A short report on the progression of ash dieback

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Abstract. – Ash dieback disease occurs throughout Belgium and mortality of *Fraxinus excelsior* is high. In 2013 about one hundred saplings in Botanic Garden Meise were labelled so that the progression of this disease could be monitored and the outcomes of this disease predicted. In two years of monitoring more than half of the seedlings have died and the remaining ones are often seriously damaged. It is predicted that at least another third of the remaining plants will die by 2016. It is too early to say whether any ash will remain in a few years, but there are still 7% of saplings that show no signs of the disease.

Samenvatting. – Een beknopt verslag over de voortschrijdende essen-sterfte. De essenziekte komt in heel België voor en leidt tot aanzienlijke sterfte van *Fraxinus excelsior*. In 2013 werden in het domein van Plantentuin Meise honderd jonge boompjes gelabeld met als doel de ziekte te monitoren en de verdere gevolgen ervan te voorspellen. Na twee jaar van waarnemingen is meer dan de helft van de boompjes dood en de overblijvende exemplaren zijn dikwijls ernstig aangetast. We gaan ervan uit dat minstens een derde van de overblijvende exemplaren in 2016 zal sterven. Het is te vroeg om te voorspellen of er over enkele jaren nog essen zullen overblijven, maar tot nog toe is 7% van de jonge boompjes gevrijwaard gebleven van ziektesymptomen.

Résumé. – Un rapport succinct sur le progres de la maladie des frênes. La maladie des frênes est connue de tout le territoire de la Belgique et conduit à une mortalité importante chez *Fraxinus excelsior*. En 2013, cent jeunes arbres furent étiquetés dans le domaine du Jardin botanique Meise avec le but de surveiller la maladie et prévoir les conséquences. Après deux ans d'observations, plus de la moitié des plantes sont mortes et les autres sont souvent affectées. Il est supposé qu'au moins un tiers des jeunes arbres restants dépérira en 2016. Il est trop tôt pour prédire si d'ici quelques années il restera encore des frênes, mais à présent 7% des jeunes arbres ne montrent pas les symptômes de la maladie.

Introduction

Ash dieback disease has been spreading westward in Europe since the 1990s and now covers the whole of Europe where ash commonly occurs. It was first detected in Belgium in 2010 and has since spread throughout the country (Chandelier, 2011). It was certainly present in Botanic Garden Meise in 2012, if not earlier. The disease is the result of infection with an ascomycete fungus, *Hymenoscyphus fraxineus* (Kowalski & Holdenrieder 2009, Baral *et al.* 2014). It causes various symptoms such as wilting and blacking of the leaves in the growing season; dieback of young shoots; necrotic legions on the stems; dark staining of the wood and a distinctive pinkish or purplish hue on the dead bark of young shoots (Fig 1). Given the rapid spread and high mortality rate it is obvious that ash dieback will have profound consequences for ash (*Fraxinus excelsior*) and its associated species, such as insects, fungi and lichens. Furthermore, ash is one of the commonest trees in Belgium (Van Rompaey & Delvosalle 1979), so its loss is likely to have cascading effects on the species composition of many woodlands, and on forest ecosystem functioning. For this reason I decided to monitor the progression of this disease within the Botanic Garden so that we can better forecast the impact. Though there has only been two years of monitoring I briefly report my findings here so that readers are aware of the issue and how it is progressing in Belgium.

Material and methods

Four 10 × 10 m plots were laid out in the naturally regenerating woodland at Botanic Garden Meise (WGS84: 50° 55′ 37″ N, 4° 19′ 18″ E; 50° 55′ 37″ N, 4° 19′ 17″ E; 50° 55’ 38.6” N 4° 19′ 21″ E; 50° 55′ 39″ N, 4° 19′ 29″ E). These plots were selected because the areas contained a large number of ash saplings. Within these plots all ash seedlings greater than 40 cm tall were labelled with a small (2 cm × 4 cm) plastic tag attached with a stretchable plant tie. Each tag was engraved with a unique num-

ber so that the plant could be identified. These plots were not intended to be replicates but just a convenient method of refinding the tagged plants. In the first year either the height or the girth of the plant was measured with a tape measure, depending upon whether the plant was small enough to measure the height. In the first year and each subsequent year each plant was scored for the apparent damage caused by ash dieback. The same scoring scheme was used as that by Pliūra *et al.* (2011). This is a 5 point system where 1 is a dead plant; 5 is an undamaged plant and 2–4 are progressively less damaged plants. The plots were laid out on 14 April 2013. In 2014 plots 1 and 2 were scored on 14th April and plots 3 and 4 on 21st April. In 2015 plots 1 and 2 were scored on 6th May and plots 3 and 4 on 30th April.

Although the intention was to only tag saplings of *Fraxinus excelsior*, two of the tagged plants subsequently turned out to be *F. pennsylvanica*, which have obviously seeded themselves from a mature tree in the Garden's collections about 60 m away. These plants have remained tagged, but their results are not included here. A total of 110 *F. excelsior* plants were tagged of a range of sizes, though only six had a girth greater than 20 cm. These data are deposited in an Open Access repository (Groom 2015).

Results

Of the 110 plants tagged, 98 were refound in 2014 and 90 in 2015. The unfound plants were disproportionately the smallest ones, because these are most easily lost when dead. It is also suspected that some were lost to deer grazing. Missing observations were ignored and not assumed to be lost due to disease. After one year 28% of the refound plants had died and after the second year a total of 51% of the refound plants had died (32% from the previous year). Eight plants have so far not shown any symptoms of disease (score = 5). The health scores of living plants were the highest in the first year, before the disease had spread to the majority of plants. However, the remaining plants in 2014 and 2015 have similar scores for their health (Fig. 2). The reason that the average health score did not decline further was that the least healthy plants died and although the remaining plants continued to decline the average remained the same.

Figure 1. *A typical example of a shoot with ash dieback. The upper portion of the branch has died and new shoots are sprouting from below the necrosis.*

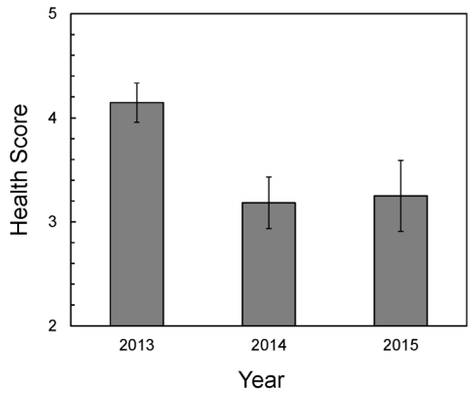

Figure 2. *The average health score of living plants (excluding dead trees with score = 1). Trees undamaged by disease have a score of 5 and the lowest score a living tree can have is 2. Error bars are 95% confidence intervals of the mean. The number of living trees were 110, 71 and 44 in 2013, 2014 and 2015, respectively.*

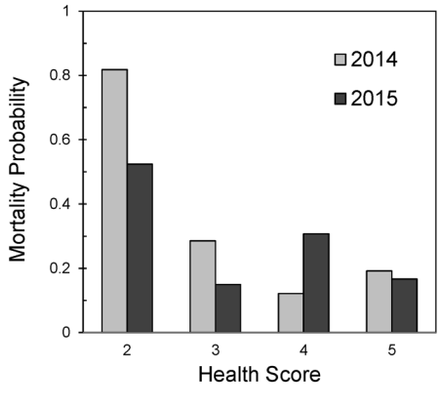

Figure 3. *The mortality probability of plants with each health score in the previous year.*

Using these results it is possible to calculate the probability that a tree will die given its health in the previous year (Fig. 3). These probabilities can be used to predict the future mortality by multiplying the number of plants in each health category by the mortality rate for that category. Not surprisingly, the plants with the lowest health score have the highest probability of dying during the following year. Using these probabilities and the health scores from 2015 one can predict the likely number of deaths by 2016. This suggests that we will lose another 30%–40% by next year, depending on whether you use the probabilities from 2015 or 2014, respectively.

Discussion

Ash dieback is clearly having a significant impact on the ash populations in the Botanic Garden and there is little sign of it abating soon. These results are comparable to those of Pliūra *et al.* (2011) who also found high mortality rates in plants from Western Europe. It is too early to say if there are any resistant trees in the population, however, the existence of a small number of unaffected trees gives hope that ash will evolve resistance. McKinney *et al.* (2011) showed considerable natural genetic variation in the susceptibility of ash to ash dieback, which is consistent with these results, though even if resistance does eventually spread, it is likely that ash will nevertheless decline rapidly, before eventual reasserting itself.

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