The Impact of Ash Dieback on Veteran and Pollarded Trees in Sweden

by Vikki Bengtsson, Anna Stenström and Camilla Finsberg

SUMMARY: Ash dieback is a fungal disease caused by *Chalara fraxinea* that affects ash throughout Sweden. Surveys to study of the impact of ash dieback on veteran trees were made in the south west of Sweden in 2009 and 2011. These found that 76% of the ash trees observed were affected by ash dieback disease in 2011 compared with 63% in 2009 and that 3% had died between the surveys. In 2009 there was no relationship between girth and ash dieback, but in 2011 there was a tendency towards ash trees with a larger girth being less affected. There was also a geographical gradient, with trees in the eastern part of the county being more affected. The results in relation to pollarding varied between the years studied. Trees that had been pollarded less than ten years ago were more affected in 2011 compared with 2009.

Introduction and background

Many ash trees in Sweden are in poor health having thin crowns with dead branches and reduced leaf area. The ash trees have been affected by a fungal disease called ash dieback caused by *Chalara fraxinea* (the sexual form is known as *Hymenoscyphus pseudoalbidus*) (Kowalski, 2006; Hietala and Solheim, 2011), which appears to affect ash over its entire distribution area in Sweden. The disease was first discovered in Poland and Lithuania 12 years ago and roughly 60-80% of the ash trees in these countries are dead (EPPO, 2010). The disease has also been identified in the Czech Republic, Denmark, Germany, Austria, Norway, Belgium and most recently from Great Britain (Schumacher et al, 2007; EPPO, 2010; Jankovsky and Holdenrieder, 2009; Chandelier et al, 2011; Forestry Commission, 2012).

The exact biology of the disease is still somewhat unclear, but it spreads by wind-dispersed spores that develop on fruit bodies growing on the stalks of the previous year's leaves. The disease infects via leaf stalks and leaves, and newly infected shoots become red-brown in colour when the fungus has killed off the cambium. The new buds on the most recent annual shoots do not then come into leaf in the spring (Kowalski and Holdenrieder, 2009b). The fungus appears to kill the trees by girdling the trunk thus interrupting the flow of nutrients and water and causing necroses (Barklund, 2009). It is unclear whether the fungus alone causes the symptoms

An ancient ash pollard in cycle which has the first signs of ash dieback. (Photo: Vikki Bengtsson)

A shoot affected by ash dieback.
(Photo: Vikki Bengtsson)

observed as several environmental factors such as drought, frost, water logging and changed winter climate may also have an effect (Bakys et al, 2009a, Bakys et al, 2009b; Schumacher et al 2010). The disease can cause the death of both small and large trees.

The disease has spread very quickly since it was first discovered in Sweden in 2001/2002 on the island of Öland. Although it is still unclear how many trees will succumb to the disease it is considered unlikely that ash will disappear completely from the landscape. This is because different individuals appear to have different levels of resistance; a completely healthy ash tree can be standing beside a sick one, probably due to genetic variation in the population (Barklund, 2009; Pliura et al 2011; Mckinney et al 2011). Even if some ash trees appear to have a greater level of resistance to ash dieback, no resistant trees have yet been clearly identified. The disease remains a great threat to the ash population in Sweden not only as it can kill trees itself, but also because landowners fell ash trees due to a lack of information or because they believe that they then reduce the risk of spread.

A great deal of money is invested in pollarding ash trees and also for restoration of old lapsed pollards. One study has shown that the restoration of old lapsed ash pollards is more risky in areas where there is ash dieback (Eklund, 2009). There is however, relatively little scientific evidence relating to pollarding and much of the research has been focused on younger trees or plantations rather than veteran trees. Due to the lack of data, relating to pollarding and veteran trees, the County Administrative Board in Västra Götaland decided to establish a monitoring programme of their veteran ash trees in the summer of 2009 (Bengtsson and Stenström, 2009). The same trees were re-surveyed in 2011 and this paper describes the results from both of these surveys (Bengtsson et al, 2012).

Method

Around half of the County of Västra Götaland has been surveyed to record veteran trees and in 2009 the database contained information on more than 25,000 trees, of which 17% were ash. A random sample of 337 of these trees, both pollards and maidens, were examined in July, August and September in 2009 and re-visited in the summer of 2011 (Figure 1). Among the group of trees that were recorded as pollards, there was an even spread between those which had been recently pollarded (within the last ten years) and lapsed pollards (more than thirty years since they were last pollarded).

The ash trees were located with the help of a GPS and map. The trees were assessed from the ground with the help of binoculars, using field symptoms of ash dieback such as red/brown shoots and necroses as indicators, and then scored according to a five-point scale:

0 – completely healthy.
1 – lightly affected (c.<10 % of the crown affected).
2 – affected (c.10-30 % of the crown affected).
3 – significantly affected (c.>30% of the crown affected).
4 – dead.

The symptoms of the ash dieback can look similar to frost damage, but as there was little frost damage in the years of the survey there is a high likelihood that the symptoms identified in this survey were due to ash dieback. However, as no laboratory analysis was undertaken, it is not possible to be absolutely certain.

The differences between years was analysed with chi-square test. The effects of pollarding were analysed with 2-way ANOVA, after checking for normal distributions and equal variances. Relationships between longitude, girth and ash dieback score were assessed using a correlation test. The statistical analyses were carried out using PASW Statistics 18™. When comparing results between years nine trees were excluded: two of the trees were already dead in 2009; two trees had suffered mechanical failure and lost large portions of their crowns; and the remaining five could not be identified with certainty due to the accuracy of the GPS coordinates.

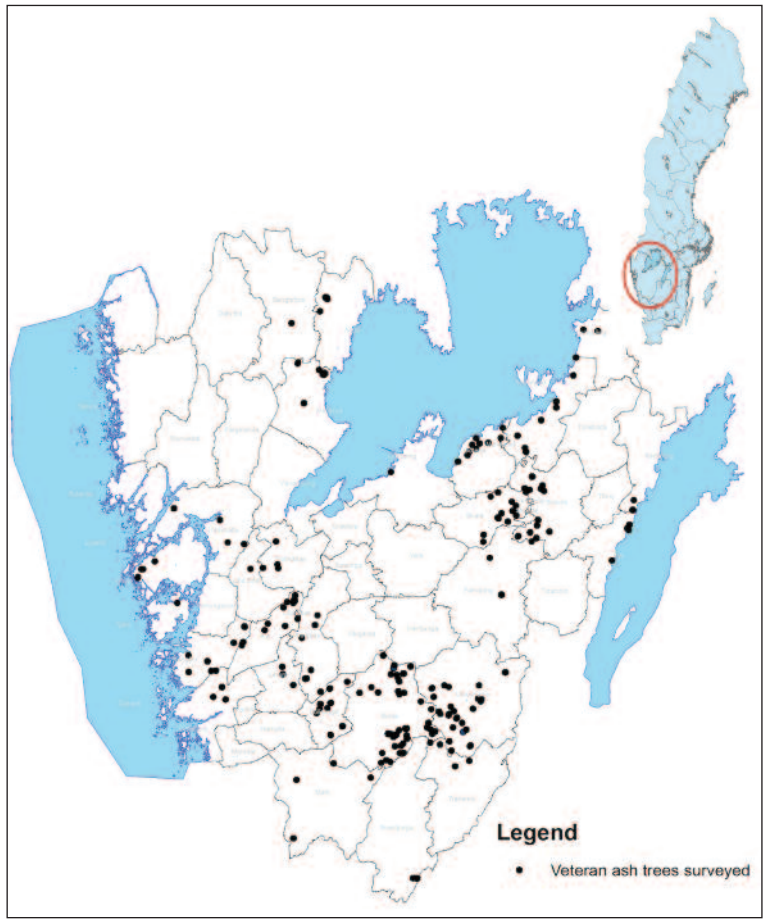

Figure 1. Map showing the distribution of the surveyed ash trees in Västra Götaland, south west Sweden.

Results

Veteran ash trees affected by ash dieback are spread out over the whole county; no part was free of the disease in 2009 or 2011.

In both years more than half of the veteran ash trees were affected by ash dieback, 63% were affected in 2009 increasing significantly to 76% in 2011 ($p<0.001$). The proportion of ash trees that died between 2009 and 2011 was 3%, which gives an average mortality rate of 1.5% per year.

It was also interesting to see how the trees had moved between the classes over the two-year period (Figure 2). In 2009 the majority of the trees were either uninfected or only lightly infected and the most common change between years was that uninfected trees became lightly infected. However progress of the disease could be rapid; five trees, which were healthy in 2009, were dead in 2011 and 20 trees changed from being healthy or lightly affected to significantly affected.

In contrast the health of a number of trees was recorded as having improved which was an unexpected result. For example some lightly infected trees appeared to become healthier and some trees heavily infected (class 3) in 2009 were only lightly infected (class 1) in 2011. Similar results were found in a Danish study (Thomsen, 2010), which found that some trees produced lots of new shoots as a response

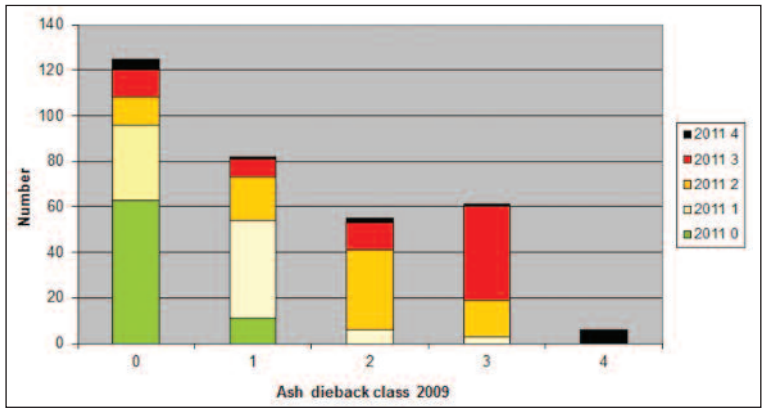

Figure 2. The number of veteran ash trees in each ash dieback class in 2011, distributed within the columns of how affected they were in 2009 (0 = healthy, 1 = lightly affected, 2 = affected, 3 = significantly affected, 4 = dead).

to the disease and means that the crown can appear to be in better condition than previously.

Analysis of data collected in 2011 suggested that the severity of infection was related to tree size with those having large girth being less affected. Similarly there appeared to be geographic variation with ash trees worse affected the further east they were in the county. However these relationships were weak and only explained a small amount of the wide variation on the impact of the disease.

Pollarding and Ash Dieback

The impact of ash dieback appears to be related to the management history of individual trees, but the relationship was complicated and varied between years. The survey in 2009 found that trees that had been pollarded within the last ten years were healthier than either maidens or lapsed pollards, but when they became affected by the disease, they were harder hit (Bengtsson and Stenström, 2009). The severity of infection on these recent pollards increased noticeably between 2009 and 2011 (Figure 3). In 2011 lapsed veteran pollards were less affected than maiden veteran trees, with trees pollarded within the last ten years being intermediate.

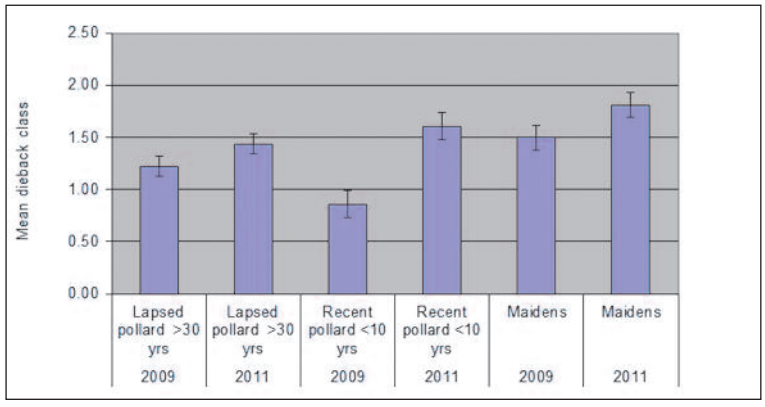

Figure 3. Average ash dieback class in 2009 and 2011 for different types of tree (lapsed pollard, recent pollard, maiden). 0 = healthy, 1 = lightly affected, 2 = affected, 3 = significantly affected, 4 = dead.

Discussion

The relationship between tree size and age, and the impact of dieback is not yet well-understood. Skovsgaard et al (2010) showed that the impact of ash dieback was greater on trees that were of smaller than average size, which is consistent with the results from our study, but the reason why ash trees with a larger girth seem to cope better is currently unclear. Larger girth may be connected to greater age and one could speculate that older trees have a different community of endophytes that influence the resistance of the tree or the pace of fungal spread. It could also be as simple as that it takes longer for the fungus to move through a larger tree.

There is evidence to suggest few ash trees older than 20 years die of ash dieback and that trees are just weakened to eventually die as a consequence of honey fungus or another secondary cause (Skovsgaard, 2009). Similarly a study from Poland and Denmark has shown that *Phytophthora* fungi may make ash trees more susceptible to ash dieback (Orlikowski et al, 2011). Other investigations have shown that a reduction in the vitality of the crown was primarily caused by ash dieback fungus, but symptoms caused by species of honey fungus were also present which are probably secondary factors (Skovsgaard et al., 2010; Bakys et al., 2011). The observation that few old trees appear to have died from ash dieback in our study is consistent with the above research

that older trees probably die as a consequence of a secondary factor. There is little data on the mortality rates of veteran ash trees with which to compare, but other species of veteran trees (mainly beech and oak) have similar rates of mortality (Read et al, 2010; Bengtsson and Fay, 2009).

The results from this study with regard to pollarding were difficult to interpret because they varied between the survey years, but it can be concluded that trees pollarded less than ten years ago were more significantly affected by the disease since 2009 than maidens or uncut trees. However, as the exact date of pollarding for each tree and the time at which the disease arrived at the tree's location are unknown, it is difficult to draw any conclusions about the relationship between pollarding and infection. It is possible that pollarding removes the affected shoots and thus the fungus, providing temporary respite from the disease. More research is required in this area, especially if pollarding could take place under controlled conditions.

The geographical gradient found in our survey may reflect the fact that the fungus appears to have come from the east and trees in the easterly regions may have had the disease for longer. It could also be a consequence of environmental factors such as rainfall and temperature or even genetic differences between trees. Abiotic factors that may be involved in ash dieback are drought, frost, waterlogging and changed winter climate (Schumacher et al 2010), but the mechanism and timing of their effects are still unclear. The fungus appears to be suited to a colder climate indicated by the fact that the cankers that are formed as a consequence of the disease seem to grow more during the winter (Jankovský and Holdenrieder, 2009). As another example ash trees growing in wetter conditions appear to be more susceptible to the disease (Eklund, 2009).

Recent studies have shown significant differences in resistance to the disease between different clones of ash (Pliura et al., 2011; Mckinney et al., 2011). An interesting observation from this work is that the clones that are associated with early autumn colours seem to be less susceptible to ash dieback than those which turn later. This research gives some hope that there will be ash trees in the landscape in the future even if the proportion of the population with this resistance was very small.

There is currently no 'cure' for ash dieback. As the fungus seems to be spread by the wind it can spread a long way and there is probably little benefit in felling individual trees that are affected to reduce the risk of the disease spreading. Indeed there may even be a risk in removing trees as a preventative measure because just those trees could hold the key to the future conservation of ash trees. The most important thing we can focus on now is to collect as much information as possible regarding ash trees that appear to have an increased resistance to the disease. Norway has implemented very restrictive rules regarding the movement of wood, plants and plant material to try to prevent the spread of ash dieback. Similar regulations apply to tools used for felling and tree surgery (Mattilsynets, 2008). Sadly the lack of such preventative measures has meant that the disease has arrived in the UK on around 2000 nursery trees imported from Holland. The disease has also been found in trees planted in 2009 in a woodland in Scotland (Forestry Commission, 2012). It remains to be seen whether the disease can be contained or eradicated or if it is already too late.

An ash that had severe symptoms of ash dieback in 2011, but which was completely healthy in the 2009 survey. (Photo: Vikki Bengtsson)

References

The original reports from which this article was compiled were written in 2009 and 2012; they are in Swedish, with English summaries and are available to download free from http://www.lansstyrelsen.se/vastragotaland/Sv/publikationer/Pages/default.aspx?year=&catSub=&doctype=1&freeText=askskottsjuka&numItems=

Barklund, P. (2009) www-skogsskada.slu.se. Skadebeskrivning – Askskottsjuka.

Bakys, R., Vasaitis, R., Barklund, P., Ihrmark, K. & Stenlid, J. (2009a) Investigations concerning the role of *Chalara fraxinea* in declining *Fraxinus excelsior*. *Plant Pathology*, **58**, 284-292

Bakys, R., Vasaitis, R., Barklund, P., Thomsen, I.M. & Stenlid, J. (2009b) Occurrence and pathogenicity of fungi in necrotic and non-symptomatic shoots of declining common ash (*Fraxinus excelsior*) in Sweden. *Eur. J. Forest Res*., **128**, 51-60

Bakys, R., Vasiliauskas, A., Ihrmark, K., Stenlid, J., Menkis, A. & Vasaitis, R. (2011) Root rot, associated fungi and their impact on health condition of declining *Fraxinus excelsior* stands in Lithuania. *Scandinavian Journal of Forest Research*, **26**(2) 128-135

Bengtsson, V. & Fay, L. (2009) Veteran Tree Survey, Ashtead and Epsom Commons. City of London Open Spaces Department, City of London report. www.pro-natura.net

Bengtsson, V. & Stenström, A. (2009) Inventering av askskottsjuka i Västra Götalands län 2009. Länsstyrelsen i Västra Götalands län (Survey of ash dieback in the County of Västra Götaland 2009, English summary), Naturvårdsenheten, rapport 2009:80.

Bengtsson, V., Stenström, A. & Finsberg, C. (2012) Askskottsjuka –ett nytt hot mot våra skyddsvärda träd?(Ash dieback – a new threat to our veteran trees? English summary), Naturvårdsenheten, rapport 2012:xx.

Chandelier, A., Delhaye, N., & Helson, M. (2011) First report of the ash dieback pathogen *Hymenoscyphus pseudoalbidus* (anamorph *Chalara fraxinea*) on *Fraxinus excelsior* in Belgium. *Plant Disease*, **95**(2), 220-220.

Eklund, S. (2009) Hamlingav Ask, Fraxinusexcelsior, ochhurdetpåverkarträdetsutsatthet-föraskskottsjukan (Pollarding of ash, *Fraxinus excelsior*, and how it influences susceptibility to ash dieback). Examensarbete Skövde Högskola.

EPPO (2010) http://archives.eppo.org/MEETINGS/2010_conferences/chalara_oslo.htm

Forestry Commission (2012) www.forestry.gov.uk/ashdieback

Hietala, A.M. & Solheim, H. (2011) *Hymenoscyphus* species associated with European ash. EPPO Bulletin, 41, 3–6. doi: 10.1111/j.1365-2338.2010.02426.x

Jankovský, L. & Holdenrieder, O. (2009) *Chalara fraxinea* – ash dieback in the Czech Republic. *Plant Protect. Sci.*, **45**, 74-78.

Kowalski, T. (2006) *Chalara fraxinea* sp. nov. associated with dieback of ash (*Fraxinus excelsior*) in Poland. *Forest Pathology*, **36**, 264–270.

Kowalski, T. & Holdenrieder, O. (2009a) The teleomorph of *Chalara fraxinea*, the causal agent of ash dieback. *Forest Pathology*, **39**, 304–308.

Kowalski, T. & Holdenrieder, O. (2009b) Pathogenicity of *Chalara fraxinea*. *Forest Pathology*, **39**, 1-7. doi: 10.1111/j.1439-0329.2008.00565.x

Mattilsynet (2008). http://www.mattilsynet.no/english/plant_health/regulations_of_8_september_2008_concerning_measures_against_chalara_fraxinea_63077

McKinney, L.V., Nielsen, L.R., Hansen, J.K. & Kjær, E.D. (2011) Presence of natural genetic resistance in *Fraxinus excelsior* (Oleraceae) to *Chalara fraxinea* (Ascomycota): an emerging infectious disease. *Heredity*, **106**, 788-797; doi:10.1038/hdy.2010.119

McKinney, L.V., Thomsen, I.M., Kjær, E.D. & Nielsen, L.R. (2011) Genetic resistance to *Hymenoscyphus pseudoalbidus* limits fungal growth and symptom occurrence in *Fraxinus excelsior*. *Forest Pathology*. doi: 10.1111/j.1439-0329.2011.00725.x

Orlikowski, L.B., Ptaszek, M., Rodziewicz, A., Nechwatal, J., Thinggaard, K. & Jung, T. (2011) *Phytophthora* root and collar rot of mature *Fraxinus excelsior* in forest stands in Poland and Denmark. *Forest Pathology*. doi: 10.1111/j.1439-0329.2011.00714.x

Pliura, A., Lygis, V., Suchockas, V. & Bartkevicius, E. (2011) Performance of Twenty Four European *Fraxinus excelsior* Populations in Three Lithuanian Progeny Trials with a Special Emphasis on Resistance to *Chalara fraxinea*.

Baltic Forestry, **17**(1), 17-34

Schumacher, J., Wulf, A. & Leonhard, S. (2007) First record of *Chalara fraxinea* T. Kowalski sp. nov.in Germany – a new agent of ash decline. *Nachrichtenblatt des Deutschen Pflanzenchutzdienstes,* **59**(6), 121-123 (in German).

Schumacher, J. (2010) http://archives.eppo.org/MEETINGS/2010_conferences/chalara/14_Schumacher/index.html

Schumacher, J., Kehr, R. & Leonhard, S. (2010) Mycological and histological investigations of *Fraxinus excelsior* nursery saplings naturally infected by *Chalara fraxinea*. *Forest Pathology*, **40**, 419-429. doi: 10.1111/j.1439-0329.2009.00615.x

Skovsgaard, J.P., Thomsen, I.M. & Barklund, (2009) Skötselavbestånd med askottsjuka (Management of stands with ash dieback in Swedish only). *Faktaskog*, **13**, ??.

Skovsgaard, J.P., Thomsen, I.M., Skovgaard, I.M. & Martinussen, T. (2010) Associations among symptoms of dieback in even-aged stands of ash (*Fraxinus excelsior* L.). *Forest Pathology*, **40**, 7-18. doi: 10.1111/j.1439-0329.2009.00599.x

Thomsen, I.M (2010) Impact of *Chalara fraxinea* on Danish forests. http://archives.eppo.org/MEETINGS/2010_conferences/chalara/08_Thomsen/index.html.

Vikki Bengtsson* has worked professionally with nature conservation since 1992 both in the UK and in Sweden including a period as property manager for Hatfield Forest. Vikki has primarily worked with issues relating to the practical management and restoration of ancient trees and now works as a freelance ecologist in Sweden with Pro Natura.

Anna Stenström has a PhD in plant ecology. Anna works in the Nature Conservation Department at the County Administrative Board of Västra Götaland in western Sweden. Anna is responsible for implementation of the Action Plan for Veteran Trees in the County of Västra Götaland, which includes surveying, restoration and monitoring activities. She is also responsible for the implementation of an additional 25 actions plans for threatened species in Västra Götaland.

Camilla Finsberg has worked professionally as an ecologist since 1996 in Sweden. Camilla has worked mainly with surveying of grasslands, woodlands, veteran trees and the production of management plans for nature reserves. She has also surveyed veteran trees. She works as a freelance ecologist in Sweden with Pro Natura.

*Corresponding author:
Pro Natura, Träringen 66, 41679 Göteborg, Sweden. Email: Vikki.forbes@pro-natura.net 004631142480.

The Editor welcomes correspondence for publication
so if you would like to comment on this or any of the articles in this issue of
the *Quarterly Journal of Forestry*,
please write or e-mail to:

The Editor, Quarterly Journal of Forestry,

Trinity Cottage, Buckingham Place, St Day, Redruth, Cornwall TR16 5NT.

E-mail: qjf@rfs.org.uk

(If e-mailing, please include your postal address as well.)