Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Unit for Risk Assessment of Plant Pests

SLU ua 2017.2.6-3393

Date and version number

16 June 2017, Version 1

Rapid Pest Risk Analysis
Xyleborinus attenuatus

This rapid pest risk analysis (PRA) provides a quick assessment of the risks posed by the pest to Sweden, which is the PRA area being assessed. The format is an adapted version of the EPPO Express PRA scheme (EPPO 2012). Definition of terms used as well as the rating scheme and assessments are done in line with the guidance given in the EPPO CAPRA system (EPPO 2011). The likelihood of entry and establishment are assessed considering the current phytosanitary regulation in place with respect to the EU legislation (Council Directive 2000/29/EC). The definition of a quarantine pest follows the regulation (EU) 2016/2031.

Summary

Presence

Xyleborinus attenuatus is established in Sweden. The ambrosia beetle originates from Japan and eastern Russia and has until now spread to 13 European countries as well as to USA and Canada.

Entry, establishment and spread

The likelihood of entry of *Xyleborinus attenuatus* into Sweden is assessed to be very likely. The main pathways of entry are “Wood and wood products” and “Natural spread”. *X. attenuatus* is already established and further spread is assessed to be very likely since suitable host are widely distributed in Sweden, the climate is suitable and the species have a track record of being able to establish in different environments. The rate of spread is assessed to be high based on the species presumed high flight capacity and the high likelihood of spread through transportation of colonized wood material.

Impact

Both the economic, environmental and social impact was assessed to be small since there currently is little support in the easily accessible literature that the pest cause significant damage. Nevertheless, there is a risk for a similar shift towards increased impact as have been recorded for closely related ambrosia beetle species.

Management options

It is assessed to be difficult to prevent further introductions of *X. attenuatus* to Sweden. Current phytosanitary measures such as barking and heat treatment does not completely prevent entry of ambrosia beetles with wood and there is also a risk of natural spread from Denmark.

Assessment in relation to the definition of quarantine pests

The results presented in this rapid PRA shows that *Xyleborinus attenuatus* does not fulfil all of the criteria for a union quarantine pest, e.g. it is widely distributed within the EU territory. In addition, it indicates that *X. attenuatus* does not fulfil all criteria for a protected zone quarantine pest for any part of Sweden, e.g. due to limited possibilities to prevent natural spread from areas where the pest is established and that the impact was assessed to be small.

Key uncertainties and further investigation needed

There is a large uncertainty in the assessment of the future impact of *Xyleborinus attenuatus* due to the potential risk that it may shift from colonizing dead trees to colonizing live trees as has been observed for other closely related beetle-fungus symbioses (Hulcr and Dunn 2011). It would therefore be desirable if the development of *X. attenuatus*, both nationally and internationally, is followed to detect any shift towards increased impact.

Pest risk assessment

1 Name of the pest

Latin name: *Xyleborinus attenuatus*

***Synonyms*:** *Xyleborus attenuatus, Xyleborus attenuatus, Xyleborinus alni*

***Common names*:** Ambrosia beetle

***Taxonomic position*:** *Xyleborinus attenuatus* (Blandford 1894) (Coleoptera: Curculionidae: Scolytinae: Xyleborini)

2 Reason for performing the rapid PRA:

In 2016, *Xyleborinus attenuatus* was trapped in a monitoring program administrated by the Swedish Board of Agriculture.

3 Does a relevant earlier PRA exist?

☒ No

☐ Yes

4 Regulatory status of the pest

Xyleborinus attenuatus is not listed in the EC Plant Health Directive (Council Directive 2000/29/EC) nor in the lists of EPPO.

5 Current area of distribution

Xyleborinus attenuatus is considered to be native in Japan and eastern Russia (e.g. Rabaglia et al. 2006). In eastern Russia it may be considered to be rather common since it in one study accounted for 1.3% of all Scolytinae species trapped (Sweeney et al. 2016). See the homepage ”HISL - PEET Xyleborini” for a comprehensive list of references related to the native distribution of *X. attenuatus*.

X. attenuatus was found in the United States in 1995 (USDA 2011) and it has now been reported from Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Oregon, Pennsylvania and Washington (Gandhi et al. 2010; Hoebeke and Rabagalia 2007; Mudge et al. 2001; Rabaglia et al. 2006). According to the homepage “Bark and Ambrosia Beetles” it has also been found in Connecticut, Idaho, New Hampshire, New Jersey, North Carolina, Rhode Island and Vermont. At that homepage there is also a map of 226 distinct collection events in the United States.

At about the same time, i.e. 1995-1996, *X. attenuatus* was also found in Canada for the first time. It has now been reported from British Columbia, Nova Scotia and Quebec (Popa et al. 2014; Rabaglia et al. 2006; Robideau et al. 2015).

In Europe, the first record of *X. attenuatus* is from 1987 (Knížek 1988).) and it has now been found in:

- Austria (Holzschuh, 1994; Geiser and Geiser 2000)
- Czech Republic (Knizek and Zahradnik 1999; Procházka et al. 2014)
- Denmark (Hansen and Jørum 2014; Pedersen et al. 2010)
- France (Freeman and Grancher 2014)

- Germany (Bussler and Immler 2007; Flechtner 2004; Gebhardt 2002; Möller and Neumann 2000 and according to Entomofauna Germanica (2017) it has been observed in 17 out of 20 regions in Germany (80 sites in total))
- Netherlands (Vorst et al. 2008)
- Poland where it is considered common (Borowski et al. 2012; Borowski et al. 2013; Borowski and Mokrzycki 2016; Mokrzycki 2016; Papis and Mokrzycki 2015)
- Russia (Martynov and Nikulina 2016)
- Slovakia (Galko et al. 2014)
- Spain (Kirkendall and Faccoli (2010) citing another source)
- Sweden (Lindelöw 2012; Lindelöw et al. 2006)
- Switzerland (Wittenberg 2006 citing C. Besuchet, pers. comm.)
- Ukraine (Nikulina et al. 2015 where they also state that it has been recorded from all climatic zones in Ukraine (citing other sources))

However, according to Mokrzycki et al. (2011) the full extent of the current distribution in Europe is not clear, because of a confusion with the closely related *Xyleborinus saxesenii*.

In conclusion it is assessed that *X. attenuatus* is widely distributed within EU according to the criteria defined in regulation (EU) 2016/2031; Annex I; p.73 (Fig. 1).

Figure 1. Map showing European countries where *Xyleborinus attenuatus* has been reported in blue colour.

6 Is the pest present and is it widely distributed in Sweden?

X. attenuatus is already present in Sweden. In total 100 individuals have been observed from in total eight locations within the country (Lindelöw et al. 2006; ARTPORTALEN (https://www.artportalen.se/ accessed 7 June. 2017); Lindelöw, unpublished report to SJV; Fig. 2). Considering that many of these observations were not done close to any harbours it appears unlikely that all of the trapped individuals had hitchhiked with imported infested host material. In conclusion there is strong support for that *X. attenuatus* should be considered established in Sweden (using the ISPM 5 definition of establishment, i.e. “Perpetuation, for the foreseeable future, of a pest within an area after entry”).

X. attenuatus is only *known* to be present in a limited part of its potential distribution area in Sweden (Fig. 2) it is therefore assessed to be not widely distributed (according to the criteria defined in regulation (EU) 2016/2031; Annex I; p.73). It is however likely that the distribution of *X. attenuatus* in Sweden is larger than the current observations indicate due to e.g. i) the species concealed mode of life, ii) that identification requires specialist knowledge and iii) restricted sampling efforts.

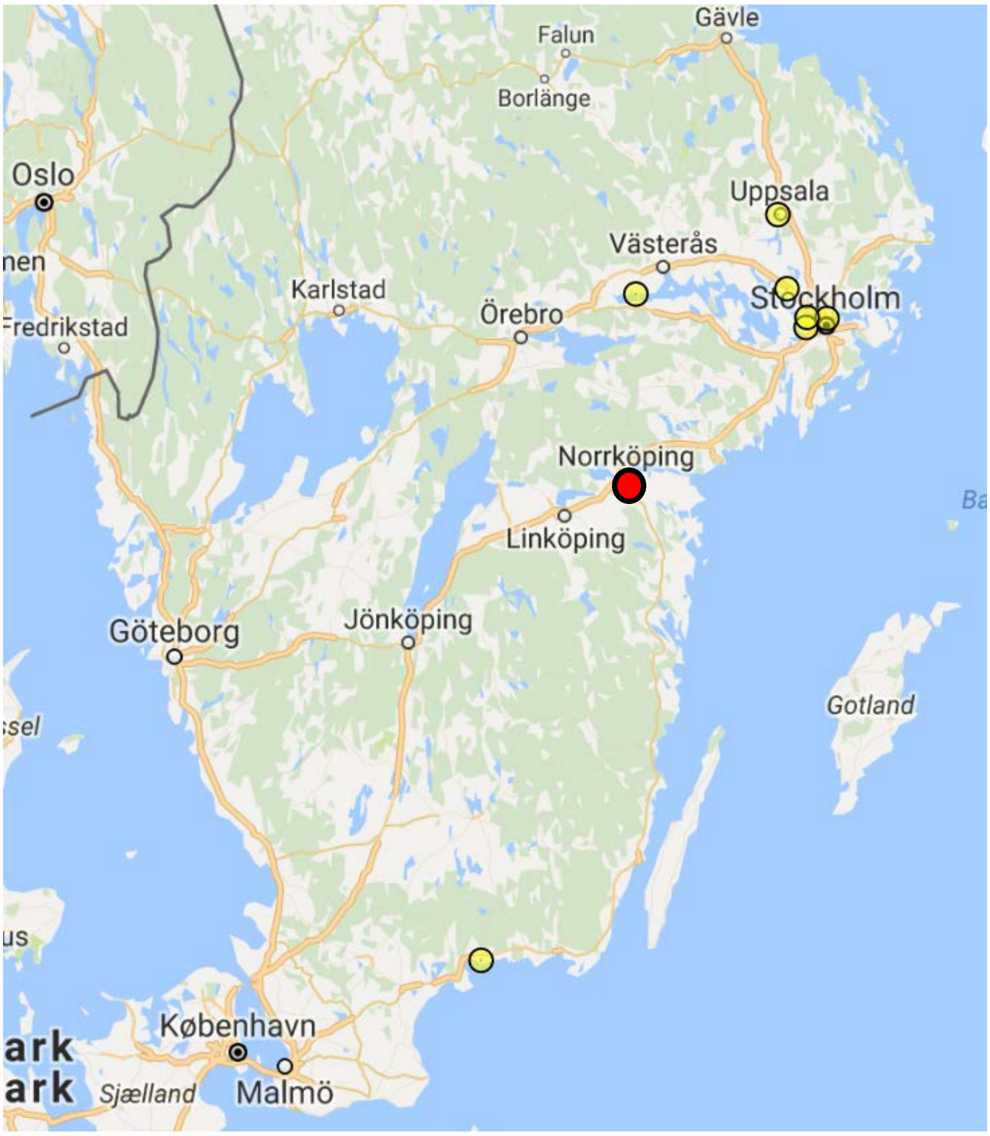

Figure 2. Yellow circles denotes locations where Xyleborinus attenuatus *has been found in Sweden (ARTPORTALEN (https://www.artportalen.se/ accessed 6 June 2017). The red circle denotes the location where* X. attenuatus *was trapped in 2016 in a monitoring program administrated by the Swedish Board of Agriculture (Lindelöw, unpublished report).*

7 Host plants and their occurrence in Sweden

Xyleborinus attenuatus is a polyphagous species that has been found in many deciduous tree species, e.g. willow (*Salix* spp.), alder (*Alnus* spp.), birch (*Betula* spp.) oak (*Quercus* spp.), aspen (*Populus* spp.), ash (*Fraxinus* sp.), lime tree (*Tilia* sp.), hazel (*Corylus*) and *Prunus* sp. (Dodds et al. 2017; Nikulina et al. 2015; Roques et al. 2010; Wood and Bright 1992). In addition, the pest has recently been found on red pine (*Pinus resinosa*), but this was regarded to represent an unlikely new host associations (Dodds et al. 2017). Host species, i.e. deciduous trees, can be found in the whole of Sweden up to the subalpine belt although deciduous forests, which constitutes 1% of the land area of Sweden, is confined to the southern part of the country (Diekmann 1999).

It is important to keep in mind that *X. attenuatus* is an ambrosia beetle and thus does not feed on their host but on the fungi that they grow in their tunnels within the wood. The wide host range may indicate that this species is more limited by finding hosts in a suitable condition (e.g. stressed or recently dead) with a suitable moisture content and density rather than on finding specific deciduous tree species. Such dependence on host condition, rather than specific host species, has been suggested for several closely related species, i.e. *Xylosandrus crassiusculus, Xyleborus volvulus, Xyleborus perforans, Xyleborus perforans, Xyleborus similis, Xylosandrus germanus* and *Xyleborinus saxesenii* (CABI 2015).

8 Is the pest a vector?

Xyleborinus attenuatus live symbiotically with *Ambrosiella* spp. (Nakasima et al. 1992). The *Ambrosiella* fungi may cause staining of the wood around the galleries but is not regarded as pathogenic (CABI 2015). There seems to be no information about that *X. attenuatus* should be a vector of any pathogenic fungi (Humble and Allen 2006).

9 Is a vector needed?

☒ No

☐ Yes

10 Pathways and likelihood of entry into Sweden

Wood and wood products: Wood and wood products are considered to be the most likely pathway for *Xyleborinus attenuatus*. The beetle reside within the wood and are thereby both protected from adverse climatic conditions during transportation and become difficult to detect at points of entry (Rassati et al. 2016). *X. attenuatus* is present in large parts of Europe as well as in several countries in North America and Asia. Wood and wood products of deciduous trees, potentially infested with *X. attenuates*, are imported to Sweden on a regular basis particularly from North America. There is also trade with Russia, parts of Asia and other European countries. For some species/genera of deciduous trees, there are import regulations with special requirements in Directive 2000/29. Although those requirements primarily target other pests they should reduce the risk for introduction of species such *as X. attenuates.*

It is assessed to be much more likely that *X. attenuatus* entered to Sweden through a pathway with imported material rather than by natural spread since the current observations in Sweden are much closer to harbours which import wood than the closest neighbouring country from where *X. attenuatus* has been reported, i.e. Denmark (Fig. 2). The pattern of observations of *X. attenuatus* suggest that it has entered into Sweden at least at three different occasions (Fig. 2).

The efficiency of the different treatments currently used to prevent the entry of pest species in wood varies when it comes to ambrosia beetles. Debarking will not remove the beetles from already colonized material as they are situated in the sapwood nor will it prevent the colonization of wood (Haack and Petrice, 2009). A heat treatment of 56°C for 30 min (e.g. ISPM 15) is sufficient to kill a range of insect (IPPC 2017; USDA 2016). In an experiment where wood was experimentally infested with adults of the closely related species *X. germanus* 100% were killed at 52˚C by hot water treatments and at 58˚C by microwave irradiation (according to the abstract in Suh (2014)). However, such treatments do not prevent the wood from being recolonized with ambrosia beetles should the conducive environmental conditions be fulfilled (Haack and Petrice, 2009). Some fumigant, like methylbromide appear to successfully kill ambrosia beetles in wood (based on the abstract of Oogita et al. (1998)).

Plants for planting: Woody plant stems of deciduous trees may be colonized by *X. attenuatus* and plants for planting is therefore considered a potential pathway. Plant for planting is judged to be a less important pathway than "Wood and wood products" due to the much smaller volumes of suitable hosts material that is transported within this pathway and because attacked living plants frequently shows symptoms that makes it easier to detect and destruct colonized material. This pathway is assessed to be unlikely but with a high uncertainty due to the lack of observations in the literature.

Natural spread: Most scolytids, including species closely related to *X. attenuatus*, are strong flyers allowing wind-aided dispersal of several kilometres (Byers 2000; Grégoire et al. 2001; Henin et al. 2003). Thus, since *X. attenuatus* is present in Denmark the likelihood of entry into Sweden through natural spread is assessed to be likely but with a high uncertainty due to the very limited species specific information in the literature of historical natural spread.

Rating of the likelihood of entry

Pathway	Very unlikely	Unlikely	Moderately likely	Likely	Very likely	Uncertainty rating[a]
Wood and wood products	☐	☐	☐	☐	☒	Low
Plants for planting	☐	☒	☐	☐	☐	High
Natural spread	☐	☐	☐	☒	☐	High

[a)] *Low/medium/high*

11 Likelihood of establishment outdoors and under protected cultivation in Sweden

Establishment outdoors: The likelihood of establishment outdoors is assessed to be very likely since:

- *Xyleborinus attenuatus* is already established in Sweden (see answer to question 6).
- The climate is suitable in a large part of Sweden. The Köppen-Geiger climate type where *X. attenuatus* has been found in Sweden, i.e. Dfb, covers a large part of Sweden since it stretches up to Örnsköldsvik on the east coast and to Torsby on the west side of Sweden (Peel et al 2007). *X. attenuatus* has also been found in this climate type elsewhere, e.g. in Sherbrooke in Canada (45.402406º N; -71.8822763º W; Popa et al. 2014).
- Suitable hosts are widely distributed in Sweden.
- A single individual is enough to initiate a population since ambrosia beetle females are usually already fertilized when they as adults disperse by flight from their natal host tree (due to sibling mating within the natal chamber; Peer and Taborsky 2007). This trait has been shown to promote colonization of new areas (Jordal *et al.* 2001).

Establishment under protected cultivation: The likelihood that *X. attenuatus* will establish on plants grown under protected cultivation is assessed to be very unlikely, but with a high uncertainty, since there does not seem to be any reports of that.

Rating of the likelihood of establishment

	Very unlikely	Unlikely	Moderately likely	Likely	Very likely	Uncertainty rating[a]
Outdoors	☐	☐	☐	☐	☒	Low
Protected cultivation	☒	☐	☐	☐	☐	High

a) Low/medium/high

12 Potential spread after introduction

Most scolytids, including species closely related to *X. attenuatus*, are strong flyers allowing wind-aided dispersal of several kilometers per year (Byers 2000; Grégoire et al. 2001; Henin et al. 2003) and host plants are broadly distributed in Sweden. Human assisted spread through transportation of infested material could become important if the beetle become common in an area. The spread rate is therefore assessed to be moderate, i.e. 1 km to 10 km per year. There is however a high uncertainty due to the restricted empirical data of spread rates from areas where the species have established.

Rating of the magnitude of spread within Sweden

	Very low	Low	Moderate rate	High	Very high	Uncertainty rating[a]
Spread rate	☐	☐	☒	☐	☐	High

[a)]Low/medium/high

13 Economic, environmental and social impact

The endangered area in Sweden is large since available hosts and a suitable climate is found in a major part of the country. There is however little support in the easily accessible literature that the pest cause significant damage. This is in agreement with a previous literature search that showed that there had not been a single report of damage by *X. attenuatus* on living trees in USA (Aukema et al. 2010; USDA 2011).

X. attenuatus is regarded to be a secondary pest (Borowski et al. 2012). The authors conclude that although *X. attenuatus* participated in the process of dying back of alder (*Alnus glutinosa*) stands in Poland the species was not expected to cause die back of alder over a large area.

Ambrosia beetles may also cause wood degradation and dark staining when it excavate its galleries into the sapwood, as a result of their symbiotic fungi (Robideau et al. 2015). Ambrosia beetles in general may cause serious damage as vectors of pathogenic fungi but there seems to be no reports of such associations with *X. attenuatus* (Humble and Allen 2006).

The risk that *X. attenuatus* should cause the extinction of native beetles through competition is assessed to be small. There are some reports that *X. attenuatus* has become relatively common in areas that it has invaded, e.g. in Poland (Borowski et al. 2012; Borowski et al. 2013) but competition between different species of ambrosia beetles is regarded to be minimal in the three-dimensional xylem habitat that they occupy within the wood (Kühnholz 2001).

It cannot be excluded that that the impact of *X. attenuatus* could increase in the future since there are many examples of similar beetle-fungus symbioses that has shifted from colonizing dead trees to colonizing live trees in their introduced ranges (Hulcr and Dunn 2011). Typically this is a shift from being a secondary pest on a wide range of host to becoming a primary pest on a narrow range of hosts. One example is the redbay ambrosia beetle *Xyleborus glabratus*, and its fungal partner *Raffaelea* spp. This symbiosis has started to kill trees of the family Lauraceae within its new range and has eradicated mature redbay (*Persea borbonia*) along the southern Atlantic coast of North America and is now threating the avocado-growing regions (Hulcr and Dunn 2011). Similarly, *X. germanus* had been in the apple growing regions in New York for a long time but it only recently began to kill the trees and now hundreds of trees are killed annually in this region (Agnello et al. 2014, 2016). Subsequently the uncertainty associated with the impact assessment is rated as high.

Rating of the magnitude of potential impact within Sweden

	Very small	Small	Medium	Large	Very large	Uncertainty rating[a]
Economic	☐	☒	☐	☐	☐	High
Environmental	☐	☒	☐	☐	☐	High
Social	☒	☐	☐	☐	☐	High

[a)]Low/medium/high

14 Overall assessment of risk

The results presented in this rapid PRA shows that *Xyleborinus attenuatus* does not fulfil all of the criteria for a union quarantine pest, e.g. it is widely distributed within the EU territory (Fig. 1). In addition, it indicates that *X. attenuatus* does not fulfil all criteria for a protected zone quarantine pest for any part of Sweden, e.g. due to limited possibilities to prevent natural spread from areas where the pest is established and that the impact was assessed to be small.

15 Risk management options

Xyleborinus attenuatus was first found in Sweden in 2002 and since then it has been found in seven more locations (Fig. 2). This indicates that it is now established in such a large area that eradication would be very difficult and require extensive resources.

Prepared by the Unit for Risk Assessment of Plant Pests
Swedish University of Agricultural Sciences

Name of Pest Risk Analyst[s]:
Niklas Björklund (information retrieval and risk assessment) and Johanna Boberg (risk assessment).

Niklas Björklund, Dept. of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, S-750 07 Uppsala, Sweden. Delivery address: Ullsväg 16, E-mail: Niklas.Bjorklund@slu.se

Johanna Boberg, Dept. of Forest Mycology and Plant Pathology, PO Box 7026, SE-750 07 Uppsala, Sweden. Visiting address: Almas allé 5, E-mail: Johanna.Boberg@slu.se

References

Agnello, A., Breth, D., Tee, E., Cox, K., & Warren, H. R. (2014). Ambrosia beetle–an emergent apple pest. *Harvest Math 101*, *518*, 25. LINK

Agnello, A, Breth, D, Davis, A. and Tee, E. (2016) Ambrosia beetle (*Xylosandrus germanus*) infestations and management trials in high-density apple orchards. Report, Dept. of Entomology, Cornell University. LINK

Aukema, J. E., McCullough, D. G., Von Holle, B., Liebhold, A. M., Britton, K., & Frankel, S. J. (2010). Historical accumulation of nonindigenous forest pests in the continental United States. *BioScience*, *60*(11), 886-897. LINK

Borowski, J., Byk, A., Mazur, S., Mokrzycki, T., & Rutkiewicz, A. (2013). Waloryzacja ekosystemów leśnych Leśnego Kompleksu Promocyjnego" Lasy Spalsko-Rogowskie" w oparciu o mycetobiontyczne chrząszcze grzybów nadrzewnych. *Studia i Materiały Centrum Edukacji Przyrodniczo-Leśnej*, *15*(2 [35]). LINK

Borowskia, J., & Mokrzycki, T. (2016). Beetles (Coleoptera) of the Rogów region. Part V-bark and ambrosia beetles (Curculionidae, Platypodinae and Scolytinae). *World Scientific News*, *33*, 27. LINK

Borowski, J., Piętka, J., & Szczepkowski, A. (2012). Insects found on black alder *Alnus glutinosa* (L.) Gaertn. when stands are dying back. *Forest Research Papers*, *73*(4), 355-362. LINK

Bussler, H., & Immler, T. (2007). Neue Borkenkäferarten in Bayern. *Forstschutz Aktuell*, *38*, 5-8. LINK

Byers, J. A. (2000). Wind-aided dispersal of simulated bark beetles flying through forests. *Ecological Modelling*, *125*(2), 231-243. LINK

CABI (2015) *Xylosandrus germanus* (black timber bark beetle), Data sheet. Online at http://www.cabi.org/isc/datasheet/57237 (accessed 8 June 2017).

Council Directive 2000/29/EC European Commission. (2000). Council directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the community of organisms harmful to plants or plant products and against their spread within the community. *Off. J. Eur. Communities*. LINK

Diekmann, M. (1999). Southern deciduous forests. *Acta Phytogeographica Suecica*, *84*, 33-54. LINK

Dodds, K. J., Hanavan, R. P., & DiGirolomo, M. F. (2017). Firewood collected after a catastrophic wind event: the bark beetle (Scolytinae) and woodborer (Buprestidae, Cerambycidae) community present over a 3-year period. Agricultural and Forest Entomology. LINK

Flechtner, G. (2004) Coleoptera (Käfer) In: Dorow et al. 2004. Naturwaldreservate in Hessen 6/2 Schönbuche. Zoologische Untersuchungen 1990-1992. Kurzfassung. Mitteilungen der Hessischen Landesforstverwaltung 39: 72-109. LINK

Entomofauna Germanica Verzeichnis der Käfer Deutschlands (2007) This is the online version of the "Directory of Beetles Germany" http://www.colkat.de/de/fhl/ *[accessed on 6 June 2017]*.

EPPO (2011) EPPO Decision-support scheme for quarantine pests. EPPO Standard PM 5/3(5). LINK *[accessed on 20 March 2017]*.

EPPO (2011). CAPRA Network. LINK [*accessed on 20 March 2017]*.

EPPO (2012) Decision-support scheme for an Express Pest Risk Analysis. EPPO Bulletin 42, 457–462. LINK

(EU) 2016/2031 Regulation (EU) 2016/2031 of the European Parliament of the Council of 26 October 2016 on protective measures against pests of plants, amending Regulations (EU) No 228/2013, (EU) No 652/2014 and (EU) No 1143/2014 of the European Parliament and of the Council and repealing Council Directives 69/464/EEC, 74/647/EEC, 93/85/EEC, 98/57/EC, 2000/29/EC, 2006/91/EC and 2007/33/EC, OJ L 317, 23 November 2016, p. 4–104. LINK

Faccoli, M. (2008). First record of *Xyleborus atratus* Eichhoff from Europe, with an illustrated key to the European Xyleborini (Coleoptera: Curculionidae: Scolytinae). *Zootaxa*, *1772*(1), 55-62. LINK

Freeman, J. C., & Grancher, C. (2014) La forêt domaniale de Bastard (Pyrénées-Atlantiques): un espace riche en Coléoptères saproxyliques aux portes de Pau. *Bull. Soc. Linn. Bordeaux*, Tome 149, nouv. série n° 42 (1), 2014 : 77-88. LINK

Galko, J., Nikolov, C., Kimoto, T., Kunca, A., Gubka, A., Vakula, J., ... & Ostrihoň, M. (2014). Attraction of ambrosia beetles to ethanol baited traps in a Slovakian oak forest. *Biologia*, *69*(10), 1376-1383. LINK

Gandhi, K. J., Cognato, A. I., Lightle, D. M., Mosley, B. J., Nielsen, D. G., & Herms, D. A. (2010). Species composition, seasonal activity, and semiochemical response of native and exotic bark and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae) in northeastern Ohio. *Journal of economic entomology*, *103*(4), 1187-1195. LINK

Gebhardt, H. (2002) *Xyleborinus alni* (Niisima) - Funde in Baden-Württemberg (Coleoptera: Scolytidae). - Mitteilungen des Entomologischen Vereins Stuttgart 37: 55-56. LINK

Geiser, E., & Geiser, R. (2000). Erstnachweise und Wiederfunde von Alt-und Totholzkäfern in der Stadt Salzburg. *Koleopterologische Rundschau*, *70*, 209-222. LINK

Grégoire, J. C., Piel, F., De Proft, M., and Gilbert, M. (2001). Spatial distribution of ambrosia-beetle catches: a possibly useful knowledge to improve mass-trapping. Integrated pest management reviews, 6(3-4), 237-242. LINK

Haack, R. A., & Petrice, T. R. (2009). Bark-and wood-borer colonization of logs and lumber after heat treatment to ISPM 15 specifications: the role of residual bark. *Journal of Economic Entomology*, *102*(3), 1075-1084. LINK

Hansen, M., & Jørum, P. (2014). Records of beetles from Denmark, 2012 and 2013 (Coleoptera). *Entomologiske Meddelelser*, *82*(2), 113-168. LINK

Henin, J. M., Huart, O., & Rondeux, J. (2003). Biogeographical observations on four scolytids (Coleoptera, Scolytidae) and one lymexylonid (Coleoptera, Lymexylonidae) in Wallonia (Southern Belgium). *Belgian journal of zoology*, *133*(2), 175-180. LINK

HISL - PEET Xyleborini (2017). Michigan State University, Holistic insect systematics laboratory. This homepage is funded by the National Science Foundation PEET program (Partnerships for Enhancing Expertise in Taxonomy), webpage
http://xyleborini.speciesfile.org/public/site/scolytinae/home/show_taxon/2560
[accessed on 6 June 2017]

Hoebeke, E. R., & Rabaglia, R. J. (2007). First reported occurrence of *Xyleborinus alni* (Coleoptera: Curculionidae: Scolytinae) in the eastern United States, with notes on its recognition and tree hosts. *Proceedings of the Entomological Society of Washington*, *109*(1), 240-248. LINK

Holzschuh, C. (1994). Zur Unterscheidung von *Xyleborinus saxesenii* (Ratzeburg) und *X. alni* (Niisima)(Coleoptera, Scolytidae). *Entomol. Basiliensis*, *17*, 311-318.

Hulcr, J., and Dunn, R. R. (2011). The sudden emergence of pathogenicity in insect–fungus symbioses threatens naive forest ecosystems. Proceedings of the Royal Society of London B: Biological Sciences, 278(1720), 2866-2873. LINK

Humble, L. M., & Allen, E. A. (2006). Forest biosecurity: alien invasive species and vectored organisms. *Canadian Journal of Plant Pathology*, *28*(S1), S256-S269. LINK

IPPC (2017) Explanatory document for ISPM 15 (Regulation of wood packaging material in international trade). Publication date: 10 Feb 2017. LINK
[accessed on 8 June 2017]

Jordal, B. H., Beaver, R. A., & Kirkendall, L. R. (2001). Breaking taboos in the tropics: incest promotes colonization by wood-boring beetles. *Global Ecology and Biogeography*, *10*(4), 345-357. LINK

Kirkendall, L., & Faccoli, M. (2010). Bark beetles and pinhole borers (Curculionidae, Scolytinae, Platypodinae) alien to Europe. *ZooKeys*, *56*, 227. LINK

Knížek, M. (1988). *Xyleborus alni* Niijima, 1909. *Acta Entomologica Bohemoslovaca*, *85*, 396.

Knizek, M & Zahradnik P. (1999) Bark and wood boring beetles in the pine stands in Forster, B.; Knizek, M.; Grodzki, W. (eds.): Methodology of Forest Insect and

Disease Survey in Central Europe. Proceedings ofthe Second Workshop of the IUFRO WP 7.03.10, Apri120-23, 1999, Sion-Chateauneuf, Switzerland. 54-59. LINK

Kühnholz, S., Borden, J. H., & Uzunovic, A. (2001). Secondary ambrosia beetles in apparently healthy trees: adaptations, potential causes and suggested research. *Integrated Pest Management Reviews*, *6*(3), 209-219. LINK

Lindelöw, Å. (2012). Introduced or overlooked? New bark beetle species in Sweden (Coleoptera; Curculionidae). *Forstschutz Aktuell*, *55*, 28-29. LINK

Lindelöw, Å., Jonsell, M., & Sjödin, G. (2006). *Xyleborinus alni* (Coleoptera; Curculionidae)-a new bark beetle found in Sweden. *Entomologisk Tidskrift*, *127*(3), 97-99. LINK

Martynov, V. V., & Nikulina, T. V. (2016). New invasive phytophagous insects in woods and forest plantings of Donbass. *Caucasian Entomological Bulletin*, *12*(1), 41-51. LINK

Mokrzycki, T. (2016). Obce gatunki korników (Coleoptera, Curculionidae, Scolytinae) w faunie Polski i potencjalne zagrożenia dla drzewostanów. *Studia i Materiały Centrum Edukacji Przyrodniczo-Leśnej*, *18*(1 [46]). LINK

Möller, G., & Neumann, B. C. (2000). Erster nachtrag zum „Verzeichnis der Käfer deutschlands ". *Entomologische Nachrichten und Berichte*, *44*(1), 61. LINK

Mudge, A. D., LaBonte, J. R., Johnson, K. J. R., & LaGasa, E. H. (2001). Exotic woodboring Coleoptera (Micromalthidae, Scolytidae) and Hymenoptera (Xiphydriidae) new to Oregon and Washington. *Proceedings of the Entomological Society of Washington*, *103*(4), 1011-1019. LINK

Nakasima, T., Otomo, T., Owada, Y., & Iizuka, T. (1992). SEM observations on growing conditions of the fungi in the galleries of several ambrosia beetles: (Coleoptera Scolytidea and Platypodidae). *Journal of the Faculty of Agriculture, Hokkaido University*, *65*(3), 239-273. LINK

Nikulina, T., Mandelshtam, M., Petrov, A., Nazarenko, V., & Yunakov, N. (2015). A survey of the weevils of Ukraine. Bark and ambrosia beetles (Coleoptera: Curculionidae: Platypodinae and Scolytinae). *Zootaxa*, *3912*(1), 1-61. LINK

Oogita, T., Naito, H., Soma, Y., Kawakami, F. (1998). Effect of low dose methyl bromide on forest insect pests. Research Bulletin of the Plant Protection Service, Japan, 34, 37-39. LINK

Papis, M., & Mokrzycki, T. (2015). Saproxylic beetles (Coleoptera) of the strictly protected area Bukowa Góra in the Roztoczański National Park. *Forest Research Papers*, *76*(3), 229-239. LINK

Pedersen, J., Hansen, M., & Vagtholm-Jensen, O. (2010). Records of beetles from Denmark, 2008 and 2009 (Coleoptera). *Entomologiske Meddelelser*, *78*(2), 117-161. LINK

Peel, M. C., Finlayson, B. L., & McMahon, T. A. (2007). Updated world map of the Köppen-Geiger climate classification. *Hydrology and earth system sciences discussions*, 4(2), 439-473. LINK

Peer, K., & Taborsky, M. (2007). Delayed dispersal as a potential route to cooperative breeding in ambrosia beetles. *Behavioral Ecology and Sociobiology*, *61*(5), 729-739. LINK

Popa, V., Guertin, C., & Werbiski, R. (2014). Evidence of *Xyleborinus attenuatus* (Blandford 1894)(Coleoptera: Curculionidae: Scolytinae: Xyleborini) populations in Quebec, Canada. *Phytoprotection*, *94*(1), 8-12. LINK

Procházka, J., Schlaghamerský, J., & Knížek, M. (2014). Bark beetles (Coleoptera: Curculionidae: Scolytinae) in beech-fir forests of the Beskydy Protected Landscape Area, Czech Republic. *Zprávy Lesnického Výzkumu*, *59*(2), 126-132. LINK

Rabaglia, R. J., Dole, S. A., & Cognato, A. I. (2006). Review of American Xyleborina (Coleoptera: Curculionidae: Scolytinae) occurring north of Mexico, with an illustrated key. *Annals of the Entomological Society of America*, *99*(6), 1034-1056. LINK

Rassati, D., Faccoli, M., Battisti, A., and Marini, L. (2016). Habitat and climatic preferences drive invasions of non-native ambrosia beetles in deciduous temperate forests. Biological Invasions, 18(10), 2809-2821. LINK

Robideau, G. P., Foottit, R. G., Humble, L. M., Noseworthy, M. K., Wu, T., & Bilodeau, G. J. (2015). Real-time PCR identification of the ambrosia beetles, Trypodendron domesticum (L.) and Trypodendron lineatum (Olivier)(Coleoptera: Scolytidae). *Journal of Applied Entomology*. 140, 299–307. LINK

Roques, A., Kenis, M., Lees, D., Lopez-Vaamonde, C., Rabitsch, W., Rasplus, J. Y., & Roy, D. B. (2010). Special Issue: Alien terrestrial arthropods of Europe. *BIORISK-Biodiversity and Ecosystem Risk Assessment*, (4). LINK

Suh, S. J. (2014). Lethal temperature for the black timber bark beetle, *Xylosandrus germanus* (Coleoptera: Scolytidae) in infested wood using microwave energy. Current Research on Agriculture and Life Sciences, 32(3), 131-134. LINK

Sweeney, J. D., Silk, P., Grebennikov, V., & Mandelshtam, M. (2016). Efficacy of semiochemical-baited traps for detection of Scolytinae species (Coleoptera: Curculionidae) in the Russian Far East. *European Journal of Entomology*, *113*, 84. LINK

USDA (2011) Risk assessment for the movement of domestic wood packaging material within the United States. USDA APHIS: pp36. LINK

USDA (2016) Survival of woodboring insects in heat-treated wood. Northern Research Station, NRS Home / Research Programs / Forest Disturbance Processes / Invasive Species / Survival of Woodboring Insects in Heat-Treated Wood Webpage
https://www.nrs.fs.fed.us/disturbance/invasive_species/firewood_treatment/
[accessed on 8 June 2017]

Wittenberg R (ed.) (2005) An inventory of alien species and their threat to biodiversity and economy in Switzerland. CABI Bioscience Switzerland Centre report to the Swiss Agency for Environment, Forests and Landscape. LINK

Vorst, O., Heijerman, T., van Nunen, F., & van Wielink, P. (2008). Enige schorskevers nieuw voor de Nederlandse fauna (Coleoptera: Curculionidae: Scolytinae). *Nederlandse Faunistische Mededelingen*, *29*, 61-74. LINK

Wood, S.L. & Bright, D.E. (1992). A catalog of Scolytidae and Platypodidae (Coleoptera), Part 2. Taxonomic Index. Great Basin Nat. Mem. 13:1-1553. LINK