Xyleborinus attenuatus (Blandford, 1894) (Coleoptera, Curculionidae, Scolytinae) in Scandinavia

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Xyleborinus attenuatus (Blandford, 1894) is for the first time recorded in Norway. This record represents bark beetle species number 73, documented as established outdoor in Norway. In addition, new data on the species in Sweden is presented. Included is also a short review of the invasive history of *X. attenuatus* in Europe and North America. Information of the biology of *X. attenuatus* is summarized and the possible importance as a pest in Norway is discussed. Identification keys for separating *X. attenuatus* and *X. saxesenii* (Ratzeburg, 1837) are included for both males and females.

Key words: *Xyleborinus attenuatus*, *X. saxesenii*, faunistics, biology, Norway, Sweden, Europe.

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Introduction

Bark beetles play an important role in forestry, both ecological and economic (Raffa *et al.* 2015). Many of the important pest species are invasive and a result of human activities and transport of goods around the world. So far, Scandinavia has faced little problems with exotic bark beetle species, but many species are possible future problems. Three species of non-European origin have established in Scandinavia. *Xylosandrus germanus* (Blandford, 1894) in Denmark (Hansen and Jörum 2014); *Cyclorhipidion bodoanum* (Reitter, 1913) in Sweden (Andersson *et al.* 2016), Norway (Ødegaard & Hanssen 2012, *cf.* Kvamme & Lindelöw 2014) and Denmark (Pedersen *et al.* 2010); and *Xyleborinus attenuatus* (Blandford, 1894) in Sweden (Lindelöw *et al.* 2006) and Denmark (Pedersen et al. 2010). The presented record of *X. attenuatus* is bark beetle species number 73 found established in Norway (Kvamme & Lindelöw 2014, Kvamme *et al.* 2015).

Material and methods

In the surroundings of Oslofjord, trees were inspected for signs of bark beetle colonization. Examination of trunks with entrance holes was done using axe and knife to uncover adults in their galleries. Adults were put in ethanol (70 %) and brought to the lab for identification. Sections of the attacked trees were also brought to laboratory and more than 300 specimens were reared.

Galleries were opened in the laboratory in order to find males and to take photos of the galleries. The identification keys used were Pfeffer (1995), Holzschuh (1994) and Pedersen *et al.* (2010). *X. attenuatus* is mentioned in standard identification literature, but often under the name *Xyleborus alni* Niisima, 1909 since it was first published in Europe (Knížek 1988). The nomenclature follows Knížek (2011).

The record of *Xyleborinus attenuatus* in Norway

The record of *X. attenuatus* was from 24.VII.2019 at a location beside Ringeriksveien, about 300m east of the Circle K gasoline station, Lier Municipality (59.768917, 10.258639), Norway (Figure 1). This record represents the first record of *X. attenuatus*, found established in Norway. Most of the specimens are from newly dead *Alnus incana* (Betulaceae) trees of about 15–20cm in breast height diameter (Figure 2). The trees were

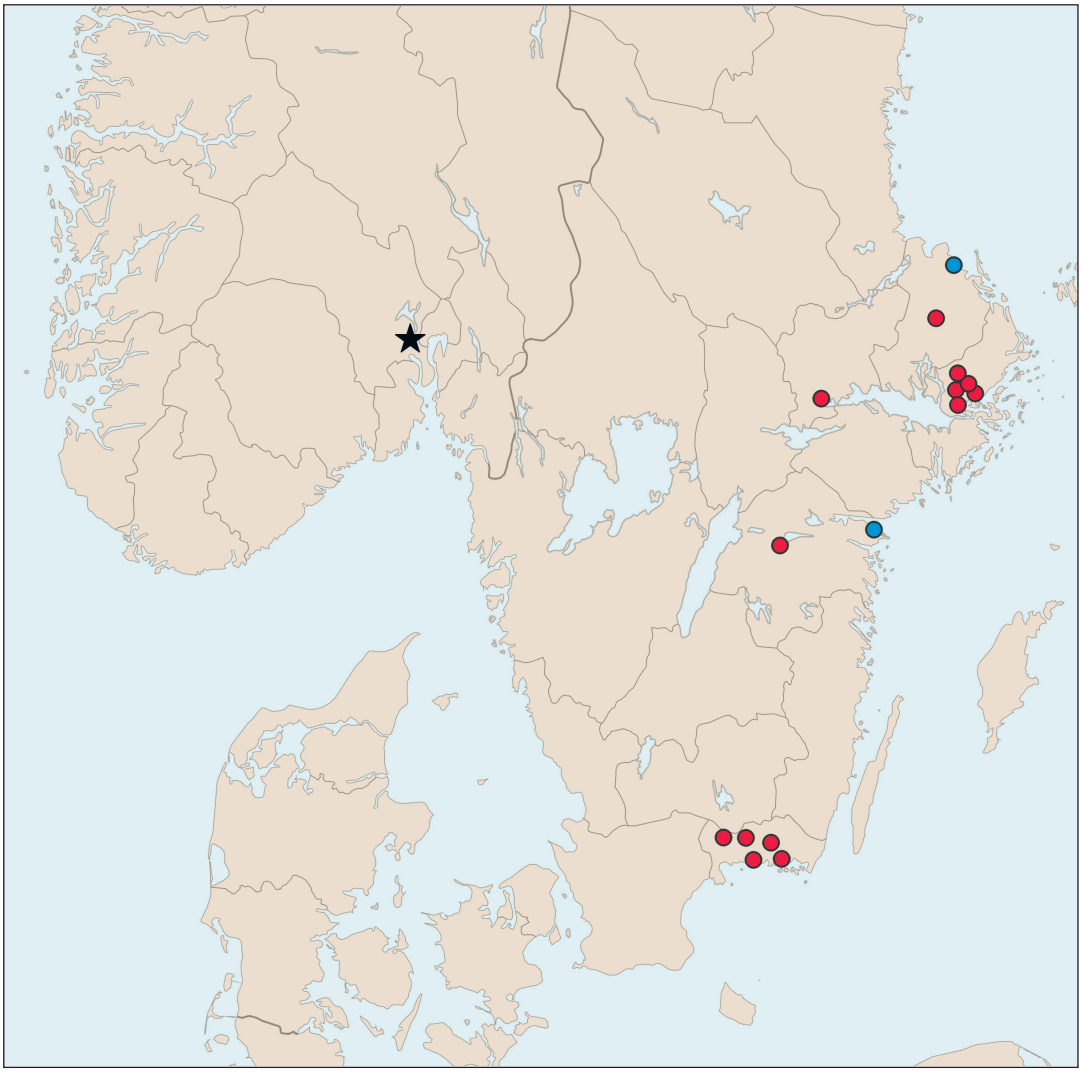

FIGURE 1. The new record of *Xyleborinus attenuatus* (Blandford, 1894), from Lier in Norway, is indicated by a blue star. The red dots show the validated Swedish records, based on the data from Swedish Species Information Centre (*cf.* Artportalen). Blue dots indicate trap catches in harbours, evaluated as intercepted.

FIGURE 2. The locality at Lier Municipality (Viken County), Norway, where *Xyleborinus attenuatus* (Blandford, 1894) was recorded. The fresh stump to the right is one of the trees in which *X. attenuatus* was established.

a part of a group of deciduous trees dominated by dead, standing *A. incana.* One dead *Salix caprea* (Salicaceae) on the other side of the road was also infested by *X. attenuatus.* The location was situated between roads and an industrial area. The cause of the death of the trees may have been disturbances, drought or other stress before the bark beetles entered the stems. Common species as *Trypodendron domesticum* (Linnaeus, 1758), *Dryocoetes alni* (Georg, 1856) and *Anisandrus dispar* (Fabricius, 1792) were found both in *A. incana* and *S. caprea* at the locality.

Note: The locality was revisited on 28.II.2020. At that time all dead trees had been cut and stems removed.

Records in Sweden

The first record of *X. attenuatus* in Sweden was from 2002, when Hans-Erik Wanntorp caught one specimen in a barrier trap on a pile of oak wood (*cf.* Artportalen). The specimen was first determined as *X. saxesenii* (Ratzeburg, 1837). In 2004, specimens were caught in barrier traps at two different locations near Stockholm (Lindelöw *et al.* 2006). During the period 2008–2014, *X. attenuatus* was found several times, both in traps and in dead trees. Bertil Ericson found males and females in a burned rowan (*Sorbus aucuparia* (Rosaceae)) and beech (*Fagus sylvatica* (Fagaceae)). The trees also contained *X. saxesenii*.

Ericson also observed how males were walking on the wood surface eventually visiting neighbouring galleries to mate (Ericson 2008).

Later the species was found 26.V.2012 in a cherry tree (*Prunus avium* (Rosaceae)) in Åholmen, Strömsholm, Västmanland (Vs) (Lindelöw unpublished). The tree was approximately 25 cm in breast height diameter and was felled by wind. In the same trunk, *Scolytus mali* (Bechstein, 1805) was found.

In 2015, one dead specimen of *X. attenuatus* was found in a standing, dead apple tree (*Malus* x *domestica* (Rosaceae)) in Uppsala, Sweden. From the same apple tree many *Scolytus mali* and *S. rugulosus* (Ratzeburg, 1837) were also reared (Henrik Wallin unpublished, pers. com.).

A list of records in Sweden is presented by The Swedish Species Information Centre (*cf.* Artportalen 2020). Together with some unpublished records, the data are compiled in Table 1. A brief introduction history of *X. attenuatus* in Europe and North – America is given in Table 2.

Biology, morphology and identification

Like many species of the tribus Xyleborini, *X. attenuatus* reproduces well protected inside wood material (Figures 5 and 6) and beetles and preimaginal stages are easily transported

TABLE 1. The records of *Xyleborinus attenuatus* (Blandford, 1894) in Sweden. * Caught in harbours in monitoring traps ruled by the Swedish Board of Agriculture. Lindelöw (2019) in unpublished report to Swedish Board of Agriculture.

Date	Province	Locality	Method	Collector	Remarks
26.VIII.2002	Uppland (Up)	Stockholm	Interception trap	Hans Erik Wanntorp	The first record in Sweden
31.III–27.IV, 14.V-4.VI.2004	Uppland (Up)	Stockholm	Interception trap	Gunnar Sjödin	
26.IV–25.V. 2005	Uppland (Up)	Lovö	Interception trap	Mats Jonsell	
15.II.2012	Uppland (Up)	Danderyd	Interception trap	Jan Höjer	
4.VI.2013	Uppland (Up)	Västra Ryd	Collected manually	David Isaksson and Erik Sahlin	
9.X.2014	Uppland (Up)	Uppsala	Collected manually	Henrik Wallin and Åke Lindelöw	
11.IV–14.V. 2018	Uppland (Up)	Hargshamn	Funnel trap	Bo Aulin	1 specimen Intercepted*
26.V.2012	Västmanland (Vs)	Åholmen, Strömsholm	Collected manually	Åke Lindelöw	
5.VI.2014	Östergötland (Ög)	Tinnerö	Interception trap	Anders Järneskog	
14.IV–16.V.2018	Östergötland (Ög)	Norrköping	Funnel trap	Bo Aulin	2 specimens Intercepted*
2016	Östergötland (Ög)	Norrköping	Funnel trap	Bo Aulin	1 specimen Intercepted*
8.IV.2008	Blekinge (Bl)	Karlshamn	Collected manually	Bertil Eriksson	
24.VI.2014	Blekinge (Bl)	Tromtö	Interception trap	Sofie Willman	
18.V.2016	Blekinge (Bl)	Ronneby	Reared	Mats Jonsell	
13.IX.2016	Blekinge (Bl)	Rödeby	Reared	Mats Jonsell	
15.IX.2016	Blekinge (Bl)	Ramdala	Reared	Mats Jonsell	
15.IX.2016	Blekinge (Bl)	Tving	Reared	Mats Jonsell	

TABLE 2. The first records of *Xyleborinus attenuatus* (Blandford, 1894) from European and North-American countries.

Year of record	Country	Reference(s) and comments
1960	Spain	Lombardero 1998, *cf.* Kirkendall & Faccoli 2010
1980-ies	Switzerland	C. Besuchet pers. com., Kenis 2005. (Year not specified)
1986, 1990	Austria	Holzschuh 1995, Holzschuh 1990
1987	Czechia	Knížek 1988 (First published record from Europe)
1987	Slovakia	Knížek 1988 (First published record from Europe)
1990	Germany	Lohse 1991, Köhler 2000, Köhler 2011, Gebhardt 2002
1995	Canada	*cf.* Haack 2006, Popa *et al.* 2014
1996	USA	Mudge *et al.* 2001, Haack 2006, Hoebeke & Rabaglia 2007
1999, 2006	Ukraine	Martynov & Nikulina 2016 (Chernihiv Region), Nikulina *et al.* 2007
2000	Denmark	Pedersen *et al.* 2010
2002	Russia (European part)	Nikulina *et al.* 2007, Martinov & Nikulina 2016, Eppo 2020, Shtapova & Petrov 2018 (Moscow region)
2002, 2004	Sweden	Hans Erik Wanntorp (Leg.) (First Swedish record). Lindelöw *et al.* 2006 (First published record from Sweden)
2005–2011	France	Freeman & Grancher 2014 (The year of first record in France is not specified)
2006	Netherlands	Vorst *et al.* 2008
1990-ies, 1996	Poland	Lohse 1991 (general information), Szafraniec S., Szoltys H. 1997 (First record with specified data)
2019	Norway	New presented record

to new localities inside the breeding substrate. The entrance hole to the breeding gallery is very small, reflecting the diameter of the female beetles (Figures 3 and 5). Only very close inspection will reveal the presence of the beetles. Combined with the small size of the imagines the occurrence is easily overlooked.

X. attenuatus is an ambrosia beetle and has an obligate symbiosis with fungi. The females bring fungi to the breeding substrate in body pockets called mycangia and inoculate the fungi in the tunnels as feed for the larvae. This is called xylomycetophagy and we use it meaning eating both fungi and wood affected by the fungi (Kirkendall *et al.* 2015). The result is a dark, discolouration of the wood around the maternal and larval galleries (Figures 4 - 6).

The males and females are highly different in size and appearance. Thus the identification key has been split and the males and females are treated separately (Table 4). Males are “dwarfs” (Figure 7) and yellowish of colour, while the females are bigger and dark coloured (Figure 8). The ratio between the sexes is biased. Females are plenty, but the males are sparse. Breeding galleries opened had usually from 1 to 3 males and up to approximately 50 females. According to Wood (1982 *cf.* Kirkendall 1993) the tribe Xyleborini is exclusively inbreeding. Mating between sisters and brothers are common in the genus *Xyleborinus* (Kirkendall *et al.* 2015). Mating takes place inside the breeding cave and the females are fertilized

FIGURE 3. An entrance hole to a breeding gallery of *Xyleborinus attenuatus* (Blandford, 1894) in *Alnus incana*. Photo: E. Fløistad (NIBIO).

FIGURE 4. Breeding galleries of *Xyleborinus attenuatus* (Blandford, 1894) seen on a cross section of *Alnus incana*. Photo: E. Fløistad (NIBIO).

FIGURE 5. The breeding gallery/cave of *Xyleborinus attenuatus* (Blandford, 1894) in *Alnus incana*. The cave has only one entrance. This gallery contained about 50 specimens. All except three were females. Photo: E. Fløistad (NIBIO).

FIGURE 6. A close up of the cave with sisters of *Xyleborinus attenuatus* (Blandford, 1894). Photo: E. Fløistad (NIBIO).

FIGURE 7. The male of *Xyleborinus attenuatus* (Blandford, 1894). Photo: E. Fløistad (NIBIO).

FIGURE 8. The female of *Xyleborinus attenuatus* (Blandford, 1894). Photo: E. Fløistad (NIBIO).

before they start dispersal flight. The result is that one female might be enough to establish a new population. Males usually stay in the breeding cave all life, but are sometimes observed walking on the surface of the host trees (e. g. Ericson 2008). While females are good flyers, males have reduced and not functional flying wings (Hamilton 1967 *cf.* Kirkendall 1993).

Many species of the tribus Xyleborini, also *X. attenuatus,* are strongly polyphagous species. A list of host trees in Europe is presented in Table 3. Most of the trees are common in Scandinavia. Both standing and lying trees are used as host substrate.

Discussion

The native area of *X. attenuatus* is Japan and eastern Russia (Rabaglia et al. 2006). The first published records known as *X. attenuatus* (called *Xyleborus alni*) in Europe were from former Czechoslovakia and Austria (Knížek 1988). However, later examinations of specimens in entomological collections showed that the first specimens in Europe were from Spain in 1960 (Lombardero 1998). The species spread fast in Europe (Table 2), facilitated by free trade within EU. The rapid pest risk analysis (PRA) made in Sweden (Björklund & Boberg 2017) shows how

TABLE 3. A compilation of host trees of *Xyleborinus attenuatus* (Blandford, 1894) based on European data.

Host tree species	References	Comments
Aesculus hippocastanum	Lindelöw *et al.* 2006	In window traps on trees
Alnus sp.	Haack 2006	In USA
Alnus glutinosa	Pfeffer 1995	
A. hirsuta	Pfeffer 1995	*cf.* Bright & Skidmore 1997
A. incana		Norway, this paper
Betula platyphylla japonica	Pfeffer 1995	*cf.* Bright & Skidmore 1997
Coryllus avellana	Pfeffer 1995	*cf.* Bright & Skidmore 1997
Fagus sylvatica	Ericson 2008	Tree harmed by fire
Malus x *domestica*	Wallin unpublished	
Populus nigra	Weigel 2008	
P. tremula	Lindelöw *et al.* 2006	Czechia, Poland (Warsawa)
Prunus avium	Lindelöw unpublished	
Quercus robur	Pfeffer 1995	
Q. sessiflora		*cf.* Bright & Skidmore 1997
Salix spp.	Pfeffer 1995, Weigel 2008	
Salix alba		*cf.* Bright & Skidmore 1997
S. caprea	Knizek 1988, Pfeffer 1995	+ Norway (this paper)
S. caprea	Lindelöw *et al.* 2006	
S. viminalis	Knizek 1988	
Sorbus aucuparia	Ericson 2008	Tree harmed by fire
Tilia amurensis	Pfeffer 1995	
T. cordata	Lindelöw *et al.* 2006	In window traps on trees
Ulmus sp.	Pedersen *et al.* 2010	Species not specified

quick the expansion has been. The protected mode of life combined with inbreeding and single female colonies and a very strong polyphagia, makes it easy for *X. attenuatus* to establish in new areas. Consequently, the species are easily distributed even with small pieces of wood material. When the conditions are favourable, the new generation spreads naturally form the establishment point.

The occurrence of *X. attenuatus* in the urban area of Southern Norway was expected due to heavy traffic and lots of imported material. Stressed and weakened or newly dead trees of different broad leaf species are suitable hosts.

We do not expect *X. attenuatus* to be a pest species killing live trees. However, it can have economic impact as a postharvest problem reducing wood quality. Special protection of valuable, high quality timber might be necessary to prevent economic loss.

Very likely *X. attenuatus* has been overlooked, and maybe confused with *X. saxesenii*. Therefor we expect many new records will be made in southern Norway in the years to come. Like *X. attenuatus,* other introduced Xyleborini species introduced to Europe have colonized a large part of the continent within a few decades. *C.*

TABLE 4. Identification key to separate *Xyleborinus attenuatus* (Blandford, 1894) and *Xyleborinus saxesenii* (Ratzeburg, 1837). The identification keys are based on and modified after Pedersen *et al.* (2010).

Males	
Pronotum as long as wide. Elytral declivity with small sharp tubercles along suture and 3rd and 5th interstriae. Length 1.8–2.2 mm	*X. attenuatus*
Pronotum ⅕ longer than wide. Elytral declivity with small, stump tubercles along suture and in the 3rd and 5th interstriae. Length 1.5–2.0 mm	*X. saxesenii*
Females	
Elytral declivity with sharp and bended tubercles along suture and in the 3rd and 5th interstriae. Length 2.5–2.8 mm	*X. attenuatus*
Elytral declivity with stump tubercles along suture and in the 3rd and 5th interstriae. Length 2.0–2.5 mm	*X. saxesenii*

bodoanum is another example already found in most countries in Europe. More species of bark beetles can be expected to establish in Norway, e. g. *X. germanus*. This species has already established in Denmark where it was found in 2012 (Hansen & Jörum 2014). In Sweden *X. germanus* was intercepted twice (Lundberg 1996, Lindelöw 2019). Being polyphagous and building up high population levels the species has a high probability to establish in Norway.

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