i>Paraphilaenus</i>	-	+	-	-	uk	uk	uk	uk	uk	<i>Stripa</i> sp.	Lodos & Kalkandelen 1983; Biedermann, 2003
	<i>Cyphonia</i>	+	-	-	-	yes	yes	yes	uk	CVC	unknown	Dellape <i>et al.</i> 2016
Membracidae	<i>Entylla</i>	+	-	-	-	uk	yes	uk	uk	CVC	unknown	De Coll <i>et al.</i> 2000; Zhang <i>et al.</i> 2011; Dellape <i>et al.</i> 2016
	<i>Ceresa</i>	+	-	-	-	uk	uk	uk	uk	uk	unknown	Dellape <i>et al.</i> 2013
	<i>Cyrtolobus</i>	+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	yes	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	yes	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011
		+	-	-	-	uk	no	uk	uk	uk	unknown	Zhang <i>et al.</i> 2011

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
<i>Cicadatra</i>	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Cyperus</i> spp., <i>Eucalyptus globulus</i> , <i>Olea europaea</i> , <i>Pinus pinaster</i> , <i>P. pinea</i> , <i>P. alpinensis</i> , <i>Quercus</i> spp., <i>Vitis vinifera</i>	EFSA, 2015
	-	+	-	-	-	uk	yes	uk	no	uk		Nickel & Remane 2002; Antonatos et al. 2019; Cornara et al. 2019, 2020
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Vitis</i> spp.	Mozaffarian & Sanborn 2010; Mehdi pour et al. 2016
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Malus domestica</i>	Dardar & Belal 2013; Dardare et al. 2013; De Jong et al. 2014
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Olea europaea</i> , <i>Pinus pinaster</i> , <i>Zea mays</i> , <i>Vitis vinifera</i>	Sueur et al. 2004
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	De Jong et al. 2014
<i>Aestuansella</i>	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	De Jong et al. 2014
<i>Cicadetta</i>	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	De Jong et al. 2014
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	Grasses	Gogala & Drosopoulos 2006
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Crataegus</i> sp., <i>Betula pendula</i> , <i>Pinus</i> sp.	Meineke, 2012; Tsagkarakis et al. 2018
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
<i>C. podolica</i> Eichwald, 1830	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. sibillae</i> Hertach & Trilar, 2015	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	Puisant & Gurcel 2018
<i>C. undulata</i> Waltl, 1837	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	
<i>C. caucasica</i> Kolenati, 1857	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. concinna</i> Germer, 1976	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. fangoana</i> Boulard, 1976	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. hageni</i> Fieber, 1872	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. lobulata</i> Fieber, 1876	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>C. tibialis</i> Panzer, 1798	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Pinus spp.</i>	Mol, 2017
<i>D. dimissa</i> Hagen, 1856	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Quercus pubescens, Platanus orientalis</i>	Puisant & Sueur 2011
<i>H. varipes</i> Waltl, 1837	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>T. argentata</i> Olivier, 1790	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Cistus ladanifer, Eucalyptus globulus, Olea europea, Pinus sp., Quercus sp.</i>	Sueur et al. 2004
<i>T. baenai</i> Boulard, 2000	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>T. brullei</i> Fieber, 1876	-	+	-	-	-	uk	uk	uk	uk	uk	unknown	EFSA, 2015
<i>T. dimissa</i> Hagen, 1856	-	+	-	-	-	uk	uk	uk	uk	uk	<i>Rubus ulmifolius, Pistacia terebinth</i>	Schedl, 1988
<i>T. leunani</i> Boulard, 2000	-	+	-	-	-	uk	uk	uk	uk	uk		EFSA, 2015
<i>T. manueli</i> Boulard, 2000	-	+	-	-	-	uk	uk	uk	uk	uk		EFSA, 2015
<i>T. pygmaea</i> Olivier, 1790	-	+	-	-	-	uk	uk	uk	uk	uk		EFSA, 2015
<i>T. anedbi</i> Boulard, 2000	-	+	-	-	-	uk	uk	uk	uk	uk		EFSA, 2015

Family/genus/species	Occurrence					Capacity of acquisition		Capacity of transmission		Disease (s) transmitted	Host plants	References
	AM	EU	AS	NA	MO	Lab	field	Lab	field			
Cercopidae											<i>Cistus</i> spp., <i>Juncus maritimus</i> , <i>Foeniculum vulgare</i> <i>Pinus alepensis</i> , <i>Quercus ilex</i>	Sueur & Aubin 2004; Sueur <i>et al.</i> 2004 EFSA, 2015 Sueur <i>et al.</i> 2004
Cercopidae											<i>Pinus</i> spp., <i>Quercus</i> spp., grasslands <i>Acacia</i> sp., <i>Alnus</i> sp., <i>Astragalus</i> sp., <i>Medicago sativa</i> , <i>Onopordon</i> sp., <i>Pistaciavera</i> , <i>Prunus domestica</i> , <i>Salix</i> sp., <i>Verbascum</i> sp. Unknown weeds; <i>Castanea vesca</i> , <i>Malus domestica</i> , <i>Medicago sativa</i> , <i>Pyrus communis</i> <i>Aegopodium</i> sp., <i>Alnus</i> sp., <i>Arrhenatherum</i> sp., <i>Chrysanthemum</i> sp., <i>Crataegus</i> sp., <i>Filipendula</i> sp., <i>Linum usitatissimum</i> , <i>Lupinus</i> sp., <i>Malus</i> sp., <i>Populus nigra</i> , <i>Prunus</i> sp., <i>Rubus</i> sp., <i>Solidago</i> sp., <i>Ulmus</i> sp., <i>Urtica</i> sp., <i>Lupinus</i> sp., <i>Vitis vinifera</i> <i>Abies</i> sp., <i>Cedrus</i> sp., <i>Crataegus</i> sp., <i>Cupressus</i> sp., <i>Juniperus</i> sp., <i>Linum usitatissimum</i> , <i>Picea</i> sp., <i>Pinus sylvestris</i> , <i>Populus</i> sp., <i>Prunus</i> sp., <i>Pseudotsuga</i> sp., <i>Quercus</i> sp., <i>Rosa</i> sp.	Holzinger <i>et al.</i> 2003 Holzinger <i>et al.</i> 2003 EFSA, 2015 Lodos & Kalkandelen 1983; Theodorou <i>et al.</i> 2021 Lodos & Kalkandelen 1983; Holzinger <i>et al.</i> 2003; Mazzoni, 2005; Holzinger, 2008 Lodos & Kalkandelen 1983; Nickel & Remane 2002; Paris <i>et al.</i> 2012 Ringenberg <i>et al.</i> 2014 EFSA, 2015

Table S2. Worldwide tritrophic interaction subspecies of *X. f*-host plant-insect vector.

Subspecies of <i>X. f</i>	Diseases	Insect vectors	References
<i>X. f multiplex</i>	PLS	<i>M. cavifrons</i> <i>M. leucomelas</i> <i>S. sagata</i>	Müller <i>et al.</i> 2021
<i>X. f pauca</i>	OQDS	<i>P. spumarius</i>	Saponari <i>et al.</i> 2014
<i>X. f pauca</i>		<i>P. italosignus</i> , <i>N. campestris</i>	Cavalieri <i>et al.</i> 2019
<i>X. f pauca</i> ST13	CVC	<i>B. xanthophis</i> <i>M. leucomelas</i>	Esteves <i>et al.</i> 2019
<i>X. f pauca</i> ST53	OQDS	<i>P. spumarius</i>	Cavalieri <i>et al.</i> 2019; Catalano <i>et al.</i> 2022
<i>X. f fastidiosa</i>	CVC	<i>O. nigricans</i> <i>H. vitripennis</i>	Hopkins and Purcell 2002
<i>X. f fastidiosa</i>	PD	<i>H. vitripennis</i>	Kyrkou <i>et al.</i> 2018; Burbank <i>et al.</i> 2020
<i>X. f</i> ST1	PD	<i>P. spumarius</i>	Moralejo <i>et al.</i> 2019
<i>X. f fastidiosa</i>	PD	<i>K. paulula</i> <i>B. ferruginea</i>	Lin and Chang 2012; Tuan <i>et al.</i> 2016