

REVIEW PAPER

Distribution of the invasive ambrosia beetle *Xyleborinus attenuatus* Blandford, 1894 (Coleoptera: Curculionidae: Scolytinae) in the Czech Republic (Central Europe)

Tomáš Fiala*, Jaroslav Holuša

Czech University of Life Sciences, Faculty of Forestry and Wood Sciences, Kamýcká 129, CZ-16500 Praha, Czech Republic

Abstract

In Europe, *Xyleborinus attenuatus* Blandford is considered an invasive bark beetle native to East Asia. We used the results of many local surveys and data from private and museum collections to get information on the distribution and abundance of *X. attenuatus* Blandford in the Czech Republic. The ambrosia beetle *X. attenuatus* Blandford is probably widespread throughout the territory of the Czech Republic, from the lowlands to the mountains, and has one generation per year in Central Europe. The flight activity lasts from mid-March to May, F1 adults emerge in August and September and overwinter in wood or in the ground under an infested tree. *X. attenuatus* Blandford predominantly occupies soft deciduous trees and so far there economic damage have not been reported yet. However, *X. attenuatus* Blandford is a vector of ambrosia fungi *Ambrosiella* spp. and *Raffaelea* spp., and therefore this ambrosia beetle should be monitored.

Key words: ethanol; first record; flight activity; window trap; *Xyleborinus saxesenii* Ratzeburg

Editor: Michal Lalík

1. Introduction

Bark beetles are important economic pests of forest stands. They play an important ecological role in the disturbance of forests (Hlásny et al. 2021). They also introduce various types of fungi, bacteria, and yeast into the wood (Kirisits 2004; Kolařík et al. 2008; García-Fraile 2018), which slow down the decomposition of dead matter (Skelton et al. 2019). Bark beetles as pests can be divided into primary pests such as *Ips typographus* Linnaeus, 1758, which have the potential to attack and kill even healthy trees (Hlásny et al. 2021), or secondary pests such as ambrosia beetles (Peng et al. 2022), reproduce rapidly under exceptional conditions such as the presence of sufficient suitable material (presence of felled, dying or weakened trees). During outbreaks, populations can cause local mortality of host trees (Holuša et al. 2019).

Xyleborinus attenuatus Blandford, 1894 (Fig. 1) is a non-native bark beetle in Europe, considered native to East Asia (Smith et al. 2020). In Europe, *X. attenuatus* Blandford was first reported in the Czech Republic and Slovakia in 1987 (Knížek 1988), but in fact, the first evidence came from Spain in 1960 (Lombardero 1998). This discrepancy is because *X. attenuatus* Blandford is

very similar to *Xyleborinus saxesenii* Ratzeburg, 1837, and is often misidentified (Lombardero 1998; Mokrzycki et al. 2011; Kvamme et al. 2020). The difference between the females of *X. attenuatus* Blandford and *X. saxesenii* Ratzeburg, recorded more frequently in both species, is the size and shape of the tubercles on the elytral declivity. *X. attenuatus* Blandford is the larger species at 2.5–2.8 mm and has sharper and more curved tubercles, whereas *X. saxesenii* Ratzeburg is smaller at 2.0–2.5 mm and the tubercles are smaller and blunter. Males are flightless and rarely leave galleries and hence are exceptionally encountered. After the determination was clarified, *X. attenuatus* Blandford was gradually found in almost all countries in Europe, in addition to the USA and Canada, and findings from five countries came before 1987 (Tab. 1, Fig. 2). *X. attenuatus* Blandford is a vector of *Ambrosiella* spp. (Nakashima et al. 1992) and *Raffaelea* spp. (Gharabigloozare 2015), but the economic damages have not yet been identified.

The aim of the work was to summarize the distribution of *X. attenuatus* Blandford in the Czech Republic. Due to its distribution throughout Europe (Tab. 1) and development in a wide range of tree species (Kvamme et al. 2020), we assume that it occurs throughout the studied area.

*Corresponding author. Tomáš Fiala, e-mail: tomas.fiala@nature.cz

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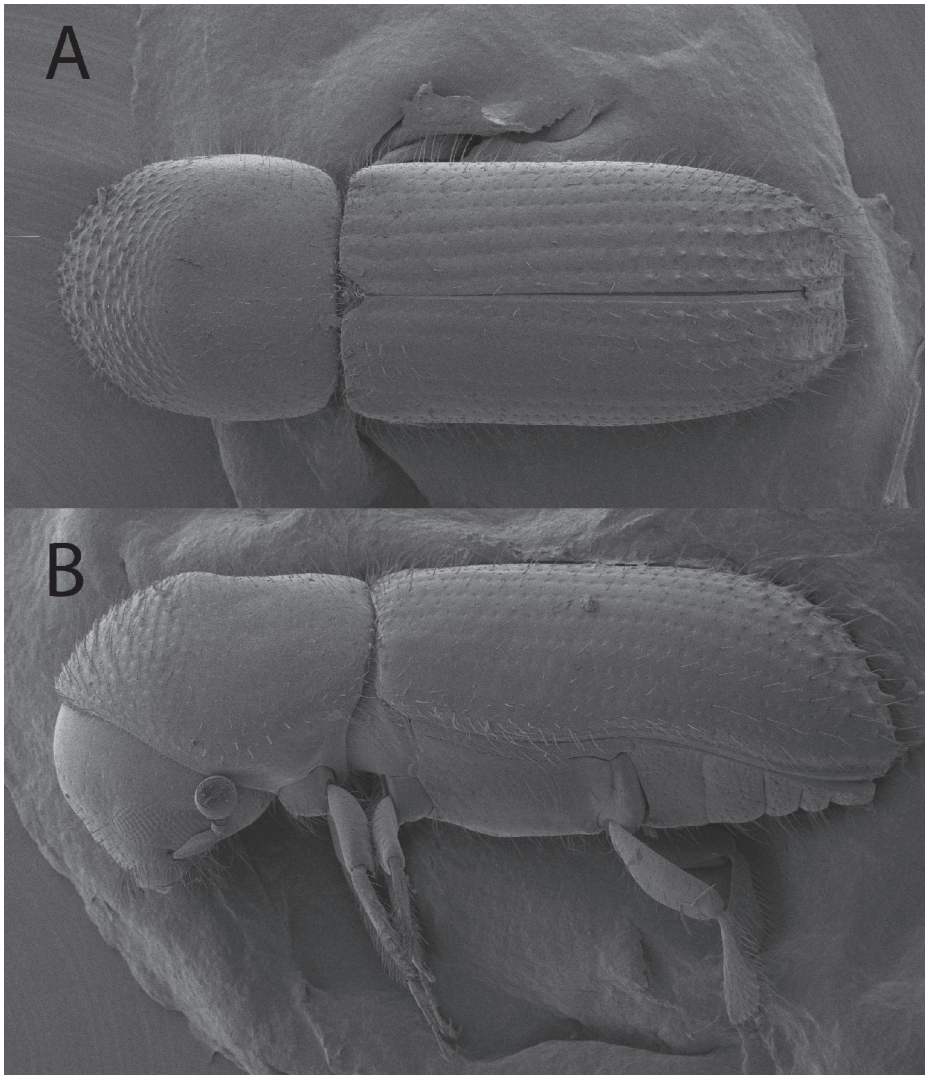


Fig. 1. Female of *Xyleborinus attenuatus* Blandford in dorsal view (a) and lateral view (b).

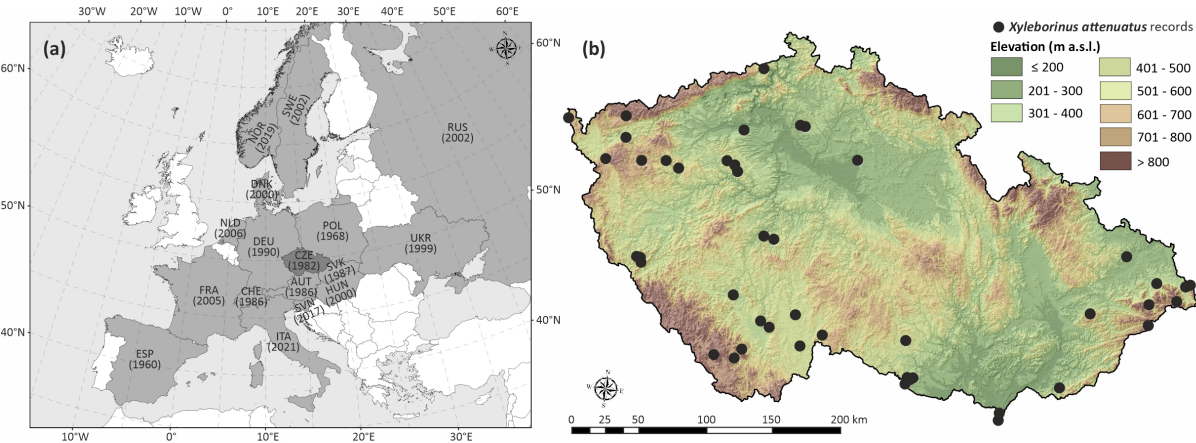


Fig. 2. Known distribution of *Xyleborinus attenuatus* Blandford in European countries with the year of detection and localities in the Czech Republic.

Table 1. First detection of *Xyleborinus attenuatus* Blandford in European and North American countries. Changes since the last list of first detection published by Kvamme et al. (2020) are highlighted in red.

Year	Country	Source
1960	Spain	Lombardero 1998
1968	Poland	Mokrzycki et al. 2011
1982	Czech Republic	this study
1986	Austria	Holzschuh 1995
1986	Switzerland	Sanchez et al. 2020
1987	Slovakia	Knížek 1988
1990	Germany	Gebhardt 2002
1995	Canada	Mudge et al. 2001
1996	USA	Haack 2006
1999	Ukraine	Martynov & Nikulina 2016
2000	Denmark	Pedersen et al. 2010
2000	Hungary	Podlussány 2001
2002	Russia (EU part)	Nikulina et al. 2007
2002	Sweden	Kvamme et al. 2020
2005–2011	France	Freeman & Grancher 2014
2006	Netherlands	Vorst et al. 2008
2017	Slovenia	Hauptman et al. 2019
2019	Norway	Kvamme et al. 2020
2021	Italy	Marchioro et al. 2022

2. Material and methods

As no nationwide monitoring has been carried out yet, we used the results of many local surveys and data from private and museum collections (Tab. 2) to gain information on the distribution and abundance of *X. attenuatus* Blandford in the Czech Republic. For the overview, we have selected finds that are reliably determined, i.e., we caught them ourselves, we revised the material, or the authors determined specimens according to the Pfeffer's key (1989).

We present sampling methods, although they are not known in all cases. Especially for data from literature and museum specimens, we do not have details about collection methods. Non-baited traps (window trap and light trap) or traps baited with ethanol or specific lures for economically important bark beetles were used. Some entomologists extract beetles directly from the galleries in the wood of the host trees. A few individuals were caught directly in flight using an entomological net or were found by sifting the litter. Material sampled by T. Fiala was preserved as dry. Samples were mounted on specimen stubs, sputter-coated with gold in the Sputter Coater JFC-1300 (JEOL, Tokyo, Japan) under argon atmosphere, and examined by scanning electron microscopy using a JEOL JSM-IT500HR instrument (JEOL, Tokyo, Japan) operating at 3 kV.

3. Results

In the Czech Republic, the occurrence of *X. attenuatus* Blandford has been confirmed in 46 localities (Fig. 2), in

all cases found beetles were females (Tab. 2). The known localities are mainly located in the southern and central parts of the Czech Republic. The species was found at altitudes from 150 to 1,200 m above sea level, but most findings come from altitudes between 400 and 600 m above sea level. Although we do not know sampling methods in published data, the analysis of known trapping methods shows that most individuals were caught in traps lured by ethanol (7 cases), window trap (7 cases), and entomological nets in flight (6 cases). Catching in a light trap and using a study of litter is unusual (Tab. 2).

In total, *X. attenuatus* Blandford was recorded in seven tree species (*Alnus glutinosa* [L.] Gaertn, *Alnus incana* [L.] Moench, *Betula pendula* Roth, *Populus tremulae* L., *Quercus* sp., *Salix caprea* L., *Salix viminalis* L.) if the individuals were obtained by extracting from the host tree. Flying beetles captured in the traps or by entomological net were found from mid-March to mid-May, with exceptional captures in June (Tab. 2).

4. Discussion

Although *X. attenuatus* Blandford was first reported in the Czech Republic in 1987 (Knížek 1988) we have found one beetle collected in 1982 in Drahov in southern Bohemia. Similarly, beetles collected earlier than this species was reported were also found in Poland and Switzerland (Kvamme et al. 2020). Up to now occurrence in Hungary, Slovenia, and Italy (Tab. 1) has not been listed (see Kvamme et al. 2020).

Known localities of *X. attenuatus* Blandford are predominantly distributed in the southern and central parts of the Czech Republic (Fig. 2), but the ecological requirements of the species meet a wide range of habitats throughout the territory of the Czech Republic. Also, the altitude of the sites with *X. attenuatus* Blandford presence represents almost the entire altitudinal gradient of the Czech Republic; so, *X. attenuatus* Blandford occurs from the lowest positions in the Pannonian basin to the highest sites of the Carpathian Mountains. It can be assumed that the species is distributed throughout the Czech Republic, but its abundance is probably low because in all cases only several beetles were collected.

We have confirmed almost all known host tree species of *X. attenuatus* Blandford in the Czech Republic. This confirms, that *Xyleborinus attenuatus* Blandford attacks mainly deciduous trees and prefers lightweight hardwood trees such as *Salix*, *Betula*, *Alnus*, *Populus*, less often it is also found on *Quercus* or *Fagus* (Kvamme et al. 2020). Among conifers, this ambrosia beetle was found on *Pinus resinosa* Aiton (Dodds et al. 2017) and *Pinus armandi* Franch. (Smith et al. 2020) but we have no evidence of the occurrence of *X. attenuatus* Blandford on conifers in the Czech Republic.

Table 2. Records of *Xyleborinus attenuatus* Blandford in the Czech Republic with a localities, date and sampling methods. Localities are villages or protected areas. Data were compiled from published literature, as well from private and museum collections (JCM – Jihočeské muzeum, České Budějovice; NNR – National Nature Reserve; NR – Nature Reserve).

Locality	Coordinates	Altitude [m a.s.l.]	Date of sampling	Number of speci- mens	Sampling method	Host tree	Source
Bystřice nad Olší	49.6400N, 18.7358E	400	30.III.2002	1	In flight		R. Szopa
Bystřice nad Olší	49.6400N, 18.7358E	400	11.IV.2008	1	In flight		R. Szopa
Cahnov NNR	48.6551N, 16.9413E	150	?? 2007		Window trap		Procházka 2011
Chotýčany	49.0683N, 14.5134E	500	31.VI.1992	1	Unknown		JCM
Chramosty	49.6696N, 14.3294E	500	23.III.2005	4	Unknown		A. Trmal
Chramosty	49.6696N, 14.3294E	500	28.IV.2005	3	Unknown		A. Trmal
Číměř	49.0627N, 15.0612E	550	30.VIII.1987	8	Dissection	<i>Salix viminalis</i> L., <i>S. caprea</i> L.	Knížek 1988
Číměř	49.0627N, 15.0612E	550	5.IX.1987	44	Dissection	<i>Salix viminalis</i> L., <i>S. caprea</i> L.	Knížek 1988
Drahov	49.1774N, 14.7638E	440	13.VI.1982	1	Unknown		JCM
Dymokury	50.2568N, 15.2034E	200	23.V.1988	5	Dissection	<i>Quercus</i> sp.	Knížek 1988
Hluboká nad Vltavou	49.1005N, 14.4180E	430	20.III.2010	1	Sowing	willow chips	F. Houška
Hnanice	48.8040N, 15.9633E	350	?	1	Unknown		R. Stejskal
Jaroměřice nad Rokytou	49.0933N, 15.9157E	450	1997		Unknown		Knížek & Zahradník 1999
Jílové – Sněžník	50.7835N, 14.0838E	600	5.V.2022	1	Light trap		E. Kula
Kelčský Javorník NR	49.4039N, 17.7714E	700	10.V.2021	1	Window trap		O. Konvička
Klimkovice	49.8082N, 18.0963E	370	15.IV.2013	1	In flight		J. Vávra
Lány – Amerika	50.1154N, 13.9264E	450	16.VI.2015	1	Unknown	<i>Quercus</i> sp.	Januš 2016
Lány – Běleč	50.0731N, 13.9657E	450	12.V.2002	2	Unknown		Rébl 2010
Lhota u Kestřan	49.2527N, 14.0979E	380	27.III.2011	1	Leaf litter		F. Houška
Loket	50.1875N, 12.7592E	400	1.V.2019	1	Lure trap	Ethanol	Holuša et al. 2021
Loučeň	48.9013N, 14.2657E	580	10.IV.2018	2	In flight		D. Čudan
Loučim	49.3769N, 13.1123E	650	7.V.2021	1	Trap lured with ethanol + peace of spruce bark		M. Kacerovský
Majdalena	48.9700N, 14.8487E	450	22.IV.1993	3	Unknown		JCM
Mašovice	48.8465N, 15.9773E	370	3.IV.2018	1	Dissection	<i>Populus tremulae</i> L.	R. Stejskal
Mionší NNR	49.5335N, 18.6511E	800	2008	1	Window trap		Procházka et al. 2014
Nejdek	50.3322N, 12.7252E	620	7.IV.2020	1	Unknown		Benedikt et al. 2021
Nižní Lhoty	49.6462N, 18.4309E	350	19.III.2004	6	In flight		R. Szopa
Nový Herštein	49.4089N, 13.0636E	650	7.V.2021	1	Trap lured with ethanol + peace of spruce bark		M. Kacerovský
Nýdek	49.6551N, 18.7808E	500	20.IV.2004	1	In flight		R. Szopa
Peruc	50.3549N, 13.9686E	310	2018	2	Trap lured with Trypovit®		Fiala & Holuša 2020
Podvoří	48.8323N, 14.2051E	580	2019	More ex.	Dissection	<i>Betula pendula</i> Roth	D. Čudan
Popice	48.8361N, 16.0078E	340	?	1	Unknown		R. Stejskal
Ranšpurk NNR	48.6786N, 16.9468E	150	2007	22	Window trap		Procházka 2011
Razula NNR	49.3599N, 18.3824E	750	2008	1	Window trap		Procházka et al. 2014
Ruda – Dolní Kráče	50.1373N, 13.8522E	400	21.IV.2002	More ex.	Dissection	<i>Alnus glutinosa</i> [L.] Gaertn	Januš 2016
Sedlčany	49.6544N, 14.4399E	350	24.III.2001	1	Unknown		Trmal 2008
Senec u Mšena	50.4360N, 14.6070E	350	9.IV.2021	1	Trap lured with XL Ecolure®		K. Resnerová
Slunečná	48.8327N, 13.9885E	850	29.IV.2018	1	Dissection	<i>Alnus incana</i> [L.] Moench	T. Fiala
Smrk NR	49.5000N, 18.3666E	1200	2008	1	Window trap		Procházka et al. 2014
Soutok	48.6352N, 16.9411E	150	IV.-V.2012	1	Unknown		J. Procházka
Štítary	50.2555N, 12.1286E	680	6.VI.2010	1	Unknown		S. Benedikt
Toužim	50.0518N, 12.9620E	640	26.V.2018	1	Dissection	<i>Alnus incana</i> [L.] Moench	Tájková et al. 2018
Truskavna	50.4390N, 14.5550E	250	9.IV.2021	1	Trap lured with XL Ecolure®		K. Resnerová
Úbočí u Dolního Žandova	50.0260N, 12.5860E	750	6.V.2022	3	Trap lured with Ethanol		T. Fiala
Úsilov	49.4045N, 13.0987E	600	6.V.2022	1	Trap lured with Ethanol		T. Fiala
Vladař NR	50.0756N, 13.2081E	610	2.V.2020	9	Trap lured with Ethanol		Holuša et al. 2021
Zahrady pod Hájem NNR	48.8861N, 17.5351E	400	2015	1	Window trap		J. Procházka
Znojmo	48.8436N, 16.0231E	340	2.IV.2009	1	Unknown		R. Stejskal
Žihle	50.0398N, 13.3520E	520	6.V.2022	3	Trap lured with Ethanol		T. Fiala

Flight activity of *X. attenuatus* Blandford begins early in spring. Based on our data it lasts from mid-March to May, and the single peak of the seasonal distribution of our data is the result of only one generation per year. This corresponds to the ecology of other species of the tribe Xyleborini in Central Europe. And in North America (Missouri), the flight period of *X. saxesenii* begins at the end of April or the beginning of May (Roling & Kearby 1975); although probably depending on the temperatures, *X. saxesenii* can have two periods of flight activity per year

(Rauleder 2003). But other species like the ambrosia beetles *Xyleborus monographus* Fabricius, 1792, and *Xyleborus dryographus* Ratzeburg, 1837 also have one generation per year. *Anisandrus dispar* Fabricius, 1792 also has one period of flight activity within a year, but it is longer and does not have such a clear peak (Markalas & Kalapanida 1997; Salmane et al. 2015; Fiala 2019). Adults of *X. attenuatus* Blandford emerge probably in August and September because at that time they are cut from the wood; they overwinter in wood or in the ground

under an infested tree, as evidenced by findings in the litter.

Since only a few individuals were caught at each locality, even if they were caught during the whole season, it is not possible to conclude which trapping method or bait is the most suitable for *X. attenuatus* Blandford detection. It is logical that many ambrosia species is attracted to ethanol (Kelsey 1994), but it is also accidentally caught in a window trap. This also complicates the creation and use of any systematic monitoring of *X. attenuatus* Blandford.

We have found only females because the ratio between the sexes is biased. Females are plenty, but the males are sparse. Usually, 1 to 3 males and up to approximately 50 females emerged in one breeding gallery (Kvamme et al. 2020). Males of *X. attenuatus* Blandford are flightless, dwarf, and mostly remain in galleries throughout their lives, while females fly well (Kirkendall 1983). Therefore, only females are caught in traps.

The distribution of *X. attenuatus* Blandford in Europe is poorly defined, due to misidentification with the ambrosia beetle *X. saxesenii* (Lombardero 1998; Mokrzycki et al. 2011; Kvamme et al. 2020). Already the author of the description Blandford (1894), who described the species as *X. attenuatus* Blandford and described it from a single female from Japan, writes that the species is very similar to *X. saxesenii* Ratzeburg. The first finding in Europe comes from Spain in 1960 (Lombardero 1998) and another from Poland in 1968 (Mokrzycki et al. 2011). The first beetles in the Czech Republic were detected in 1982 (this study). These findings in different states that are thousands of kilometres apart may indicate that *X. attenuatus* Blandford is a native species with a wide Palaearctic distribution and is only invasive in North America. Similar distances in distribution between sites (hundreds of kilometres) are known for the long-horned beetle *Gerania bosci bosci* Fabricius (Hawkeswood et al. 2021). Of course, we cannot rule out that *X. attenuatus* Blandford was introduced into Europe repeatedly within a short time and spread rapidly from several sources, as demonstrated in *Xylosandrus germanus* Blandford, 1894 in the USA (Dzurenko et al. 2021). These questions can only be solved by genetic analysis of European and Asian individuals, but obtaining more material is almost difficult, as there is no simple trapping method.

5. Conclusions

The ambrosia beetle *X. attenuatus* Blandford is probably widespread throughout the territory of the Czech Republic, from the lowlands to the mountains. We assumed this because the Czech Republic lies within the entire area of this ambrosia beetle. The available data suggest that this extensive area proves the origin of the species in wide Palaearctic region, rather than the fact that it is an invasive species on the territory of Europe. It is unlikely

that it would occupy the entire continent evenly within 40 years from the first detection in Europe. Any impact traps and/or ethanol-baited traps can be used to detect this species, but it cannot be expected that the number of beetles caught will be high due to an apparently low population density.

Acknowledgements

The authors thank Stanislav Benedikt (Plzeň), Ladislav Černý (Jihočeské muzeum, České Budějovice), František Houška (České Budějovice), Dušan Čudan (Chlum), Ondřej Konvička (Zlín), Jiří Procházka (Moravské muzeum, Brno), Robert Stejskal (Národní park Podyjí, Znojmo), Jiří Vávra (Ostrava), Václav Týr (Žihle) for providing data from their private or museum collections and Daniela Popelková (Czech University of Life Sciences, Praha) for photographs of *X. attenuatus* specimen.

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