EPPO Datasheet: *Anoplophora glabripennis*

Last updated: 2020-10-28

IDENTITY

[more photos...]

Preferred name: *Anoplophora glabripennis*
Authority: Motschulsky
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Cerambycidae
Common names: Asian long-horned beetle, Asian longhorn beetle, basicosta white-spotted longicorn beetle, starry sky beetle
[view more common names online...]
EPPO Categorization: A2 list
[view more categorizations online...]
EU Categorization: Emergency measures, A2 Quarantine pest (Annex II B)
EPPO Code: ANOLGL

Notes on taxonomy and nomenclature

Thanks to an intense taxonomical revision, the past confusion existing within the genus *Anoplophora* has been largely resolved. The genus *Anoplophora* currently includes 36 species (Lingafelter & Hoebeke, 2002). *Anoplophora glabripennis* represents a single taxonomic entity, although previous classifications (Wu & Jiang, 1998) included *A. glabripennis* within the *glabripennis*-complex, comprising *A. freyi*, *A. flavomaculata* and *A. coeruleoantennatus* (EFSA, 2019a).

HOSTS

Anoplophora glabripennis is a highly polyphagous cerambycid with a wide host range including several broadleaved tree species in both urban environments and naturally regenerating and planted forests. *Anoplophora glabripennis* is able to complete its life cycle on more than 30 plant species or genera. Although *Acer* spp. appeared to be the most attractive genus (Gao *et al*., 1997; Haack *et al*., 1997; Faccoli & Favaro, 2016) for *A. glabripennis*, its host range differs between native (Asia) and invaded areas (USA, Canada and Europe) (Haack *et al*., 2010).

In its native area (Asia), *A. glabripennis* can infest healthy trees, in particular those belonging to the plant genera *Acer*, *Populus*, *Salix* (e.g., *S. babylonica*, *S. matsudana*) and *Ulmus* (Lingafelter & Hoebeke, 2002; Wang, 2004; Williams *et al*., 2004; Haack, 2006). The major hosts are *Populus* species and hybrids in the section *Aigeiros* (e.g., *P. nigra*, *P. deltoides*, *P.* x *canadensis*) and the Chinese hybrid *P. dakhuanensis* (Hu *et al*., 2009). Some poplars in the other sections (*Alba* and *Tacamahaca*) are also affected, but are only slightly susceptible (Li & Wu, 1993; Haack *et al*., 2010). Other broadleaved plant genera have also been recorded as occasional hosts: *Alnus* spp., *Malus* spp., *Melia* spp., *Morus* spp., *Platanus* spp., *Prunus* spp., *Pyrus* spp., *Robinia* spp., *Rosa* spp., and *Sophora* spp. (Lingafelter & Hoebeke, 2002; Wang, 2004; Wang *et al*., 2005; Smith *et al*., 2009; EFSA, 2019a, b).

In the invaded areas (USA, Canada and Europe), *A. glabripennis* was mainly reported on *Acer* spp., but it is able to complete its life cycle on other broadleaved trees genera: *Aesculus* spp., *Betula* spp., *Cercidiphyllum* spp., *Fraxinus* spp., *Platanus* spp., *Populus* spp., *Salix* spp., *Sorbus* spp., and *Ulmus* spp. (CABI, 2019; Haack *et al*., 2006; Hérard *et al*., 2006; Turgeon *et al*., 2007; Sawyer, 2008; EFSA, 2019a, b). In Europe, different levels of susceptibility are reported on *Populus* spp. (Haack *et al*., 2010; Faccoli & Gatto, 2016).

In Italy, where *A. glabripennis* is still present, during survey activities carried out from 2009 to 2019 on more than 170 000 plants (more than 30 plant genera), *A. glabripennis* has been recorded to infest: *Acer* spp. (*A. campestre*, *A. negundo*, *A. platanoides*, *A. pseudoplatanus*, *A. saccharinum*), *Aesculus* spp., *Betula* spp., *Populus* spp., *Salix* spp. and *Ulmus* spp. (Regione Lombardia, 2020a).

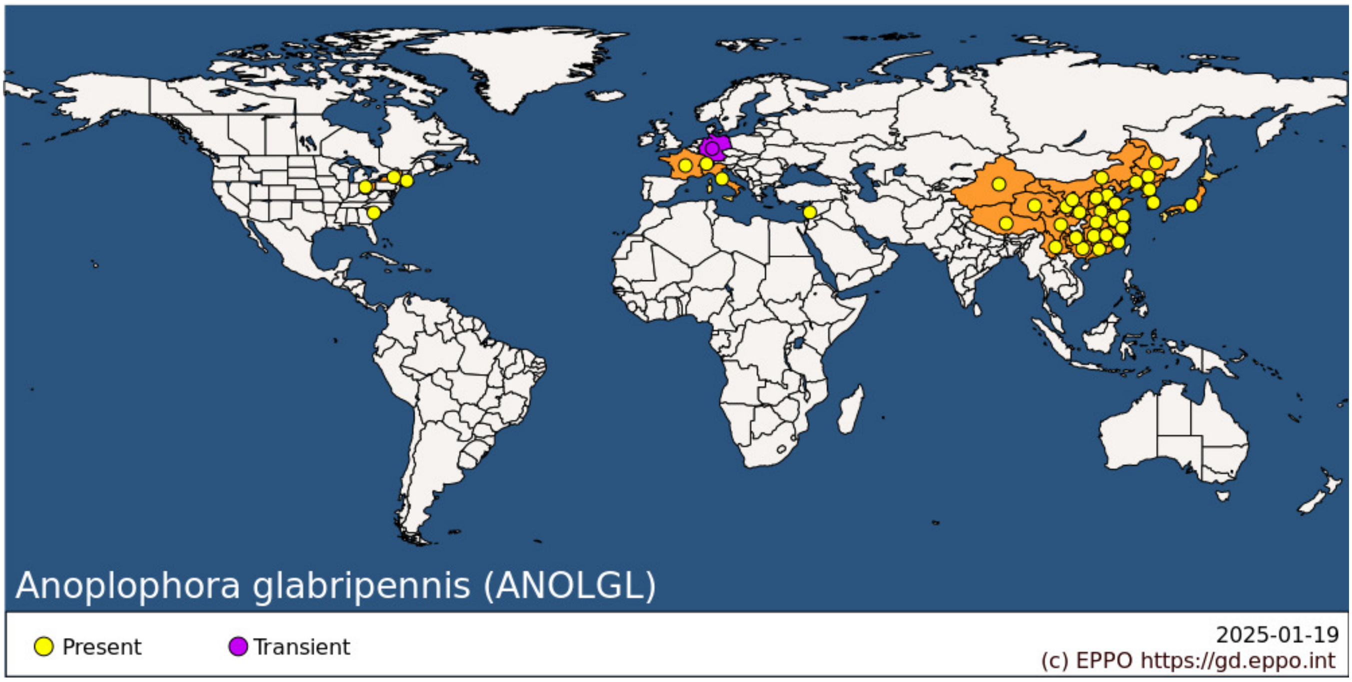
Currently, *A. glabripennis* has never been recorded on conifer trees as well as on one of the most important broadleaved European forest genus, *Quercus*; only *Quercus rubra* was reported as host of *A. glabripennis* in the USA (EPPO, 2013).

Host list: *Acer buergerianum*, *Acer negundo*, *Acer pensylvanicum*, *Acer pictum subsp. mono*, *Acer platanoides*, *Acer pseudoplatanus*, *Acer pseudosieboldianum*, *Acer rubrum*, *Acer saccharinum*, *Acer saccharum*, *Acer tegmentosum*, *Acer truncatum*, *Acer*, *Aesculus hippocastanum*, *Albizia julibrissin*, *Albizia*, *Alnus*, *Betula nigra*, *Betula pendula*, *Betula*, *Broussonetia papyrifera*, *Cajanus cajan*, *Carpinus betulus*, *Carpinus*, *Carya illinoinensis*, *Casuarina*, *Celtis*, *Cercidiphyllum japonicum*, *Cercidiphyllum*, *Corylus colurna*, *Elaeagnus angustifolia*, *Fagus sylvatica*, *Fagus*, *Fraxinus pennsylvanica*, *Fraxinus*, *Gleditsia*, *Koelreuteria paniculata*, *Koelreuteria*, *Mallotus japonicus*, *Malus domestica*, *Malus*, *Melia azedarach*, *Melia*, *Morus alba*, *Morus*, *Platanus occidentalis*, *Platanus orientalis*, *Platanus*, *Populus balsamifera*, *Populus cathayana*, *Populus deltoides*, *Populus lasiocarpa*, *Populus maximowiczii*, *Populus nigra*, *Populus simonii*, *Populus x canadensis*, *Populus*, *Prunus serrulata*, *Prunus x yedoensis* , *Pyrus bretschneideri*, *Quercus rubra*, *Salix babylonica*, *Salix nigra*, *Salix*, *Sorbus aucuparia*, *Sorbus*, *Ulmus americana*, *Ulmus parvifolia*, *Ulmus pumila*, *Ulmus*, *Vernicia montana*

GEOGRAPHICAL DISTRIBUTION

A. glabripennis is native to China and the Korean Peninsula (Lingafelter & Hoebeke, 2002); currently, it is present in most Chinese provinces. Specimens have been recorded in Japan, but the beetle is not considered to be established in the area (pest eradicated; Lingafalter & Hoebeke, 2002). *A. glabripennis* has been accidentally introduced in North America (USA and Canada) and Europe through international trade on wood packaging materials and it continues to be intercepted worldwide. In North America, the beetle was officially detected in the USA in 1996. *A. glabripennis* is present in Massachusetts, New York, Ohio and South Carolina with few occurrences or limited distribution (EPPO, 2020a). As a result of intensive surveys and strict phytosanitary measures, *A. glabripennis* was officially declared eradicated in Illinois and New Jersey in March 2008. Nevertheless, in August 2008 a specimen was detected in the city of Deerfield (Illinois), but no new infested trees have been identified since then. Additional interceptions were also reported in California and Washington, but the incursions have not led to the establishment of the pest (EPPO, 2020a). In Canada, *A. glabripennis* was first detected in Ontario, near Toronto, in 2003 (Turgeon *et al*., 2015), but the population was successfully eradicated. A second outbreak was detected in the city of Mississauga (near Toronto) in September 2013 (EPPO RS, 2014, 2015). After five years of surveys with no detection of this pest, the NPPO of Canada officially declared the successful eradication of *A. glabripennis* in the cities of Mississauga and Toronto, and as a consequence from its whole territory (EPPO RS, 2020).

In Europe the first record was in Austria in 2001 (Hérard *et al*., 2006). In Italy *A. glabripennis* was first found in 2007 in Lombardia Region (EPPO RS, 2007/166, 2014/023). It was later found in Veneto, Marche and Piemonte Regions in 2009, 2013 and 2018, respectively. Additional local outbreaks have been observed in other European countries and new interceptions are frequently reported (EPPO, 2020a). The beetle has been detected in Lebanon in 2015 and 2016 (Moussa & Cocquempot, 2017). However, in all new outbreaks it is subject to eradication measures. In January 2021, Austria declared the successful eradication of the pest from its territory.



EPPO Region: France (mainland), Germany, Italy (mainland), Switzerland
Asia: China (Anhui, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hebei, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Jilin, Liaoning, Neimenggu, Ningxia, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan, Xinjiang, Xizhang, Yunnan, Zhejiang), Japan (Honshu), Korea Dem. People's Republic, Korea, Republic, Lebanon
North America: United States of America (Massachusetts, New York, Ohio, South Carolina)

BIOLOGY

A. glabripennis generally takes one year to complete its life cycle, although it can also take two to three years depending on climatic and feeding conditions (Hua *et al*., 1992; Haack *et al*., 2010). Thus, there can be one or two generations per year. In China, the length of the lifecycle varies with climate and latitude. The further north *A. glabripennis* is found, the longer it takes for a generation to develop. In Eastern China, a generation may take one or two years to develop, while in Northern China (Neimenggu), a single generation takes two years to develop. Similar behavior was observed in Europe, where full development typically requires approximately one year in Italy and two to three years in infested areas located north of the Alps (EFSA, 2019a).

Depending on local temperatures, adults have been observed from April to December, with peak activity usually in May to July (Haack *et al*., 2010). For instance, Faccoli *et al*. (2015) stated that 90% of the beetles emergence was reached around 20th July in Italy in three consecutive years (2010-2012). The adults usually remain on the tree from which they emerged for 10-15 days before oviposition, or fly short distances to nearby trees, and feed on twigs, petioles and veins of leaves. Mate-finding is mediated by contact and short-range pheromones (He & Huang, 1993; Zhang *et al*., 2002, 2003). Although adult survival for longer than 70 days has also been recorded (Faccoli *et al*., 2015), the mean lifespan is approximately one month (Li & Wu, 1993; Faccoli *et al*., 2015) with no significant differences between males and females. Adult longevity and fecundity are influenced by the larval host plant and temperature conditions (He & Huang, 1993; Smith *et al*., 2002; Morewood *et al*., 2003; Keena, 2002, 2006; Hajek & Kalb, 2007). Egg deposition begins a week after copulation. The eggs, about 30-32 per female (Wong & Mong, 1986), are laid one by one under the bark, in oviposition slits chewed out by the female. In Northern Italy, Faccoli *et al*. (2016) reported a fecundity of 60 eggs per female. Slits are generally cut on the eastern side of the trunk or of branches greater than 5 cm in diameter (Li & Wu, 1993). Eggs hatch after about two weeks. The larva feeds in the cambial layer of bark in the branches and trunk and later enters the woody tissues. Larvae expel frass from their tunnels near the original oviposition site. Most individuals overwinter as larvae. Larvae appear to need to reach a critical weight before overwintering to induce pupation the next summer (Keena, 2005). In late spring and early summer, pupation takes place in chambers in the heartwood, accompanied by presence of characteristic wood ‘shavings’ that are packed into the chamber. Adults emerge from circular exit holes above the sites where the eggs were laid; holes measure 10-15 mm in diameter (EFSA, 2019a), but can range from 6 to 20 mm (Yan & Qin, 1992; Lingafelter & Hoebeke, 2002; Turgeon *et al*., 2007). Unlike many cerambycid species, *A. glabripennis* can attack healthy trees as well as trees under stress. Several generations can develop within an individual tree, leading eventually to its death.

DETECTION AND IDENTIFICATION

Symptoms

Most of the symptoms of *A. glabripennis* tend to be detected from approximately 1.5 m above the ground up to the middle of the crown (EPPO, 2013) and are associated with the activities of its different life stages (Ric *et al*., 2007; Haack *et al*., 2010; EFSA, 2019a): 1) the female oviposition activity – rounded pits are visible on the bark for few weeks after oviposition and the sap oozing out of freshly cut pits may be also observed; occasionally, *A. glabripennis* produces T-shaped oviposition slits which are the same as those produced by *A. chinensis* (Haack *et al*., 2010); 2) the larvae feeding activity within the wood – galleries under the bark and, later, tunnels in the wood can be recognized; given that the frass is deposited within the larval galleries, the presence of large amounts of frass and wood shavings is rare; 3) the emergence of mature adults – circular exit holes (10-15 mm in diameter), usually located above oviposition pits, are visible on the upper part of the trunk and main branches; masses of wood shavings extruding from round exit holes are also signs that adults have emerged from infested wood. Piles of wood shavings also collect at the base of infested trees; 4) the adult feeding activity – leaves, petioles, the bark of young branches (1-3 years) and shoots can be damaged; however, feeding sites of the adults are visible only for few weeks (EFSA, 2019a). Damage to woody tissue (Sjöman *et al*., 2014) results in heavy sap flow from wounds which are then liable to attack by secondary pests and pathogens.

More general symptoms can be observed on trees these include wilting foliage, sectorial crown discoloration, branch desiccation and deformation of bark. However, it should be noted that the crowns remain asymptomatic for at least 3-4 years after the beginning of the infestation. Although larval galleries cannot be observed on living trees, they are a useful indicator of infestation on processed wood (e.g., wood packaging material).

Morphology

Eggs

The eggs are 5-7 mm in length, oblong, with a shape similar to a rice grain (Lieu, 1945; Lingafelter & Hoebeke, 2002; EFSA, 2019a). When laid, the egg is white, but during development it becomes yellowish-brown. The ends of the eggs are slightly concave (Peng and Liu, 1992).

Larvae

The larvae comprise a head segment, three thoracic segments and several abdominal segments. The head is brown, while thoracic and abdominal segments are typically cream coloured. The first segment of the thorax is the largest and has a brown sclerotized shield on the dorsal side. The body tapers from thorax to abdomen. The young larvae measure between 7 and 20 mm, the mature larvae between 30 and 60 mm (Cavey *et al*., 1998; Ric *et al*., 2007; EFSA, 2019a). Larvae have neither legs nor bristles.

Pupae

The pupae are whitish, 27-38 mm by 11 mm (Lieu, 1945; Lingafelter & Hoebeke, 2002; Ric *et al*., 2007). The shape is typical of cerambycids with antenna which are visible in the ventral position and spiral-shaped (EFSA, 2019a).

Adults

Adults have a typically cerambycid shape. Males are 19-32 mm long by 6.5-11 mm wide; females are 22-36 mm long by 8-12 mm wide (Ric *et al*., 2007). The body is jet-black, glossy and may have a bluish tinge. The elytra have about 10-20 distinct irregular-shaped white or yellow spots, although in rare instances the number of patches ranges from 0 to over 60 (Lingafelter & Hoebeke, 2002; pers. comm. Dr M Faccoli, University of Padova, 2019). The major distinction between the adults of *A. glabripennis* and *A. chinensis*, the citrus long-horned beetle, is the lack of small projections (tubercles) on the basal quarter of each elytron in *A. glabripennis* (Thomas, 2004; Haack *et al*., 2010; EPPO, 2016a). The antennae have 11 segments with an alternate blue-white and blue-black banding pattern (Ric *et al*., 2006). Males have antennae which are clearly longer than their body, while in females these are as long as their body (EFSA, 2019a). The ratio of antennal length to body length ranges is about 1.6-2.5 for males and 1.2-1.8 for females (Ric *et al*., 2007).

Detection and inspection methods

Visual inspections and traps

The visual inspection of plants to detect the presence of *A. glabripennis* (in its various life stages) and/or the signs of infestation is pivotal, representing the first stage of the diagnosis process. The visual inspection should be performed at crown level where oviposition and adult emergence occur. Depending on survey conditions and to improve the pest detection, the inspections can be conducted using binoculars, bucket trucks or tree climbers (Haack *et al*., 2010). In some European countries, the visual inspection of plants is performed both in summer, to detect symptoms of the activities of different life stages of the pest, and in winter, to detect the circular exit holes of adults (EFSA, 2019a). Lombardia Region (Italy) considers that the most effective surveillance strategy is to carry out survey activities at the end of the summer to detect fresh signs of pest presence and repeat them during the period of absence of leaves by combining the use of binoculars, bucket trucks and tree climbers (Regione Lombardia, 2020a).

However, other detection methods can be useful to improve the inspection process. In several EPPO countries the use of sniffer dogs can be a sensitive and useful inspection strategy (Hoyer-Tomiczek *et al*., 2016).

A real-time PCR test allowing the detection of *A. glabripennis* DNA in frass is under development (pers. comm. Dr A Taddei, ANSES Plant Health Laboratory, FR, 2020).

Traps baited with male pheromones and different combinations of plant-derived volatiles can be used to catch adults of *A. glabripennis*. Traps can be used to monitor the areas where *A. glabripennis* has not yet been detected and to delimit the boundaries of an area considered to be infested by *A. glabripennis* (EFSA, 2019a). In Italy (Lombardia Region), where traps have been used for many years, the best results have been obtained in the recently discovered outbreaks and in those where eradication is close to being achieved. In addition, the traps are used for early detection in sites considered to be at risk (e.g., stone importers from areas where the pest is widely distributed) (Regione Lombardia, 2020a).

Additional information on tree monitoring is available in EPPO Standard PM 9/15(1) (EPPO, 2013).

Finally, activities to raise professional and public awareness concerning the threat of *A. glabripennis* are important. For instance, in the Lombardia Region (Italy), since the beginning of the infestation (Maspero *et al*., 2007), a notable communication campaign has been held (Ciampitti & Cavagna, 2014). Citizens also support the surveillance of *A. glabripennis* through the citizen science app FitoDetective (Regione Lombardia, 2020b).

Identification of **A. glabripennis**

Morphological identification of *A. glabripennis* is possible on late instar larvae and adults. For this purpose, a number of useful taxonomical keys and guides are available in the literature (e.g., Lingafelter & Hoebecke, 2002; Ric *et al*., 2007; Pennacchio *et al*., 2012). An EPPO diagnostic protocol for this pest is in preparation. Molecular identification of specimens can be performed using DNA barcoding (see EPPO Standard PM 7/129 (EPPO, 2016b)). In the Barcode of Life Data System (**BOLDSYSTEMS**), sequences of at least 50 haplotypes are available. In EPPO-Q-bank, sequences from 16 curated specimens are available (**EPPO-Q-bank**).

PATHWAYS FOR MOVEMENT

In international trade, *A. glabripennis* is most likely to move as eggs, larvae or pupae in packing material or dunnage made of the wood of host species. Individual larvae and adults have been intercepted in several EPPO countries in wooden packaging material (CABI, 2019). The import of plants for planting, including bonsais, may represent another pathway for the introduction of *A. glabripennis* (EPPO, 2013).

In natural conditions *A. glabripennis* spreads slowly. The maximum annual spread rate was estimated at 300 m from the closest infested trees (Smith *et al*., 2004; Favaro *et al*., 2015). Sometimes, adults can move further than 2 km (Favaro *et al*., 2015). However, adults are able to complete their maturation feeding on the same tree without the need to fly far (Favaro *et al*., 2015). In experimental conditions, adults can cover distances up to 14 km (Javal, 2017).

PEST SIGNIFICANCE

Economic impact

Over the last 30-40 years, there has been a policy in China to plant hybrid poplars in plantations, along roads, around farm buildings, etc. This started in Henan and Shandong provinces, but was eventually applied in most of the country. Initially, only few hybrids were used, but in vast number. Some of these hybrids were imported from other continents, while others were bred in China. Some of these, but not all, proved to be very susceptible to *A. glabripennis* and suffered serious damage. *A. glabripennis* has proliferated on these susceptible hosts, becoming a common pest in many parts of China, also attacking a range of other hardwood hosts, especially *Salix* spp. These hosts appear to be mainly fruit, ornamental and amenity trees. Since the 1980s, hybrids which are resistant to the pest have been used for new plantations of poplar (Pan, 2005), and there has been a corresponding decline in the importance of *A. glabripennis.* There is no indication that *A. glabripennis* is a pest of natural forests in China. Poplar wood damaged by *A. glabripennis* larvae can be downgraded and lose value by up to 46% (Gao *et al*., 1993).

In North America and Europe, *A. glabripennis* represents a significant threat especially in urban landscapes. Indeed, the structural weakening of trees caused by larvae activity within woody tissues poses a danger to pedestrians and vehicles from falling branches.

At a world scale, the costs for *A. glabripennis* eradication programs vary depending on the number and size of outbreaks, the length of time since discovery and the type of treatments used (Faccoli & Gatto, 2016). In China, *A. glabripennis* caused about 1.5 billion USD of economic losses per year, corresponding to 12% of economic losses from forest pests (Hu *et al*., 2009). In the USA, its maximum potential impact is estimated at 669 billion USD, with a loss of almost 35% of the canopy and of 30% tree mortality (Nowak *et al*., 2001). In New York State, the suppressing program of 1996 infestation cost more than 4 million USD (USDA, 1998). Between 1998 and 2006, the USA invested nearly 249 million USD in eradication programs (Smith *et al*., 2009). Haack *et al*. (2010) stated that, as of 2008, total costs for eradication programs were 373 million USD in USA, 464 000 EUR in Austria, 55 000 EUR in France, 65 000 EUR in Germany and 23.5 million CAD in Canada. In 2015, a study was performed to quantify the costs of *A. glabripennis* in the first year of the eradication program in Northern Italy (Faccoli & Gatto, 2016). 367 infested trees were removed, and the total costs amounted to 48 000 EUR (41% for plant removal, 38% for trees survey and 21% for scientific advice). The expected damage in the following year was reduced by 52%; the ornamental value of the saved trees was 6 times higher than the costs for their protection (Faccoli & Gatto, 2016).

Control

In China, control measures include the direct application of insecticides (Chen *et al*., 1990; Liang *et al*., 1997), trap trees combined with insecticide treatments (Sun *et al*., 1990) or the use of insect-pathogenic nematodes (providing up to 94% mortality; Liu *et al*., 1992). As certain poplar hybrids are relatively resistant (Qin *et al*., 1996), the planting of such hybrids is now preferred, and the use of very susceptible hybrids is avoided.

In North America and Europe, *A. glabripennis* is subject to eradication, a long process requiring continued efforts for monitoring and cutting down trees. The infested sites are monitored to identify newly attacked trees, which are cut down and chipped. The deriving wood material is transported, under official control, to an approved processing facility (e.g., waste-to-energy plant).

Beginning in the first year of detection of the infestations in North America and Europe, major eradication efforts were implemented in each infested site. However, *A. glabripennis* adults and newly infested trees were recorded each year in most sites, even where the initial size of the infestation was limited (Hérard *et al*., 2009). In the USA, control measures aim to contain and eradicate the outbreaks in urban areas. However, the cryptic lifestyle and tendency of the beetle to lay small numbers of eggs on several trees combine to make it difficult to define the limits of the outbreak and thus eradicate the beetle without destroying large numbers of trees. In most situations, wholesale felling of infested trees is unlikely to be a viable option, unless the infestation is very localized. For the EPPO region, a national regulatory control system for the monitoring, eradication and containment of *A. glabripennis* is available in EPPO Standard PM 9/15(1) (EPPO, 2013).

Phytosanitary risk

A. glabripennis is able to attack and cause damages to fruit, ornamental and forest plants of a very broad range of species. The same plant species may grow in natural forests, in agricultural areas or can be cultivated in urban areas as ornamental trees, however *Anoplophora glabripennis* infestations are often confined to urban isolated trees in the countries where the pest has been introduced (Faccoli et al., 2016).

The availability of host plants is not a limiting factor for its establishment and spread in the EPPO countries as well as climatic conditions, except in the most northern areas.

The number of new outbreaks and interceptions reported since the late 1990s to date, in North America and Europe, show that, despite the implementation of international rules, the risk of accidental introduction of this pest via wood packaging material remains high. For this reason, it is important to implement surveillance and early detection activities in areas with a higher commercial flow.

PHYTOSANITARY MEASURES

The main pathway of *A. glabripennis* is wood packaging material and therefore the most important phytosanitary measure to be applied in international trade is the use of wood packaging that meets the requirements of the ISPM 15.

The survey, felling and destruction of infested trees are effective to reduce population size, prevent spread and, in some circumstances, to attempt eradication (MacLeod *et al*., 2002).

As a general approach, it has also been recommended that when importing plants for planting (except seeds) and wood commodities of *Betula, Fagus, Fraxinus, Populus, Quercus, Salix, and Ulmus* from countries where *A. glabripennis* occurs, precautions should have been taken to avoid any infestations while the consignments are transported through possibly infested areas (EPPO, 2017a, b, c, d; EPPO, 2018; EPPO, 2020b, c).

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