EPPO Datasheet: *Euwallacea fornicatus sensu stricto*

Last updated: 2024-01-19

IDENTITY

Preferred name: *Euwallacea fornicatus sensu stricto*
Authority: (Eichhoff)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Curculionidae: Scolytinae
Other scientific names: *Euwallacea whitfordiodendrus* (Schedl), *Xyleborus fornicatus* Eichhoff, *Xyleborus tapatapaoensis* Schedl
Common names: polyphagous shot-hole borer
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EPPO Code: EUWAWH

Notes on taxonomy and nomenclature

Euwallacea fornicatus was originally described as *Xyleborus fornicatus* Eichhoff. Numerous other similar *Euwallacea* were described and synonymized, and the species was assumed to be variable. After the invasion of different populations, it became clear that the variation assumed for the species corresponded to different cryptic species (Stouthamer *et al.*, 2017), and the taxon was referred to as *E. fornicatus* species complex. This complex was referred to by different common names, the polyphagous shot hole borer (PSHB), Kuroshio shot hole borer (KSHB) and tea shot hole borer (TSHB). After a review of the species complex using an integrated approach with morphometrics and molecular tools by Gomez *et al.* (2018), the syntype of *Xyleborus fornicatus* was rediscovered and all of the species within the complex were validated by morphometric and phylogenetic analyses (Smith *et al.*, 2019). The species complex includes: *E. fornicatus*, *E. fornicatior* (Eggers), *E. kuroshio* Gomez and Hulcr, and *E. perbrevis* (Schedl). These taxonomic changes shifted the species names associated with the widely used common names. *Euwallacea fornicatus* is therefore the 'Polyphagous Shot Hole Borer' and *Euwallacea perbrevis* is the 'Tea Shot Hole Borer'.

HOSTS

The *Euwallacea fornicatus* species complex has a broad host range. Gomez *et al.* (2019) updated the list of hosts to 412 plant species in 75 families; 109 are reported as breeding hosts, 95 are commercial timber tree species and 43 are species used for fruit production. Recently, after the report of *E. fornicatus* in South America, new additional hosts were recorded (Ceriani-Nakamurakare *et al.*, 2023). In the United States (California), the beetles were found on more than 200 hosts, though only 19 of these were shown to be reproductive hosts (Eskalen *et al.*, 2013).

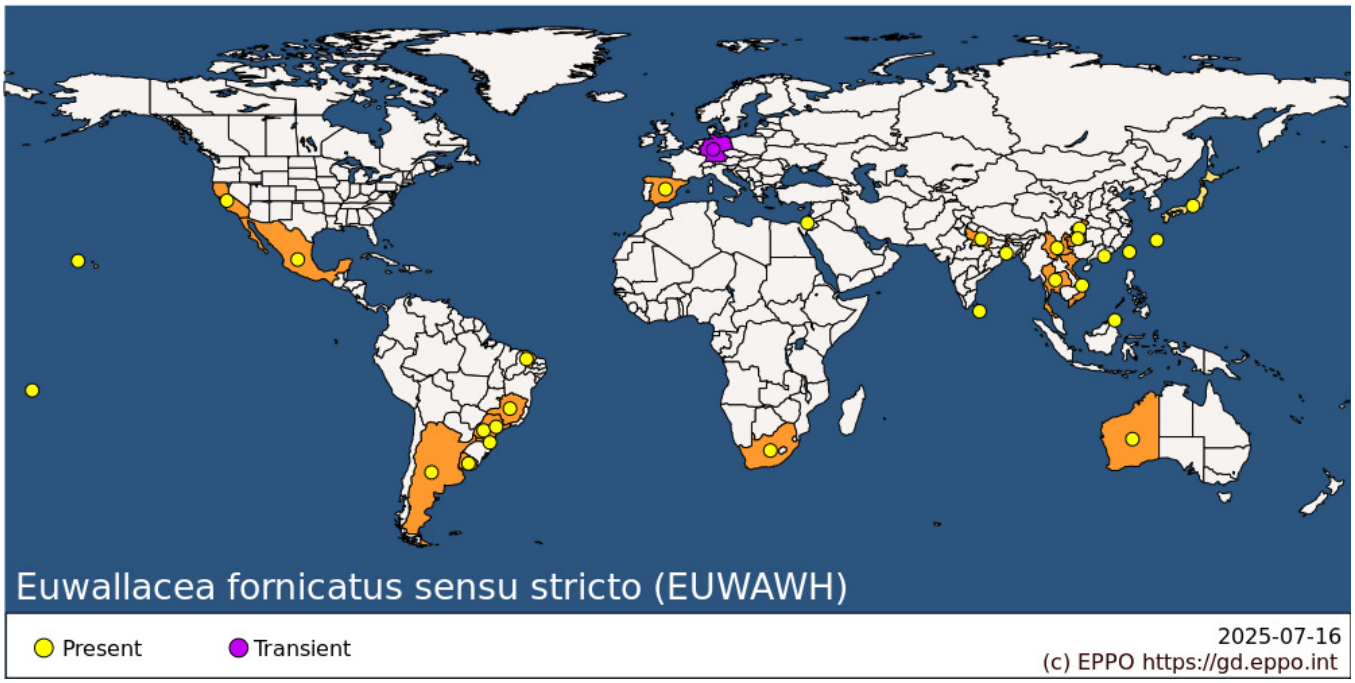
Host list: *Acacia auriculiformis*, *Acacia floribunda*, *Acacia longifolia*, *Acacia mangium*, *Acacia mearnsii*, *Acacia melanoxylon*, *Acacia retinodes*, *Acacia saligna*, *Acacia stenophylla*, *Acacia victoriae*, *Acaciella glauca*, *Acalypha wilkesiana*, *Acer buergerianum*, *Acer campestre*, *Acer caudatifolium*, *Acer davidii*, *Acer japonicum*, *Acer macrophyllum*, *Acer negundo*, *Acer obtusifolium*, *Acer palmatum*, *Acer paxii*, *Acer pectinatum*, *Acer pictum subsp. mono*, *Acer pseudoplatanus*, *Acer saccharinum*, *Acer x freemanii*, *Adansonia digitata*, *Afrocarpus falcatus*, *Afrocarpus gracilior*, *Afzelia quanzensis*, *Aglaia odorata*, *Agonis flexuosa*, *Ailanthus altissima*, *Alangium chinense*, *Albizia adianthifolia*, *Albizia julibrissin*, *Albizia kalkora*, *Albizia lebbeck*, *Albizia sp.*, *Alectryon excelsus*, *Aleurites moluccanus*, *Allocasuarina decussata*, *Allocasuarina humilis*, *Alnus cordata*, *Alnus glutinosa*, *Alnus incana*, *Alnus jorullensis*, *Alnus rhombifolia*, *Aloysia virgata*, *Anisodontea scabrosa*, *Annona reticulata*, *Araucaria columnaris*, *Arbutus unedo*, *Archontophoenix alexandrae*, *Archontophoenix cunninghamiana*, *Bambusa sp.*, *Banksia grandis*, *Banksia integrifolia*, *Banksia littoralis*, *Banksia menziesii*, *Banksia prionotes*, *Banksia saxicola*, *Bauhinia forficata*, *Bauhinia galpinii*, *Bauhinia petersiana*, *Bauhinia purpurea*, *Bauhinia variegata var. candida*, *Bauhinia variegata*, *Beilschmiedia miersii*, *Betula pendula*, *Bischofia javanica*, *Blepharocalyx salicifolius*, *Bocconia arborea*, *Bombax ceiba*, *Bossiaea linophylla*, *Bougainvillea sp.*, *Brachychiton acerifolius*, *Brachychiton australis*, *Brachychiton bidwillii*, *Brachychiton discolor*, *Brachychiton diversifolius*, *Brachychiton populneus*, *Brachychiton rupestris*, *Brachylaena discolor*, *Brahea armata*, *Broussonetia papyrifera*, *Brugmansia suaveolens*, *Brugmansia x candida*

, Buddleia saligna, Bunchosia armeniaca, Bursera hindsiana, Butia capitata, Buxus sempervirens, Caesalpinia mexicana, Callerya sp., Calliandra surinamensis, Callistemon salignus, Calodendrum capense, Calpurnia aurea, Camellia chrysanthoides, Camellia drupifera, Camellia grijsii, Camellia hiemalis, Camellia indochinensis, Camellia japonica, Camellia oleifera, Camellia reticulata, Camellia rosiflora, Camellia semiserrata, Camellia x williamsii, Camptotheca acuminata, Carya illinoinensis, Cascabela thevetioides, Cassia brewsteri, Cassia fistula, Cassia leptophylla, Castanospermum australe, Casuarina cunninghamiana, Casuarina equisetifolia, Casuarina obesa, Catalpa speciosa, Ceanothus caeruleus, Cedrus atlantica, Ceiba pentandra, Ceiba speciosa, Celtis africana, Celtis australis, Celtis bungeana, Celtis laevigata, Celtis sinensis, Celtis tala, Ceratonia siliqua, Cercis canadensis, Cercis chinensis, Cercis siliquastrum, Cestrum nocturnum, Cestrum sp., Chamaedorea elegans, Chionanthus retusus , Chiranthodendron pentadactylon, Cinnamomum camphora, Cinnamomum glanduliferum, Cinnamomum tenuifolium , Citharexylum montevidense, Citharexylum spinosum, Citrus x aurantium var. paradisi, Citrus x aurantium var. sinensis, Citrus x aurantium, Citrus x latifolia, Citrus x limon var. meyerii, Citrus x limon, Cleyera japonica, Cocculus laurifolius, Cocculus orbiculatus, Colletia paradoxa, Combretum erythrophyllum, Combretum kraussii, Commiphora harveyi, Coprosma repens, Cordia caffra, Cordyline stricta, Cornus controversa, Cornus drummondii, Cornus florida, Corylus colurna, Corymbia calophylla, Corymbia ficifolia, Crinodendron patagua, Cunninghamella sp., Cunonia capensis, Cupaniopsis anacardioides, Cussonia spicata, Dahlstedtia pinnata, Dalbergia delavayi, Dalbergia sissoo, Davidia involucrata, Delonix regia, Desmodium elegans, Diospyros dichrophylla, Diospyros glabra, Diospyros inconstans, Diospyros kaki, Diospyros lycioides, Diospyros whyteana, Diploglottis australis, Dombeya acutangula, Dombeya cacuminum, Dombeya rotundifolia, Dombeya tiliacea, Dovyalis caffra, Dracaena draco, Dracaena marginata, Dracaena sp., Duranta erecta, Ebenopsis ebano, Ehretia latifolia, Ekebergia capensis, Elaeocarpus decipiens, Elaeocarpus sp., Enterolobium contortisiliquum, Eriobotrya japonica, Erythrina americana, Erythrina caffra, Erythrina chiriquensis, Erythrina corallodendron, Erythrina crista-galli, Erythrina falcata, Erythrina flabelliformis, Erythrina folkersii, Erythrina humeana, Erythrina livingstoniana, Erythrina lysistemon, Erythrina macrophylla, Erythrina variegata, Erythrina x bidwillii, Erythrina x sykesii, Eucalyptus camaldulensis, Eucalyptus cinerea, Eucalyptus cladocalyx, Eucalyptus diversicolor, Eucalyptus froggattii, Eucalyptus globulus, Eucalyptus gomphocephala, Eucalyptus kitsoniana, Eucalyptus leucoxylon, Eucalyptus perriniana, Eucalyptus polyanthemos, Eucalyptus robusta, Eucalyptus rudis, Eucalyptus torquata, Euphorbia tirucalli, Fagus crenata, Fagus sylvatica, Faidherbia albida, Fatsia japonica, Feijoa sellowiana, Ficus altissima, Ficus aspera, Ficus benghalensis, Ficus benjamina, Ficus carica, Ficus elastica, Ficus macrophylla, Ficus maxima, Ficus microcarpa, Ficus natalensis, Ficus obliqua, Ficus platypoda, Ficus racemosa, Ficus religiosa, Ficus rubiginosa, Ficus sur, Ficus sycomorus, Firmiana simplex, Frangula californica, Fraxinus americana, Fraxinus angustifolia subsp. oxycarpa, Fraxinus angustifolia, Fraxinus excelsior, Fraxinus griffithii, Fraxinus sp., Fraxinus uhdei, Fraxinus velutina, Gardenia thunbergia, Geijera parviflora, Geoffroea decorticans, Gleditsia japonica, Gleditsia triacanthos, Grevillea banksii, Grevillea olivacea, Grevillea robusta, Grewia occidentalis, Gymnosporia buxifolia, Hakea multilineata, Hakea prostrata, Hakea salicifolia, Halleria lucida, Handroanthus impetiginosus, Harpephyllum caffrum, Harpullia arborea, Harpullia pendula, Hauya elegans subsp. cornuta, Heliocarpus donnellsmithii, Heptapleurum actinophyllum, Heptapleurum arboricola, Heteropterys purpurea, Hibiscus martianus, Hibiscus mutabilis, Hibiscus rosa-sinensis, Hibiscus tiliaceus, Homalanthus populifolius, Hovenia dulcis, Howea forsteriana, Hymenosporum flavum, Ilex aquifolium, Ilex cornuta, Ilex latifolia, Ilex mitis, Inga edulis, Inga feuillei, Inga insignis , Inga sp., Inga uruguensis, Inga vera, Jacaranda cuspidifolia, Jacaranda mimosifolia, Jatropha cinerea, Jatropha mcvaughii, Juglans californica, Juglans mandshurica, Juglans nigra, Juglans regia, Juniperus chinensis, Juniperus virginiana, Kigelia africana, Kiggelaria africana, Koelreuteria bipinnata, Koelreuteria elegans, Koelreuteria paniculata, Lagunaria patersonia, Lambertia orbifolia, Leonotis leonurus, Ligustrum japonicum, Ligustrum ovalifolium, Ligustrum sinense, Ligustrum vulgare, Liquidambar formosana, Liquidambar styraciflua, Liriodendron tulipifera, Livistona chinensis, Lonchocarpus nitidus, Luehea divaricata, Lysiphyllum carronii, Macadamia integrifolia, Machilus thunbergii, Magnolia campbellii, Magnolia compressa, Magnolia cylindrica, Magnolia delavayi, Magnolia denudata, Magnolia doltsopa, Magnolia figo, Magnolia foveolata, Magnolia grandiflora, Magnolia grandis, Magnolia guatemalensis, Magnolia hodgsonii, Magnolia liliiflora, Magnolia pacifica, Magnolia sargentiana, Magnolia sharpii, Magnolia sprengeri, Magnolia tamaulipana, Magnolia virginiana, Magnolia x brooklynensis, Magnolia x loebneri, Magnolia x soulangeana, Magnolia x veitchii, Magnolia yunnanensis, Malus domestica, Malus floribunda, Malus sylvestris, Mangifera indica, Manihot esculenta, Melaleuca quinquenervia, Melaleuca rhaphiophylla, Melaleuca teretifolia, Melaleuca viminalis, Melia azedarach, Melianthus major, Metasequoia glyptostroboides, Mezoneuron kauaiense, Milicia excelsa, Moringa sp., Morus alba, Morus nigra, Morus rubra, Murraya paniculata, Myrsine laetevirens, Myrsine melanophloeos, Neltuma articulata, Neltuma caldenia, Neltuma glandulosa, Neolitsea sericea, Nuxia floribunda, Ochroma pyramidale, Olea europaea subsp. africana, Olea europaea, Olinia ventosa, Olneya tesota, Oncoba spinosa, Osmanthus fragrans, Osteospermum moniliferum, Pararchidendron pruinosum, Parasenegalia visco, Parkinsonia aculeata, Parkinsonia florida, Parkinsonia x sonorae, Paulownia tomentosa, Peltophorum africanum, Persea americana, Peumus boldus, Phellodendron amurense

, Phoebe cavaleriei, Photinia x fraseri, Pinus densiflora, Pinus douglasiana, Pipturus argenteus, Pistacia atlantica, Pistacia chinensis, Pistacia terebinthus subsp. palaestina, Pithecellobium sp., Pittosporum ligustrifolium, Pittosporum undulatum, Platanus mexicana, Platanus occidentalis, Platanus orientalis, Platanus racemosa, Platanus wrightii, Platanus x hispanica, Plumeria rubra, Podalyria calyptrata, Podocarpus henkelii, Populus alba, Populus brandegeei, Populus deltoides, Populus euphratica, Populus fremontii, Populus nigra, Populus simonii, Populus trichocarpa, Populus x canadensis, Populus x canescens, Protea mundii, Prunus africana, Prunus armeniaca, Prunus avium, Prunus caroliniana, Prunus cerasifera, Prunus cerasoides, Prunus domestica, Prunus dulcis, Prunus ilicifolia, Prunus mexicana, Prunus mume, Prunus nigra, Prunus persica var. nucipersica, Prunus persica, Prunus serrulata, Pseudobombax ellipticum, Pseudocydonia sinensis, Psidium guajava, Psoralea aphylla, Psoralea pinnata, Pterocarya stenoptera, Pyrus calleryana, Pyrus communis, Pyrus kawakamii, Quararibea funebris , Quercus acutissima, Quercus agrifolia, Quercus alba, Quercus brantii, Quercus calliprinos, Quercus castaneifolia, Quercus chihuahuensis, Quercus chrysolepis, Quercus dentata subsp. yunnanensis, Quercus engelmannii, Quercus frainetto, Quercus hartwissiana, Quercus ilex, Quercus infectoria, Quercus ithaburensis, Quercus lobata, Quercus look, Quercus macrocarpa, Quercus mexicana, Quercus myrsinifolia, Quercus palustris, Quercus petraea, Quercus pontica, Quercus robur subsp. pedunculiflora, Quercus robur, Quercus rubra, Quercus rugosa, Quercus suber, Quercus virginiana, Quercus x rosacea, Quercus x turneri, Rhamnus alaternus, Ricinocarpos hybrids, Ricinocarpos pinifolius, Ricinus communis, Robinia pseudoacacia, Robinsonella discolor, Rosa sp., Roystonea regia, Salix acmophylla, Salix alba, Salix babylonica, Salix eastwoodiae, Salix exigua, Salix gooddingii, Salix humboldtiana, Salix laevigata, Salix lasiolepis, Salix mucronata, Salix nigra, Sambucus sp., Sapindus drummondii, Sapindus saponaria, Schinus longifolia, Schinus molle, Schinus polygama, Schinus terebinthifolia, Schotia brachypetala, Searsia chirindensis, Searsia lancea, Senegalia burkei, Senegalia caffra, Senegalia galpinii, Senna candolleana, Senna racemosa, Senna spectabilis, Senna x floribunda, Solanum granuloso-leprosum, Solanum mauritianum, Sparrmannia africana, Spyridium globulosum, Stenocarpus sinuatus, Sterculia quadrifida, Strelitzia nicolai, Styphnolobium japonicum, Syzygium cordatum, Syzygium cumini, Syzygium smithii, Tamarindus indica, Tara cacalaco, Taxodium distichum, Tecoma capensis, Tecoma stans, Templetonia retusa, Terminalia mantaly, Tetrapanax papyrifer, Tilia americana, Tilia caroliniana, Tipuana tipu, Toona ciliata, Trema orientale, Triadica sebifera, Trichilia emetica, Trichilia glabra, Ulmus alata, Ulmus americana, Ulmus davidiana var. japonica, Ulmus glabra, Ulmus minor, Ulmus parvifolia, Ulmus procera, Ulmus pumila, Umbellularia californica, Ungnadia speciosa , Vachellia campeachiana, Vachellia caven, Vachellia farnesiana, Vachellia karroo, Vachellia sieberiana var. woodii , Vachellia sieberiana, Vepris lanceolata, Verbesina gigantea, Vernicia fordii, Viburnum lantana, Viburnum odoratissimum, Virgilia divaricata, Virgilia oroboides, Vitex trifolia, Vitis vinifera, Washingtonia filifera, Wigandia urens, Wisteria floribunda, Wisteria sinensis, Xylomelum occidentale, Xylosma congesta, Zelkova carpinifolia, Zelkova serrata, Zenia insignis, Ziziphus jujuba, Ziziphus spina-christi

GEOGRAPHICAL DISTRIBUTION

All species within the *Euwallacea fornicatus* species complex are native to Asia and Oceania (Smith *et al.* 2019). *Euwallacea fornicatus*, considered to be native in China, Japan, Malaysia, Samoa, Sri Lanka, Taiwan, Thailand, and Vietnam, has been introduced into Argentina, Israel, South Africa, United States (California and Hawaii), and Europe (Ceriani-Nakamurakare *et al.*, 2023; Eskalen *et al.*, 2012; Mendel *et al.*, 2012; Paap *et al.*, 2018; Rugman-Jones *et al.*, 2020; Schuler *et al.*, 2022). Outbreaks of *E. fornicatus* (species complex) reported in Europe correspond to findings in greenhouses: Poland (Poznan-2019), Italy (Merano-2020), Netherlands and Germany (Berlin and Erfurt-2021) (Schuler *et al.*, 2023). In Poland, Italy, Erfurt (Germany) and the Netherlands, the eradication of the plants (or infested part of the plants) resulted in the successful eradication of the beetles, whereas the eradication process in Berlin is reported to be still in progress.



EPPO Region: Germany, Israel, Spain (mainland)
Africa: South Africa
Asia: China (Chongqing, Guizhou, Xianggang (Hong Kong), Yunnan), India (Uttar Pradesh, West Bengal), Israel, Japan (Ryukyu Archipelago), Malaysia (Sabah), Sri Lanka, Taiwan, Thailand, Vietnam
North America: Mexico, United States of America (California, Hawaii)
South America: Argentina, Brazil (Ceara, Minas Gerais, Parana, Santa Catarina, Sao Paulo), Uruguay
Oceania: Australia (Western Australia), Samoa

BIOLOGY

Most ambrosia beetle species attack only plants that died recently or are dying. However, a few species, including *E. fornicatus*, colonize healthy trees and cause damage through mass accumulation (Hulcr and Stelinski, 2017), where tree pathogens producing localized necrosis cause a significant amount of damage when inoculated by a large number of beetles (Smith & Hulcr, 2015).

Females of this species will typically make a divided or simple gallery encircling the stem, with a few longitudinal tunnels in small branches (Browne, 1961). Eggs are laid individually or in small clusters once the entrance tunnel has been completed. Diploid females produce haploid male offspring from unfertilized eggs, as is the case for other ambrosia beetles in the tribe Xyleborini. Newly emerged females stay in the galleries for several days where they are fertilized by the few brothers present. After mating, females leave the gallery through the original entrance hole (Browne, 1961). Adults develop in 22 days at 24°C (75°F), producing 57 female adults in 6 weeks, 7% of which are males (Cooperband *et al.*, 2016).

The larvae, which has three instars (as typical of Xyleborini), feed entirely on symbiotic ambrosia fungi cultivated in longitudinal galleries of twigs and transverse galleries of thicker branches (Gadd, 1941). The fungi are transported to new trees in specialized pocket-like structures called mycangia (Batra, 1967). The fungi are obligate symbionts of the beetles and serve as their source of nutrition, with severe pathogenic effects for some plant species. The symbiotic fungus invades the tree vascular tissue, causing cambial necrosis, sugar or gum exudates, branch dieback, and mortality of a broad range of tree hosts (Eskalen *et al.*, 2013). The symbiotic fungus *Fusarium euwallaceae* is associated with *E. fornicatus*, causing branch dieback once introduced (Eskalen *et al.*, 2012; Freeman *et al.*, 2013).

DETECTION AND IDENTIFICATION

Symptoms

E. fornicatus bores and tunnels into the trunk, stems and branches of healthy trees and causes damage through mass accumulation. Females usually colonize the base of secondary branches, resulting in localized branch dieback. The symbiotic fungus invades the tree vascular tissue, causing cambial necrosis, sugar or gum exudates, branch dieback, and mortality of a broad range of tree hosts (Eskalen *et al.*, 2013).

Morphology

Eggs

The eggs are very small, round and partly translucent, with a smooth surface. They are laid singly or in groups. Freshly laid eggs are pale, but they gradually darken before eclosion, hatching in 4 to 6 days.

Larva

The mature larva is about 3.5 mm long and 1.1 mm wide (Gardner, 1964). Larvae are white, legless, C-shaped, with a reddish head, taking 16-18 days to pupate. The head is colourless, about 0.5 mm wide, with the anterior margin nearly straight. The body integument is smooth except for a few scattered minute spicules.

Pupa

Pupae are similar in size to the adults and are white. Adults emerge after 7-9 days.

Adult

Females of the genus *Euwallacea* can only be distinguished from other Xyleborini by a combination of characters including unarmed pronotal margin, contiguous procoxae, having an obliquely costate dorsolateral margin of the pronotum, semicircular foretibiae, and have only sparse setae and small declivital denticles (Gomez *et al.,* 2018). To identify specifically *E. fornicatus*, several morphological characters can be used, and all specimens fit within these measurement ranges (Smith *et al.,* 2019). Total length is 2.60 mm ? 2.70 mm. Elytral length of 1.44–1.72 mm, 8–9 socketed denticles in the margin of protibial. The pronotal width is 1.00–1.14 mm and the elytral width is 0.48–0.62 mm.

Detection and inspection methods

E. fornicatus is not attracted to ethanol (Dodge *et al.*, 2017). Quercivorol and ?-copaene have shown to be attractants, with synergistic effects increasing captures when combined (Dodge *et al.*, 2017; Kendra *et al.*, 2019). Sticky panels and black interception traps have been shown to be more efficient at capturing *E. fornicatus* than Lindgren traps (Kendra *et al.*, 2019). Cooperband *et al.* (2017) suggested the existence of two pheromones, 2-heneicosanone and 2-tricosanone. Pheromones have rarely been reported for ambrosia beetles within the Scolytinae with just a few known examples (Borden *et al.*, 1976; Borden & Slater, 1969; Francke & Heemann, 1974); these are probably involved in social behaviour inside galleries and the ecological and applied implications are yet to be tested.

Potential hosts, such as avocado, should be surveyed periodically for trees showing branch dieback and signs of beetle attack at junctions of small and mid-size shaded branches showing the presence of exit holes which have been described as white ‘sugar volcanoes’. Compacted frass and sawdust are also a (non-specific) sign of infestation, typically seen in the base of branches and in the trunk.

PATHWAYS FOR MOVEMENT

Active flight is one of the main means of movement to previously uninfested areas. Adult females can fly up to 400 m, but usually will attack hosts in a range of 35 m. However, the movement of timber and wood packaging material, such as dunnage and crating, has led to increasing transport and establishment of ambrosia beetles. The main pathway for ambrosia beetles such as *E. fornicatus* is wood packaging material and timber trade. Movements of infested host plants for planting can also transport all stages of the pest; attacks can be found on branches as small as 2 cm in diameter.

PEST SIGNIFICANCE

Economic impact

Severe economic impacts have been reported in Argentina, South Africa, California, Israel, and throughout Asia. *E. fornicatus* bores and tunnels into the trunk, stems and branches of healthy trees and causes damage through mass accumulation. Females usually colonize the base of secondary branches, resulting in localized branch dieback. Additionally, aside from negatively impacting the tree's health, these attacks weaken its structure, posing a potential hazard to both people and property.

In Israel, *E. fornicatus* has caused severe impacts to the avocado industry (Mendel *et al.*, 2012). In South Africa, it is considered the most damaging tree pest introduced in the country, with high impacts in urban environments (Paap *et al.*, 2020). In Argentina, it was found colonizing the main trunks and the base of secondary branches of maples, although other hosts were reported (Ceriani-Nakamurakare *et al.,* 2023). This colonization led to localized branch dieback and/or structural damage within a span of less than 12 months, while complete tree death typically occurs around 24 months. In California (United States), it poses a great ecological and environmental threat to infested areas by attacking a wide range of ornamental, and agriculturally important hardwood species hosts (Chen *et al.*, 2020).

Control

Management is based on early detection, sanitation measures and preventive measures. Infested branches should be removed and destroyed (chipped, burned or buried). Heavily infested trees need to be destroyed (chipped, burned, or covered by a tarp under direct sun for 'solarization'). Solarization works best using polyethylene sheeting during high temperature months, with ambient temperatures at least 35°C (95°F) (Jones & Paine, 2015).

Injecting systemic insecticides can help with protection of high-value ornamental trees. Preventative treatments with emamectin benzoate alone (systemic insecticide) or combined with propiconazole (systemic fungicide), reduces significantly the attack and colonization of *E. fornicatus* (Grosman *et al.*, 2019). Injection into trees that are already infested typically does not work. Preventative insecticide sprays on bark surface work for ambrosia beetles, but need to be re-applied frequently because the effect only lasts between 4 and 8 weeks. Bark penetrant should be used to assure an extended effect.

Phytosanitary risk

A very wide range of host plants have been recorded for many of the species of *Euwallacea* and related genera. Any woody material of a suitable size and moisture content may be infested. The direct risk of establishment of populations of *E. fornicatus* into areas of the world outside its present distribution, and particularly into further tropical and subtropical parts of Africa and the Americas, should be considered as a serious threat to natural and planted ecosystems. In the EPPO region, incursions in glasshouses show that pathways for entry do exist, and the presence of *E. fornicatus* in Israel demonstrates that the pest has the potential to establish and cause damage on avocadoes in the Southern part of the region. Following a pest risk analysis, it has been considered that this insect (and its associated symbiont) was a serious threat to fruit crops and other woody plants grown for agricultural, forestry, and ornamental purposes (EPPO, 2021).

PHYTOSANITARY MEASURES

The increasing global movement of commodities has increased significantly the transport of *E. fornicatus* and related species in timber and wood packaging material, such as dunnage and crating. International Standards for Phytosanitary Measures No. 15 (ISPM 15) provides guidance for establishing measures to reduce the risk of pests associated with all types of wood packaging material. ISPM 15 affects all wood packaging material (pallets, crates, dunnage, etc.) and requires that they be debarked and then treated, and stamped or branded with a mark of compliance. Round wood or sawn wood (with or without bark) of host trees, as well as wood chips and other wooden products, should come from a pest free area or should have been treated to eliminate the pest. For host plants for planting, it may be required that they should originate from pest-free areas or pest-free production sites where plants

are grown under physical isolation (EPPO, 2021).

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