This text is an integral part of the *EPPO Study on bark and ambrosia beetles associated with imported non-coniferous wood* and should be read in conjunction with the study

Pest information sheet
Ambrosia beetle

XYLOSANDRUS CRASSIUSCULUS (COLEOPTERA: SCOLYTINAE)

'Asian' ambrosia beetle, granulate ambrosia beetle

EPPO lists: Xylosandrus crassiusculus was added to the EPPO Alert List in 2009, updated since (EPPO, 2018a). It is currently not regulated by EPPO countries (EPPO Global Database; EPPO, 2018b). The assessment of potential risks in this information sheet is not based on a full PRA for the EPPO region, but on an assessment of the information for that species used to prepare the information sheet. PRAs prepared for Slovenia (Slovenian Forestry Institute, 2017) and for UK (Defra, 2015) were reviewed.

PEST OVERVIEW

Taxonomy

Xylosandrus crassiusculus (Motschulsky 1866). Synonyms: *Phloeotrogus crassiusculus* Motschulsky 1866; *Xyleborus semiopacus* Eichhoff 1878; *Xyleborus semigranosus* Blandford 1896; *Dryocoetes bengalensis* Stebbing 1908; *Xyleborus mascarenus* Hagedorn 1908; *Xyleborus ebriosus* Niisima 1909; *Xyleborus okoumeensis* Schedl 1935; *Xyleborus declivigranulatus* Schedl 1936.

Associated fungi

Mycangial symbiont *Ambrosiella roeperi* (Harrington *et al.*, 2014); no mention of its pathogenicity was found. Other fungi were isolated from galleries: *Aspergillus niger*, *Candida*, *Fusarium lateritium*, *F. oxysporum*, *F. solani*, *Nectria cinnabarina*, *Penicillium* spp., *Pestalotia* spp., *Phomopsis* spp., *Pichia* spp. and *Saccharomycopsis* spp.; particularly species in the genera *Ophiostoma*, *Fusarium*, and *Phomopsis* can be plant pathogenic (Ranger *et al.*, 2016, citing others). In Italy, some potentially pathogenic fungi of *Ceratonia siliqua* such as *Fusarium solani*, *Botryosphaeria obtusa* and *Phomopsis theicola* were isolated in association with necrosis close to holes made by *X. crassiusculus* (Francardi *et al.*, 2017).

Morphology and biology

Adults measure 1.5-3 mm and are dark reddish brown in colour. Populations essentially contain females (1:10 male-female ratio). *X. crassiusculus* is haplodiploid (males derive from unfertilized eggs), and presents high levels of inbreeding among siblings within the gallery system (Ranger *et al.*, 2016 citing others). Emerging females leave infested plants and disperse to colonize hosts. They bore a tunnel with a brood chamber and one or more branches into the sapwood of their host (and sometimes the heartwood). Larvae hatch and feed on the symbiotic fungus growing inside the galleries. In the tropics, breeding is continuous throughout the year with overlapping generations (up to four generations per year in Taiwan (Oliver and Mannion, 2001 citing others). In South-Eastern USA, beetles are active from March to the autumn, and the life cycle takes about 55 days, with usually two generations per year (EPPO, 2018a).

Adults bore into twigs, branches or small trunks of woody host plants and introduce the symbiotic ambrosia fungus on which adults and larvae feed. Ranger *et al.* (2016, citing others) note that *X. crassiusculus* prefers stems and trunks to branches, and that although it has a preference for stems below 7.5 cm diameter, it is not strongly size-selective and also attacks recently cut stumps and logs stored in mill yards. In Japan, *X. crassiusculus* was found in logs (12-20 cm diameter) of *Pasania edulis* (Sone *et al.*, 1998). On grapevine, *X. crassiusculus* attacked mostly the main trunk (Reddy and Verghese, 2006). Browne (1963) noted that seedlings or saplings of less than 1 cm diameter are not attacked. Attacks on live trees usually occur at the base of the plant in young trees or at the sites of lesions or bark wounds on older trees (Pennacchio *et al.*, 2003 citing others). Smith and Hulcr (2015) note that *X. crassiusculus* has the ability to thrive on relatively dry lumber and is able to produce very abundant offspring within a single year if given sufficient supply of wood.

X. crassiusculus is apparently able to attack healthy plants (EPPO, 2018a). However, stress conditions due to water damage, improper planting, drought stress, low temperature, and diseases are considered to play an important role in the selection behaviour of *X. crassiusculus* (Landi *et al.*, 2017 citing Gorzlancyk *et al.* 2013).

Ranger *et al.* (2016, citing others) note that plants that are ‘apparently healthy’ are likely to be experiencing or have a history of physiologically stress at the time of attack. In addition to water-related stress (flooding, inadequate drainage), field observations from ornamental plant nurseries suggest that frost injury or low temperature stress may predispose intolerant trees to attack. *X. crassiusculus* is known to attack healthy newly transplanted trees, especially in nurseries (Lightle *et al.*, 2007, citing Solomon 1995).

Spread biology
Adult males do not fly. Adult females can fly but there is no data on their flight capacity. Ranger *et al.* (2016) mention that *X. crassiusculus* generally flies low to the ground, with traps below 3 m found more effective (citing others). Grégoire *et al.*, (2001) suggested that the closely related species *X. germanus* has sufficient mobility to cover 2 km. Based on data on the flight capability of similar species, the Slovenian PRA concluded that *X. crassiusculus* can fly several 100 metres or several kilometres (citing Grégoire *et al.* 2001, Putz 2014), and when assisted by wind, may passively travel over greater distances.

Nature of the damage
Infested plants show progressive wilting, branch dieback, shoot breakage and general decline. Newly planted seedlings are often attacked at the root collar and the resulting girdling can stunt or kill the young tree (EPPO, 2018a). Damage on grapevine in India seems to relate to established vineyards, but the original reference was not found (cited in Reddy and Verghese, 2006). Infested wood presents galleries and discolouration due to the associated fungus, thus reducing wood quality for timber use. *Xylosandrus* spp. generally do not cause rapid mortality of trees, except for small diameter hosts in case of mass attacks; for large trees, a progressive wilting of the foliage is observed (Nageleisen *et al.*, 2015), as well as dieback (Francardi *et al.*, 2017). Cases of mortality due to *X. crassiusculus* as reported in the literature are mentioned under *Known impact*.

Detection and identification
- *Symptoms*. Symptoms include wilting and decline of trees, powdery frass coming out of entry holes in the form of toothpick-like structures or piling up in small amounts on the ground (base of the host). Abundant gummosis is produced on the bark of some species (*Prunus* spp., carob trees).
- *Trapping. X. crassiusculus* are attracted to ethanol (Reding *et al.*, 2011). Conophthorin enhances the attractant effect of ethanol on *X. crassiusculus*, and verbenone is a deterrent (Van der Laan and Ginzel, 2013).
- *Identification.* Keys for the identification of females of *Xylosandrus* species in Europe are provided in Pennacchio *et al.* (2003), Nageleisen *et al.* (2015), Gallego *et al.* (2017), Francardi *et al.* (2017). Molecular identification methods are available (Landi *et al.*, 2017).

Distribution (see Table 1)
X. crassiusculus is considered to originate from Asia, and to have been introduced into Africa hundreds of years ago. More recently, it has been introduced into the Americas (detected in the USA in the 1970s; in Costa Rica and Panama in the 1990s, in several South American countries after 2000) (EPPO, 2018a). It is also present in Oceania.

In Asia, it is found in India, South-East Asia, China and north to Korea and Japan and also at relatively high elevations in the Himalayas in Bhutan and Tibet (Fletchmann and Atkinson, 2016, citing others). In the USA, the dry climate of southern Texas and northeastern Mexico and associated scrub and grassland communities appear to form a natural barrier to the unaided dispersal (Fletchmann and Atkinson, 2016). In South America, Landi *et al.* (2017) suggest that the expansion of *X. crassiusculus* continues, with recent findings in Argentina and Uruguay.

In the EPPO region, *X. crassiusculus* has been found to date in five countries:
- In Italy, *X. crassiusculus* was first found in 2003 in Tuscany (near Pisa) in a mixed forest dominated by *Pinus pinaster* and *Quercus cerris.* Following further trapping, it was considered established. In 2007, infested *Ceratonia siliqua* (carob) were found in gardens in Liguria. In Veneto, few specimens of *X. crassiusculus* were trapped at the Marghera harbour near Venezia in 2010 (EPPO, 2017, 2018a), and many specimens were also found in the municipality of Selva del Montenello (Faccoli *et al.*, 2011). In 2016, severe attacks were also recorded on *Ceratonia siliqua* in the National Park of Circeo, Lazio (Francardi *et al.*, 2017). *X. crassiusculus* has also been found in Friuli Venezia Giulia (Gallego *et al.*, 2017, citing pers. obs.). In spring 2018, large infestations of *X. crassiusculus* together with *X. germanus* were recorded in

many chestnut plantations of Piemonte (Cuneo province) (M. Faccoli, pers. obs., 2018-03). This is the first record of *X. crassiusculus* on chestnut in Europe and the first record for Piemonte.

- In France, *X. crassiusculus* was found in 2014 infesting carob trees (*Ceratonia siliqua*) in a stand growing in an urban area of Nice, Southeastern France. It has been observed several times on the French Riviera (L-M Nageleisen and T. Noblecourt, pers. comm. 2018-05).
- In Spain, *X. crassiusculus* was first found in October 2016 on four dead carob trees (*Ceratonia siliqua*) in an abandoned mountain orchard used as green space, near Benifalló (Valencia) and two neighbour live carob trees were infested (Gallego *et al.*, 2017).
- In Slovenia *X. crassiusculus* was detected for the first time close to the Italian border in August 2017 (121 specimens in a single trap at the edge of a deciduous forest and near a vineyard). No infested plants or signs of *X. crassiusculus* have been observed (EPPO RS, 2018).
- In the Netherlands, four specimens of *X. crassiusculus* were trapped in June-August 2017 in 3 locations where commodities with wood packaging material are imported from various sources (NPPO of the Netherlands, 2018).

Host plants (Table 2)

X. crassiusculus is a highly polyphagous pest on many deciduous tree and shrub species. Over 120 hosts have been reported in the literature (Atkinson *et al.*, 2014). Host genera as per Atkinson (2018) are given in Table 2. In tropical areas, it has been reported on economically important crops (e.g. *Camellia sinensis, Carica papaya, Cocos nucifera, Coffea arabica, Mangifera indica, Theobroma cacao*) or forest tree species (e.g. *Aucoumea klaineana, Tectona grandis*). In more temperate areas, it has been reported on many fruit and nut crops (e.g. *Carya illinoinensis* (pecan), *Ceratonia siliqua* (carob), *Diospyros kaki, Ficus carica* (fig), *Malus domestica* (apple), *Prunus avium* (cherry), *P. domestica* (plum), *P. persica* (peach), as well as on many forest and ornamental woody species (e.g. *Acacia, Alnus, Azalea, Cornus, Eucalyptus, Hibiscus, Koelreuteria, Lagerstroemia, Liquidambar, Magnolia, Prunus, Quercus, Populus, Salix, Ulmus*) (EPPO, 2018a). A few records mention conifers: *Juniperus* spp. (Horn and Horn 2006); *Pinus* (Slovenian Forestry Institute, 2017 citing Wood, 1982).

To date, in France, Italy and Spain, it has been found on *Ceratonia siliqua* (carob tree), in France also on *Cercis siliquastrum* (Judas tree) and, in a trial, was able to attack logs of chestnut (*Castanea sativa*), oleaster (*Olea oleaster*), European hop-hornbeam (*Ostrya carpinifolia*), and green oak (*Quercus ilex*) (the conditions of the trial did not allow it to be shown whether the pest reproduced) (DSF, 2018); in Italy *X. crassiusculus* was first recorded on sweet chestnut (*Castanea sativa*) in 2018 (M. Faccoli, pers. obs.). In Italy and Slovenia, it has also been trapped in a forested area (Pennacchio *et al.*, 2003, EPPO RS, 2018), where it may have other yet undetermined hosts. The pest was not observed on hosts in Slovenia (only trapped in a forested area).

Known impacts and control in current distribution

In the EPPO region, *X. crassiusculus* has been found in natural areas and on few ornamental species that have a limited use in the region, as well as on *Castanea sativa*. Some damage has recently started to be reported. In Italy in 2016, severe attacks on *Ceratonia siliqua* were recorded in the Circeo National Park in association with *X. compactus* (Francardi *et al.*, 2017). In spring 2018, large infestations in Piemonte (together with *X. germanus*) killed several dozen young chestnut trees (2-3 years old) recently planted in about 10 different sites. In France, mortality of carob trees have been reported, in conjunction with drought conditions (DSF, 2018).

In Asia, *X. crassiusculus*, has been reported as an occasional pest of live trees and shrubs (Hulcr *et al.*, 2017, citing others). It is considered a pest of *Acacia* in Vietnam, and a serious pest of hardwood plantations and young trees in nurseries (Thu *et al.*, 2010). In Thailand, *X. crassiusculus* attacks newly sawn rubberwood and is common in durian plantations (Beaver *et al.*, 2014 citing others). In Pakistan, tree mortality has been reported on *Mangifera indica* (EPPO, 2018a), where decline and death is observed mostly in neglected/badly managed orchards, and sometimes in conditions of shortage of irrigation water (http://www.pakistaneconomist.com/issue2004/issue48/i&e6.php, Khuhro *et al.*, 2017).

In India, *X. crassiusculus* is a sporadic pest in certain *Vitis vinifera*-growing areas (Mani *et al.*, 2013). It has become a serious grapevine pest in part of Karnataka and Andhra Pradesh, where mortality may occur; following attacks, the plants begin to dry, and they die within 15-20 months (Reddy and Verghese, 2006). The yield of untreated grapevines is reduced (Keshavareddy and Verghese, 2008). From the literature, it would appear that it does not attack only young plants, as trials on control methods were carried out in a 21-year old vineyard (Reddy and Verghese, 2006). In India, *X. crassiusculus* was also implicated in the death of *Grevillea robusta* (the most common of 9 Coleopteran borers) (Sreedharan *et al.*, 1991).

Mortality has been observed in Fiji on seedlings of *S. macrophylla* (mahogany). In Costa Rica and Panama, *X. crassiusculus* has been found in primary tropical forests on many tree species. However, in these natural forests, it is not known if it can kill healthy trees (EPPO, 2018a). In Ghana *X. crassiusculus* has almost completely destroyed young plantations of *Khaya ivorensis* and *Aucoumea klaineana,* with the sapling stems cut into several pieces by tunnels running in various direction; attacks occurred shortly after transplanting, only when rather unusually large planting stock had been used (Browne, 1963).

In the USA, *X. crassiusculus* has become an important pest of ornamental and fruit trees, more particularly in nurseries and trees used in landscaping. Although no figures are given, it is stated that *X. crassiusculus* has caused moderate to heavy losses in US nurseries (e.g. on potted *Quercus shumardii* and *Ulmus parviflora*), on chestnut, peach and pecan orchards (EPPO, 2018a; Horn and Horn, 2006). In Maryland, where *X. germanus* and *X. crassiusculus* were recorded feeding on over 140 plant species during monitoring in nurseries in 2002-2014, and causing damage, Gill (2014) mentions specifically *X. crassiusculus* in relation to azalea (a private arboretum reported extensive loss of azalea plants every year since 2008), European beech (*Fagus sylvatica*), *Carpinus*, paperbark maple, *Cornus kousa* hybrids, Rose of Sharon and Japanese maple. Attacks, leading to some mortality, on young apparently healthy peach trees in orchards were observed (Kovach and Gorsuch, 1985). Mortality of *Castanea mollissima* (small trees in an experiment, 1-2 cm trunk diameter at 15.2 cm high) was also observed (Oliver and Mannion, 2001). Atkinson *et al.* (2014) reports attacks leading to death on 3 m saplings of *Quercus shumardii* (Shumard oaks) with no visible stress or other attacks, and attacks on large *Ulmus parvifolia* (Drake elm) saplings, which did not directly kill the plants. In ornamental nurseries, mass attacks can result in extensive losses. Although they do not always result in plant death, the growth, aesthetic, and economic value of nursery plants can be negatively affected. Tunnelling by ambrosia beetles can kill small-diameter plants or make them unmarketable, and ornamental producers generally have very little to no tolerance for ambrosia beetle attacks (Ranger *et al.*, 2016, citing others). *X. crassiusculus* has become one of the most damaging insect pests for deciduous trees growers, as they invest a lot of time and money on its control (Werle *et al.*, 2012). *X. crassiusculus* has frequently been listed as the most destructive ambrosia beetle in the southeastern USA (Werle, 2016, citing others).

Finally, *X. crassiusculus* has caused economic damage by boring into stored hardwood lumber (Landi *et al.*, 2017 citing others). *X. crassiusculus* was a major component of an ambrosia beetle infestation in the sapwood of *Liquidambar styraciflua* (sweetgum) logs at a mill yard in Florida in 1999, due to storage of too many logs too long before processing (Atkinson *et al.*, 2014). Smith and Hulcr (2015, citing a pers. comm.) state that losses of significant volumes of timber, particularly hardwood, have increasingly been reported from Florida and Georgia (Smith and Hulcr, 2015).

Some impact due to attacks by *X. crassiusculus* and *X. compactus* in the Circeo National Park have been reported (Francardi *et al.*, 2017). The authors concluded that *X. crassiusculus* and *X. compactus* may represent a serious phytosanitary risk in the Circeo National Park because of the wide variety of susceptible plants in the park or in the neighbouring areas.

Control: In relation to the finding in Italy, Pennacchio *et al.* (2003) stated that the main control method is rapid felling of colonized trees and burning of the wood before adult emergence. Moreover, stacks of wood should be quickly destroyed if there are signs of the presence of *X. crassiusculus*. For valuable wood or in young plantations, Pennacchio *et al.* (2003) mentions that pyrethroid treatments may be applied during the flight and early breeding period, in order to kill adults in the initial phase of penetration. Injection of emamectine benzoate might be used to prevent or cure the attack of individual trees of high aesthetic or conservation value. In the USA, insecticide treatments (incl. pyrethroids) have been applied in nurseries to protect plants from attack (Frank and Sadof, 2011; Ranger *et al.*, 2016).

Trapping should be used to detect the arrival of the pest, and inspections conducted to detect attacked trees. Multifunnel or crossvane interception traps, baited with ethanol, can be used. Multipheromone traps (using current bark beetle's aggregation pheromone components) are the subject of research in Europe. Attacked trees should be left in the nursery until the trunk is fully attacked (in order to focus attacks on infested trees), then removed and buried or burned (Mizell and Riddle, 2004). *X. crassiusculus* was reported as eradicated in Oregon (LaBonte, 2010).

New management strategies are being envisaged, but not fully developed yet, such as push-pull strategy using repellents (e.g. verbenone) to push the pest away from vulnerable nursery stock and attractants (e.g. ethanol) to pull it into annihilative traps (Ranger *et al.*, 2016). Reding *et al.* (2017) found that *X. crassiusculus* and other ambrosia beetle species were attracted to ethanol-injected trap trees, and suggested such trees might be used to attract ambrosia beetles, for example in the context of monitoring or push-pull strategies.

POTENTIAL RISKS FOR THE EPPO REGION

Pathways

Entry

X. crassiusculus has been intercepted in the USA (Haack and Rabaglia, 2013) and in New Zealand on 'unspecified casewood' (Brockerhoff *et al.*, 2003), here interpreted to be wood packaging material. *X. crassiusculus* has also been intercepted in the EU on wood packaging material at several occasions (e.g. Europhyt, 2016, 2017; NPPO of the Netherlands, 2018). Numerous cases of entry to new areas are known. Life stages are associated with the xylem. *X. crassiusculus* has a preference for the lower part of relatively small trees, but has also been found on logs. All wood commodities may therefore be pathways. Processes applied to produce wood commodities would destroy some individuals. The likelihood of entry on wood chips, hogwood and processing wood residues would be lower than on round wood, as individuals would have to survive processing and transport, and transfer to a suitable host is less likely. The wood would also degrade and not be able to sustain development of the pest (*X. crassiusculus* needs a sufficient level of humidity). Bark on its own is an unlikely pathway.

Plants for planting may be a pathway, although such plants are normally subject to controls during production, and attacked plants may be detected and discarded. *X. crassiusculus* is an important nursery pest in part of the USA. In the EPPO region, *X. crassiusculus* has been reported in forests or gardens (and in a plantation of the sweet chestnut), and not in nurseries. Plants for planting are currently considered a pathway from outside the EPPO region. Cut branches are a less likely pathway, as they are used indoors, and the pest is unlikely to fly to a suitable host. It is not known if cut branches of hosts are used and traded.

Finally, *X. crassiusculus* is an inbreeder, which is favourable to entry and establishment.

Summary of pathways (uncertain pathways are marked with '?'):

- *wood (round or sawn, with or without bark, incl. firewood) of hosts*
- *wood chips, hogwood, processing wood residues (except sawdust and shavings)*
- *wood packaging material if not treated according to ISPM 15*
- *plants for planting (except seeds) of hosts*
- *cut branches of hosts?*

Because of the large and uncertain host range, pathways may cover all non-coniferous species. The pathways may also cover the known coniferous hosts (incl. Christmas trees).

Spread (following introduction, i.e. within EPPO region)

X. crassiusculus may enter new countries in the EPPO region through natural spread. This may have happened from Italy (Friuli Venezia Giulia) to Slovenia. The outbreak in France is close only to Italy, and in Spain is far from any border. Spread to Switzerland is less likely due to the obstacle of the Alps. *X. crassiusculus* may also spread with wood commodities of potentially many deciduous trees. If *X. crassiusculus* entered nursery production in the EPPO region, plants for planting may also spread the pest. Human-assisted pathways may lead to multiple introductions from which local spread could occur.

Establishment

X. crassiusculus has already established in several EPPO countries of the Mediterranean Basin, and may establish throughout the Mediterranean area, although it is not known if the most arid areas would also be at risk. In the North, Smith and Hulcr (2015) note that in colder temperate zones with more extensive freezing, *X. crassiusculus* is often replaced by *X. germanus*. However, it is present in North America to Ontario and Washington State. The climate types where it occurs are present in a large part of the EPPO region, throughout Europe to the South of Scandinavia and into European Russia.

Given its wide host range, *X. crassiusculus* is likely to find hosts throughout that area. However, in Southern Europe, it has been found so far on a limited number of species, including *Ceratonia siliqua* (carob), *Cercis*

siliquastrum, which have a limited distribution in the EPPO region, as well as on *Castanea sativa*, which is grown more widely for fruit, wood production and as ornamental tree.
Areas with suitable climates and host plants are available in the EPPO region, and establishment in areas where it does not already occur is possible.

Potential impact (including consideration of host plants)
So far in the EPPO region, there are few indications of damage. *X. crassiusculus* has been found in natural areas or on few ornamental species that have a limited use in the region. However, attacks on *Castanea sativa* in plantations, including mortality have been observed in Piemonte, Italy in 2018. Mortality of *Ceratonia siliqua* trees has also been reported from Italy and France. Many woody plants attacked by *X. crassiusculus* are important fruit crops, forest trees or woody ornamentals in the EPPO region. *X. crassiusculus* has occasionally become a significant and aggressive pest. *X. crassiusculus* has the potential to cause damage to chestnut plantations, to be a pest in nurseries (as reported from the USA), and possibly in orchards and plantations of other hosts. Data is lacking on its potential impact in forests and wood production, although impact on logs have been reported from the USA.

Table 1. Distribution

	Reference	**Comments (with references)**
EPPO region		
France	EPPO, 2018b	First found in 2014 in Alpes Maritimes
Italy	EPPO, 2018b	First found in 2003 in Toscana, later in Liguria, Veneto, Friuli Venezia Giulia, Lazio, Piemonte (EPPO, 2018b; Faccoli *et al*., 2011; Francardi *et al*., 2017; Gallego *et al*., 2017; M. Faccoli, pers. obs., 2018)
Spain	EPPO, 2018b	First found in 2016 (Gallego *et al.*, 2017). Benifaió municipality, Comunidad Valenciana
Slovenia: transient, actionable, under surveillance	EPPO RS, 2018	Based on pest notification by the NPPO
Netherlands: transient: non-actionable, under surveillance	NPPO of the Netherlands, 2018	Pest notification by the NPPO
Absent: Belgium (no pest record); Lithuania (confirmed by survey)	EPPO, 2018b	
Unconfirmed: Israel	NPPO of Israel, 2018	Reported by Buse *et al*. (2013) as trapped during surveys in a stand of old oaks (*Quercus calliprinos*) in northern Israel. Possibly a misidentification, not represented in the Israelian collection of Scolytinae, never collected by Israelian specialists (NPPO of Israel, 2018).
Africa		
Cameroon	EPPO, 2018b	
Congo Dem. Rep.	EPPO, 2018b	

	Reference	Comments (with references)
Cote d'Ivoire	EPPO, 2018b	
Equatorial Guinea	EPPO, 2018b	
Gabon	EPPO, 2018b	
Ghana	EPPO, 2018b	
Kenya	EPPO, 2018b	
Madagascar	EPPO, 2018b	
Mauritania	EPPO, 2018b	
Mauritius	EPPO, 2018b	
Nigeria	EPPO, 2018b	
Seychelles	EPPO, 2018b	
Sierra Leone	EPPO, 2018b	
Tanzania	EPPO, 2018b	
Asia		
Bhutan	EPPO, 2018b	
China (Fujian, Hunan, Sichuan, Xianggang (Hong Kong), Xizhang, Yunnan)	EPPO, 2018b	
India	EPPO, 2018b	
India (Andaman and Nicobar Islands, Assam, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal)	EPPO, 2018b	
Indonesia	EPPO, 2018b	
Japan -Hokkaido, Honshu, Kyushu, Shikoku -Also Ryukyu Islands	-EPPO, 2018b -Ito and Kajimura, 2009	
Korea Dem. Rep.	EPPO, 2018b	
Korea Rep.	EPPO, 2018b	
Malaysia	EPPO, 2018b	
Myanmar	EPPO, 2018b	
Nepal	EPPO, 2018b	
Pakistan	EPPO, 2018b	

	Reference	**Comments (with references)**
Philippines	EPPO, 2018b	
Sri Lanka	EPPO, 2018b	
Taiwan	EPPO, 2018b	
Thailand	EPPO, 2018b	
Vietnam	EPPO, 2018b	
North America		
Canada (Ontario)	EPPO, 2018b	
USA - Alabama, Arkansas, Delaware, Florida, Georgia, Hawaii, Indiana, Kansas, Louisiana, Maryland, Michigan, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, South Carolina, Tennessee, Texas, Virginia, Washington - Kentucky	- EPPO, 2018b - Gomez *et al.*, 2018	first record in 1974 in South Carolina on a dying graft of *Liquidambar styraciflua* (EPPO, 2018a) Reported as eradicated from Oregon in LaBonte (2010)
Central America		
Guatemala	EPPO, 2018b	
Honduras	Storer *et al.* 2017	Citing unpublished collection by the author in 2013
Panama	EPPO, 2018b	First record 2003 (Kirkendall and Ødegaard, 2007)
South America		
Argentina	EPPO, 2018b	First record in Landi *et al.* (2017)
Brazil (Amapa, Pernambuco, Rio de Janeiro, Sao Paulo)	EPPO, 2018b	2012
Costa Rica	EPPO, 2018b	First record 1996 (Kirkendall and Ødegaard, 2007)
French Guiana	EPPO, 2018b	2009
Uruguay	EPPO, 2018b	First record in Landi *et al.* (2017)

	Reference	Comments (with references)
Oceania		
Australia (Queensland)	EPPO, 2018b	
New Caledonia	EPPO, 2018b	
New Zealand (absent, intercepted only)	EPPO, 2018b	
Palau	EPPO, 2018b	
Papua New Guinea	EPPO, 2018b	
Samoa	EPPO, 2018b	

Table 2. Host genera (all from Atkinson, 2018, except * from Horn and Horn, 2006 and other sources)

Family	Genus
Adoxaceae	*Sambucus*
Adoxaceae	*Viburnum*
Altingiaceae	*Liquidambar*
Anacardiaceae	*Gluta*
Anacardiaceae	*Holigarna*
Anacardiaceae	*Lannea*
Anacardiaceae	*Pistacia*
Anacardiaceae	*Swintonia*
Annonaceae	*Annona*
Annonaceae	*Sageraea*
Apocynaceae	*Alstonia*
Apocynaceae	*Amoora*
Apocynaceae	*Plumeria*
Apocynaceae	*Wrightia*
Arecaceae	*Neodypsis*
Asparagaceae	*Dracaena*
Asparagaceae	*Ruscus*
Betulaceae	*Ostrya**
Burseraceae	*Aucoumea*
Burseraceae	*Canarium*
Calophyllaceae	*Calophyllum*

Family	Genus
Calophyllaceae	*Kayea*
Cannabaceae	*Cannabis*
Combretaceae	*Terminalia*
Convolvulaceae	*Ipomoea*
Cornaceae	*Cornus*
Cucurbitaceae	*Luffa*
Cupressaceae	*Juniperus**
Dilleniaceae	*Dillenia*
Dipterocarpaceae	*Dipterocarpus*
Dipterocarpaceae	*Hopea*
Dipterocarpaceae	*Shorea*
Dipterocarpaceae	*Vateria*
Ebenaceae	*Diospyros*
Eleaocarpaceae	*Elaeocarpus*
Euphorbiaceae	*Hevea*
Euphorbiaceae	*Lasiococca*
Fabaceae	*Cercis*
Fabaceae	*Dalbergia*
Fabaceae	*Erythrina*
Fabaceae	*Erythrophleum*
Fabaceae	*Gleditsia*

Family	Genus
Fabaceae	*Gliricidia*
Fabaceae	*Ougeinia*
Fabaceae	*Scorodophloeus*
Fabaceae	*Ceratonia*
Fagaceae	*Castanea*
Fagaceae	*Castanopsis*
Fagaceae	*Lithocarpus*
Fagaceae	*Quercus*
Juglandaceae	*Carya*
Lamiaceae	*Vitex*
Lamiaceae	*Tectona*
Lauraceae	*Cinnamomum*
Lauraceae	*Laurus*
Lauraceae	*Machilus*
Lauraceae	*Persea*
Lauraceae	*Phoebe*
Lythraceae	*Lagerstroemia*
Magnoliaceae	*Liriodendron*
Magnoliaceae	*Magnolia*
Malvaceae	*Sterculia*
Malvaceae	*Theobroma*

Family	Genus
Melastomataceae	*Swietenia*
Melastomataceae	*Topoboea*
Meliaceae	*Cedrela*
Meliaceae	*Guarea*
Meliaceae	*Khaya*
Mimosaceae	*Albizzia*
Moraceae	*Artocarpus*
Moraceae	*Castilla*
Moraceae	*Cecropia*
Moraceae	*Ficus*
Moraceae	*Pachytrophe*
Moraceae	*Pourouma*
Myristicaceae	*Myristica*
Myristicaceae	*Pycnanthus*
Myrtaceae	*Syzygium*
Olacaceae	*Ongokea*
Oleaceae	*Olea**
Phyllanthaceae	*Bischofia*
Pinaceae	*Pinus*
Poaceae	*Saccharum*
Proteaceae	*Grevillea*
Rosaceae	*Malus*
Rosaceae	*Prunus*
Rosaceae	*Pyrus*
Rosaceae	*Sorbus*
Rutaceae	*Chloroxylon*
Rutaceae	*Murraya*
Rutaceae	*Zanthoxylum*
Salicaceae	*Populus*
Sapindaceae	*Koelreuteria*
Sapindaceae	*Ungnadia*

Family	Genus
Sapotaceae	*Pouteria*
Styracaceae	*Styrax*
Ulmaceae	*Doonia*
Ulmaceae	*Ulmus*
Vitaceae	*Leea*
Vochysiaceae	*Vochysia*

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