# EPPO Datasheet: *Agrilus bilineatus*

Last updated: 2020-04-22

## IDENTITY

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**Preferred name:** *Agrilus bilineatus*
**Authority:** (Weber)
**Taxonomic position:** Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Buprestidae
**Other scientific names:** *Agrilus aurolineatus* Gory, *Agrilus bivittatus* Kirby, *Agrilus flavolineatus* Mannerheim, *Buprestis bilineata* Weber
**Common names:** two-lined chestnut borer, twolined chestnut borer (US)
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**EPPO Categorization:** A2 list, Alert list (formerly)
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**EPPO Code:** AGRLBL

## HOSTS

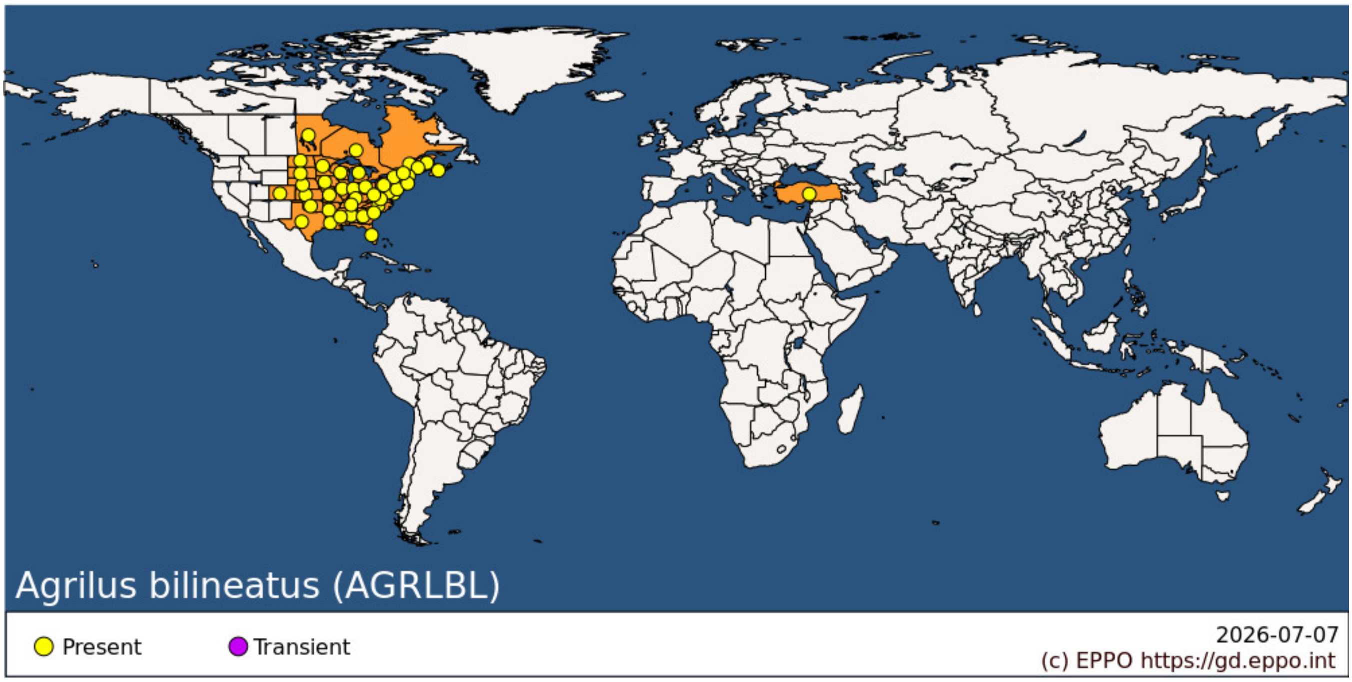
In North America, *A. bilineatus* attacks *Castanea dentata* (Fagaceae) and numerous species of North American *Quercus* species (Fagaceae), including *Q. alba, Q. coccinea, Q. ellipsoidalis, Q. fusiformis, Q. lyrata, Q. macrocarpa, Q. marilandica,, Q. michauxii, Q. muehlenbergii, Q. nigra, Q. palustris, Q. prinus (= Q. montana), Q. robur, Q. rubra, Q. stellata, Q. texana (= Q. nuttallii* and *Q. shumardii* var. *texana), Q. velutina* and *Q. virginiana* (Chittenden, 1900; Chapman, 1915; Fisher, 1928; Haack, 1986; Lewis, 1987; Haack & Accavatti, 1992; Solomon, 1995; Nelson & Hespenheide, 1998; Nelson *et al*., 2008; Jendek & Poláková, 2014; Petrice & Haack, 2014; EPPO, 2019). Complete development of *A. bilineatus* in the European species, *Q. robur* (pedunculate oak), has also been documented in Michigan (Haack,1986; Petrice & Haack, 2014).

**Host list:** *Castanea dentata*, *Castanea*, *Quercus alba*, *Quercus coccinea*, *Quercus ellipsoidalis*, *Quercus fusiformis*, *Quercus lyrata*, *Quercus macrocarpa*, *Quercus marilandica*, *Quercus michauxii*, *Quercus muehlenbergii*, *Quercus nigra*, *Quercus palustris*, *Quercus prinus*, *Quercus robur*, *Quercus rubra*, *Quercus stellata*, *Quercus texana*, *Quercus velutina*, *Quercus virginiana*, *Quercus*

## GEOGRAPHICAL DISTRIBUTION

*A. bilineatus* is endemic to eastern North America in regions where chestnut (*Castanea*) and oak (*Quercus*) are native. The range of *A. bilineatus* extends from New Brunswick westward to Manitoba in Canada, southward to Texas and eastward to Florida (Horn, 1891; Hopkins, 1894; Chapman, 1915; Fisher, 1928; Haack, 1980; Nelson *et al*., 1981; Dunn *et al.*, 1986a; Bright, 1987; Nelson, 1987; Nelson *et al*., 2008; Hansen *et al*., 2012; Fauske, 2018; EPPO, 2019; TFPR, 2011; Webster & DeMerchant, 2012).

In the EPPO region, *A. bilineatus* adults have been collected in Turkey in two separate years (2013, 2016) and at two locations over 200 km apart (near and to the east of Istanbul) (Jendek, 2016; H?zal & Arslangündogdu, 2018). *A. bilineatus* is considered to be established in Turkey (EPPO, 2019).




**EPPO Region:** Türkiye
**North America:** Canada (Manitoba, New Brunswick, Nova Scotia, Ontario, Québec), United States of America (Alabama, Arkansas, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin)

## BIOLOGY

Throughout its range, *A. bilineatus* usually completes its life cycle in a single year, although some individuals can require 2 years (Cote & Allen, 1980), which may be attributed to slower larval developmental rates in vigorous hosts, populations that occur where summers are cool and short, or individuals that develop from eggs that are laid in late summer (Chamorro *et al.*, 2015). Last-instar larvae need to experience an extended cold period before they will pupate and transform to adults, as is common in many *Agrilus* species that develop in temperate latitudes (Chamorro *et al*., 2015; Reed *et al.*, 2018).

After emerging, adults fly to the crowns of trees and feed on foliage (Chapman, 1915; Dunbar & Stephens, 1976). Such feeding is required for adults to become sexually mature.

Adults mate on the trunks and branches of host trees, as well as nearby plants and wood piles (Chapman, 1915). In a field study, *A. bilineatus* males were attracted to caged females (Dunn & Potter, 1988), suggesting a pheromone was involved but none has yet been discovered. In the closely related species *A. planipennis*, males were found to use contact and short-range pheromones in addition to visual cues for locating females (Lelito *et al*., 2007; Poland *et al.*, 2015).

Females deposit eggs in bark cracks and crevices, often singularly or sometimes in groups (Chapman, 1915; Haack & Benjamin, 1982). Females secrete a substance over the eggs (Chapman, 1915), which probably aids in cementing the eggs to the host and reducing desiccation (Chamorro *et al.*, 2015). Females oviposit on different sized host material from the base of the tree trunk to branches as small as 2–4 cm in diameter (Chapman, 1915). *A. bilineatus* larvae usually hatch from eggs in 10–14 days (Chapman, 1915; Dunbar & Stephens, 1976) and immediately tunnel into the bark. First-instar larvae enter the bark directly from the side of the egg attached to the bark, and therefore are never exposed on the bark surface (Chapman, 1915). Larvae tunnel in the cambial region, scoring both the inner bark (phloem) and outer sapwood (xylem). Larval galleries tend to meander or form a zig-zag pattern, with early instars (first and second) tending to tunnel in any direction, but late instars (third and fourth) tending to tunnel across the wood grain (Chapman, 1915). The larval galleries are packed with frass (Haack, 1985). Larvae typically tunnel into the outer sapwood or the outer bark to moult and then return to the cambial region to feed (Chapman, 1915). Total gallery length for all instars can extend more than 80 centimetres (Chapman, 1915).

Starting in late summer, mature fourth (last) instar larvae prepare individual pupal cells in either the outer bark, if the bark is sufficiently thick, or the outer sapwood (Chapman, 1915; Petrice & Haack, 2014). Before constructing the pupal cell, larvae extend their gallery close to the outer bark surface, which creates a pathway that the future adult will enlarge with its mandibles and use to exit the tree the following year (Chamorro *et al.*, 2015). The pupal cell is about half the length of the mature larva's body. The larva creates the cell by tunnelling so that its head remains close to the ventral side of its body and continues until the head nears the tip of the abdomen, thus situating itself in a J-shaped position to overwinter. In Wisconsin, some larvae begin to construct pupal cells in August, while by October nearly all fourth-instar larvae have constructed pupal cells (Haack & Benjamin, 1982). Larvae that are still early instars in autumn will remain in the cambial region during winter. These larvae resume feeding the following spring and summer, and construct their pupal cell after they are mature, thus overwintering twice before emergence. Immature larvae that overwinter in the cambial region often suffer higher mortality than those that overwinter in pupal cells (Dunbar & Stephens, 1976). Within individual trees, larvae feeding in the upper branches and crown tend to construct pupal cells earlier than those in the trunk (Haack & Benjamin, 1982).

Pupation occurs in spring and early summer. Within the pupal cell, the J-shaped mature larva becomes a prepupa by contracting its body to about half its former length and straightening out with its head pointing outward towards the bark surface (Chapman, 1915). The prepupa then moults to the pupal stage. In Wisconsin, pupation occurs from late April into July, peaking in May (Haack & Benjamin, 1982). Pupation was reported to last an average of 10 days indoors by Chapman (1915) and an average of 12 days at 24°C or 9 days at 30°C by Haack & Benjamin (1982).

A new adult remains generally motionless within its pupal cell for the first 2 days after eclosion, allowing time for its cuticle to harden, and then it begins to enlarge the exit tunnel it initiated earlier as a larva and finally emerges from the tree in approximately 3 days at 24°C or 2 days at 30°C (Haack & Benjamin, 1982). The exit hole is about 5 mm wide, D-shaped as in a semicircle, with the flat side of the D aligning with the dorsal side of the adult's body (Haack & Acciavatti, 1992). Adults of both sexes live 8–28 days at temperature conditions ranging from 20°C to 30°C. Adult females appear to oviposit preferentially on stressed trees, such as girdled trees (Dunbar & Stephens, 1976; Cote & Allen, 1980; Haack & Benjamin, 1982; Dunn et al., 1986a), perhaps attracted to the volatile chemical compounds released by the trees (Dunn *et al.*, 1986b).

## DETECTION AND IDENTIFICATION

### Signs and symptoms

The first symptom of *A. bilineatus* infestation is wilted foliage on scattered crown branches in late summer (Haack & Acciavatti, 1992). This corresponds to the period when most larvae are third and fourth instars whose feeding galleries score deeper into the xylem tissue and ultimately girdle the tree (Haack & Benjamin, 1982). *Castanea* and *Quercus* have ring-porous xylem. Water is conducted primarily in the outermost annual ring of xylem in ring-porous trees, making them highly susceptible to girdling by cambial feeding insects. The wilted foliage turns brown and remains attached for several weeks or even months. Such branches will not produce new foliage in subsequent years. Tree death can occur in a single year, especially during *A. bilineatus* outbreaks, but tree death over a 2–4 -year period is more common. Infestation usually begins in the crown branches and then moves downward along the lower trunk in subsequent years (Haack & Benjamin, 1982; Haack *et al.*, 1983). There is a succession of other bark- and wood-infesting insects that colonize portions of trees previously infested by *A. bilineatus* (Haack *et al.*, 1983).

The principal signs of infestation are the D-shaped exit holes present on the bark surface that adults construct as they chew through the bark during emergence and the frass-packed meandering galleries that larvae construct in the cambial region between the bark and sapwood (Chapman, 1915; Haack & Acciavatti, 1992). Development of ridges or swelling on the bark surface as a result of callus tissue developing over the larval galleries occasionally occurs on thin-barked trees, especially on branches, but less so on the trunks. Signs of adult feeding on the margin of the leaves may be noticeable in mass infestation.

### Trapping

Applying adhesive to plastic bands wrapped around the lower trunk of girdled host trees has been used to capture flying *A. bilineatus* adults when they land on the stressed trees (Haack & Benjamin, 1982; Dunn *et al.*, 1986a). In addition, *A. bilineatus* adults have been captured on purple, yellow and green sticky traps (Petrice & Haack, 2014), as well as in green funnel traps coated with fluon to increase slipperiness (Petrice & Haack, 2015). Several species of male *Agrilus* are attracted to dead *Agrilus* or 3D-printed adults when used as decoys and placed on host plants (Lelito *et al.*, 2007; Domingue *et al.*, 2015).

### Morphology

*Eggs*

The eggs of *A. bilineatus* are oval, creamy white when first deposited, becoming reddish and then tan as they mature (Chapman, 1915). Eggs are about 1–1.2 mm long, 0.5–0.8 mm wide and 0.3 mm thick (Chapman, 1915, Miller, unpublished data). Eggs can be laid singly, or in clusters, with most clusters containing 2–4 eggs (Chapman, 1915; Haack & Benjamin, 1982).

*Larvae*

Larvae are elongate, legless, creamy white to yellowish and dorsoventrally flattened. The head is dark brown (Petrice & Haack, 2014). There are ten abdominal segments, with the last segment terminating in two brown urogomphi (Chamorro *et al.*, 2012; Petrice & Haack, 2014). The presence of urogomphi is characteristic of Agrilus larvae (Burke, 1917). *A. bilineatus* has four larval instars (Chapman, 1915; Cote & Allen, 1980; Haack & Benjamin, 1982). On emergence from the egg, first-instar larvae measure 1–1.5 mm, while fourth instars reach 18–24 mm (Chapman, 1915). Morphological characters of the urogomphi can be used to distinguish *A. bilineatus* from some other *Agrilus* species, such as the *Quercus*-infesting European species *A. sulcicollis* (Petrice & Haack, 2014), which has become established in North America.

*Pupae*

Pupae, 6–10 mm in length, are creamy white at first, becoming darker as the adult forms (Chapman, 1915).

*Adults*

Adults are elongate and can vary from 5 to 13 mm in length depending on the condition of the host in which they developed (Haack & Acciavatti, 1992). The head of *A. bilineatus* is bronzy green in colour while the thorax and abdomen are mostly black with a greenish tinge (Horn, 1891; Fisher, 1928). There is a yellow stripe along each side of the thorax and also along the centre of each elytron. These stripes are very characteristic of this species as no other *Agrilus* species colonizing oaks in Europe has such stripes. The abdomen has a shiny appearance. Females tend to be more robust than males. However, the main distinguishing character between the sexes is presence of a central groove along the second abdominal sternite on males and the lack thereof on females.

## PATHWAYS FOR MOVEMENT

Natural dispersal through adult flight has not been studied in *A. bilineatus*. However, adults of a related species, *A. planipennis*, flew an average of 1.3 km/day, with some flying more than 7 km/day in flight mill studies (Taylor *et al.*, 2010). Bark- and wood-infesting insects, including most *Agrilus* species, can be transported in live plants as well as wood products such as logs, firewood, solid wood packaging, lumber, bark and wood chips (Meurisse *et al.*, 2019). As for live plants, such as nursery stock, no signs of infestation (e.g. exit holes) are obvious until a year or two after oviposition. Similarly, for the wood products, *Agrilus* individuals would be most likely to complete development in items with some bark (e.g. logs and dunnage), given that *Agrilus* larvae feed in the cambial region and pupate in either the outer bark or outer sapwood. For example, during 1984–2008, there were 49 distinct interceptions of *Agrilus* individuals at US ports-of-entry, of which 5 interceptions were in live plants, 30 in dunnage, 13 in crating and pallets, and 1 at large (Haack, unpublished data). In cut firewood stored outdoors, Petrice & Haack (2007) recorded successful adult emergence of *A. planipennis* for 2 years after infested trees were cut. Although live *Agrilus* life stages could be transported in bark or wood chips (McCullough et al., 2007; Økland *et al.*, 2012), the risk of individuals completing development would be greatest for those transported as J-shaped mature larvae, prepupae,

pupae and pharate adults because they no longer need to feed before transforming to adults or emerging. Another method of inadvertent human-assisted dispersal, although more relevant for already established insects, is through ‘hitchhiking’ whereby *Agrilus* adults are moved on the outside or inside of vehicles (Buck & Marshall, 2008).

## PEST SIGNIFICANCE

### Economic impact

In North America, *A. bilineatus* is usually a secondary pest, infesting and killing *Castanea* and *Quercus* trees weakened by various stress events. For example, widespread *A. bilineatus* outbreaks have frequently followed periods of severe drought (Hursh & Haasis, 1931; Haack & Benjamin, 1982; Mattson & Haack, 1987; Haack & Mattson, 1989; Millers *et al.*, 1989) and defoliation (Knull, 1932; Baker, 1941; Staley, 1965; Nichols, 1968; Kegg, 1971; Dunbar & Stephens, 1975; Wargo, 1977; Cote & Allen, 1980; Haack, 1985; Millers *et al.*, 1989; Stringer *et al* ., 1989; Muzika *et al.*, 2000). Other outbreaks of *A. bilineatus* have followed ice storms, hail damage and late spring frost events (Haack, 1985). Individual trees or small groups of trees have also been killed by *A. bilineatus* in areas where soil compaction has occurred or soil levels have dramatically changed, which can occur during construction in wooded sites (Felt & Bromley, 1932; Haack & Acciavatti, 1992; Koval & Heimann, 1997). Individual outbreaks usually persist for a few years, often subsiding once normal rainfall resumes or defoliator populations fall to endemic levels. *A. bilineatus* has also been reported to infest host trees that were already infected with various tree pathogens, such as the causal agent of armillaria root rot (*Armillaria* spp.; Wargo, 1977; Wargo et al., 1983), oak wilt [*Bretziella fagacearum* (=*Ceratocystis fagacearum*); Stambaugh *et al.*, 1955; Lewis, 1987] and chestnut blight (*Cryphonectria parasitica;* Dunn *et al.*, 1990; Metcalf & Collins, 1911).

At this time, *Q. robur* is the only European tree species known to be highly susceptible to *A. bilineatus*, given that apparently healthy trees were infested and killed in Michigan (Haack, 1986; Haack, unpublished data). *A. bilineatus* also readily attacked *Q. robur* trees in Michigan that were artificially girdled to induce stress, and among these trees *A. bilineatus* attacked trees showing less evidence of stress compared to *A. sulcicollis* (Petrice & Haack, 2014). However, the seed sources of the *Q. robur* trees planted in Michigan likely do not fully represent the total genetic diversity found in Europe. Nevertheless, if European *Castanea* and *Quercus* species are as susceptible to *A. bilineatus* as are Eurasian *Betula* species to the North American borer *A. anxius* (Miller *et al.*, 1991; Nielsen *et al.*, 2011), then *A. bilineatus* could become a devastating forest pest in Europe given the importance of these tree species (Conedera *et al*., 2016; Eaton *et al.*, 2016). Alternatively, *A. bilineatus* could become another important contributing factor to chestnut and oak decline in Europe, joining the many other European borers already present (Evans *et al.*, 2004; Sallé *et al.*, 2014; Reed *et al*., 2018).

### Control

When considering control options for borers such as *Agrilus* species, it is important to consider that *Agrilus* beetles typically infest weakened trees preferentially and the first or second years of infestation may go undetected until exit holes are visible on the bark surface after adults emerge. Therefore, efforts to maintain good tree health have been recommended for decades (Chittenden, 1897; Burke, 1910; Haack & Acciavatti, 1992; Koval & Heimann, 1997). Note that the above relationship between successful *Agrilus* infestation and weakened trees is typical for native *Agrilus* infesting native trees, but when an *Agrilus* species encounters a non-coevolved host tree, the *Agrilus* beetles can often infest and kill apparently healthy trees.

Several control methods have been recommended to lower *A. bilineatus* populations. For example, considering cultural control options, sanitation cutting of infested branches or trees prior to adult emergence, followed by burning or chipping, has long been recommended (Hopkins, 1904; Felt, 1924; Dunbar & Stephens, 1976; Haack, 1985; Haack & Acciavatti, 1992; Koval & Heimann, 1997). Alternatively, cutting infested trees early in summer when most larvae are early instars, and simply allowing the logs to remain in the forest, can greatly reduce subsequent adult emergence because the host tissues dry out too quickly to support complete larval development (Haack & Benjamin, 1980a). Cutting logs in shorter sections can hasten desiccation and increase larval mortality. Chipping of infested wood greatly reduces survival of A. bilineatus (Dunbar & Stephens, 1974) and similarly for other *Agrilus* such as *A. auroguttatus* (Jones *et al*., 2013) and *A. planipennis* (McCullough *et al.*, 2007).

Several insecticides have been used over the past century to protect against or treat host trees with *A. bilineatus* infestation, many of which are now prohibited. Insecticides can also be used to control defoliating insects, which should help maintain host vigour and thus reduce susceptibility to *A. bilineatus* (Felt & Bromley, 1931; Haack & Acciavatti, 1992). Insecticides used to target *A. bilineatus* have been applied as trunk and foliar sprays for leaf-feeding and egg-laying adults, as well as sprays to the bark surface of trees and logs to target the overwintering stages and adults as they chew through the bark (Felt, 1935; Dunbar & Stephens, 1974, 1976; Haack & Benjamin, 1980b; Herms *et al.*, 2014). Since the early 2000s, several new insecticides (e.g. azadirachtin, emamectin benzoate, clothianidin, dinotefuran and imidacloprid) have been tested in the United States for control of *A. auroguttatus* (Coleman *et al.*, 2016, 2017) and *A. planipennis* (Petrice & Haack, 2006; McCullough *et al.*, 2011; Herms *et al.*, 2014; Smitley *et al.*, 2015). The above new classes of insecticides are registered in the United States for other buprestid borers, including *A. bilineatus.* These newer products can be applied as soil drenches, soil injections, trunk injections or cover sprays on the trunk, branches and foliage (Herms *et al.*, 2014). One promising product is emamectin benzoate, a systemic insecticide administered by trunk injection, which has demonstrated 2-year control against both *Agrilus* larvae and leaf-feeding adults (Herms *et al*., 2014; McCullough *et al*., 2011).

In addition to the above control methods, practices that maintain good tree health, such as fertilization and watering, have long been recommended (Dunbar & Stephens, 1976). Such practices are best suited for urban areas or valuable shade trees. However, at a forest stand level, thinning in advance of gypsy moth (Lymantria dispar) defoliation appeared to lessen subsequent *Quercus* mortality caused by *A. bilineatus* (Muzika *et al.*, 1997).

The current heat treatment standard in ISPM 15 for wood packaging materials requires that a minimum core temperature of 56°C be maintained for 30 continuous minutes. Haack and Petrice (unpublished data) recorded 99% *A. bilineatus* mortality in oak logs subjected to 56°C for 30 minutes while holding the heating chamber temperature constant at 65°C or less. However, there was 100% *A. bilineatus* mortality at a core temperature of 56°C when the chamber was held at 70°C or more, or at a core temperature of 60°C no matter the chamber temperature. Given that many commercial kilns run at chamber temperatures exceeding 70°C, complete mortality of *A. bilineatus* life stages would be expected for the vast majority of wood that is heat treated to current ISPM 15 standards.

Several parasitoids and predators of *A. bilineatus* have been reported in the literature. Some of the larval parasitoids include species of *Atanycolus* (Braconidae), *Leluthia* (Braconidae), *Phasgonophora* (Chalcididae), *Spathius* (Braconidae) and *Wroughtonia* (Braconidae) (Hopkins, 1892; Chittenden, 1897; Chapman, 1915; Cote & Allen, 1980; Haack *et al.*, 1981; Petrice & Haack, 2014). Similarly, some of the larval and pupal predators were species of *Adelocera* (Elateridae), *Cymatodera* (Cleridae), *Phyllobaenus* (Cleridae) and *Tenebrioides* (Trogossitidae) (Dunbar & Stephens, 1976; Cote & Allen, 1980; Haack *et al.*, 1981). Various bird species also feed on *A. bilineatus* adults and within-tree life stages (Dunbar & Stephens, 1976; Cote & Allen, 1980).

### Phytosanitary risk

The broad range of *A. bilineatus* in eastern North America, from southern Canada to the southern United States, indicates that *A. bilineatus* can tolerate a wide array of climatic conditions and therefore could likely establish throughout much of the EPPO region where its host trees are present. *Castanea sativa,* the only native species of *Castanea* in Europe, occurs from England and Belgium in northern Europe, southward to Morocco in North Africa, and eastward through southern Europe to Azerbaijan (Conedera *et al.*, 2016). There are many species of *Quercus* in Europe, with some reaching southern Norway, Sweden and Finland (*Q. robur* and *Q. petraea*), while others reach northern Africa (*Q. afares, Q. ilex* and *Q. suber*) (Quercus Portal, 2017). *Q. robur* has the largest geographic range of any of the European oaks, extending from Scotland and Norway in the north to Portugal, Greece and Turkey in the south and eastward in Russia to the Urals (Eaton *et al.*, 2016). *Castanea sativa* and the many European *Quercus* species are important as timber and ornamentals trees, as well as for food for humans and wildlife (Conedera *et al.*, 2016; Eaton *et al.*, 2016). In North America, the only European tree species that *A. bilineatus* has been documented to infest is *Q. robur*. In these situations, both occurring in Michigan, *A. bilineatus* apparently infested and killed *Q. robur* trees planted as ornamentals on the Michigan State University (MSU) campus (Haack, unpublished data), and at two MSU Experimental Forest genetic test sites where it was inter-planted with native *Q. alba* and *Q. rubra* trees (Haack, 1986).

## PHYTOSANITARY MEASURES

*A. bilineatus* was added to the EPPO Alert List in 2018 (EPPO, 2018) and to the EPPO A2 list in 2019. Suggested phytosanitary measures are specified in the pest risk analysis (PRA) performed by EPPO in 2018 (EPPO, 2019) and these are as follows. Plants for planting of *Castanea* spp. and *Quercus* spp. should originate from pest-free areas or pest-free sites of production under complete physical isolation, plants being packed in conditions preventing infestation during transport (or commercialized outside the period where adults are present). Round wood and sawn wood of more than 6 mm thickness of *Castanea* spp. and *Quercus* spp. should either originate in pest-free areas or undergo debarking followed by heat treatment, irradiation or fumigation. Alternatively, the bark may be removed with 2.5 cm of outer xylem. Bark and cut branches of *Castanea* spp. and *Quercus* spp. should originate in pest-free areas. Wood chips, hogwood and processing wood residues should originate in pest-free areas and be stored and transported under control of the NPPO to prevent contamination by adults. Wood packaging material should undergo treatment according to ISPM 15.

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