Dendrochronology as a tool for dating *Anoplophora* spp. outbreaks

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Introduction

Dendrochronology, the study of tree rings, is a high-precision tool to date outbreaks of xylobiont insects such as the invasive Asian longhorned beetle, *Anoplophora glabripennis* (Motschulsky), and citrus longhorned beetle, *Anoplophora chinensis* (Forster). Dendrochronology enables dating of the exact year and provides an estimate of the season of insect-induced wounds such as oviposition pits (only for *Anoplophora glabripennis*) or exit holes. This information can be used to support eradication measures and understand population dynamics of *Anoplophora* spp.

Materials and methods

Anoplophora beetles leave traces in the wood of living trees during various stages in their lifecycles: after hatching, by forming exit-holes, by laying eggs and by maturation feeding. These activities lead to wounding of the cambium zone – the interface between the bark and sapwood of trees. Every time the cambial zone is wounded, the tree responds with a series of wound reactions to secure the vital function of its xylem and phloem for transport and storage of water and assimilates. An instant reaction to wounding is the dying-off of the directly affected cambium cells.

Hereafter, a barrier zone closing the wound to the outside is formed. This barrier zone comprises traumatic parenchyma cells *callus*, wound-periderm and wound xylem and the wound remains visible as a scar within a particular tree ring. By dating the tree rings containing these specific scars, the exact year of wounding can be determined. An indication of the season of wounding can be obtained by studying the position of the scar within the tree ring.

Since 2008 we have studied wound reactions in trees infected by *Anoplophora* and in experimentally wounded trees as well as seasonal growth dynamics of host species, *e.g. Acer palmatum,* to enhance the precision of dating.

Results

Our research shows that dating precision is limited due to highly variable intra-annual growth. Yet, we are able to distinguish three periods, *i.e.* outside growing season, growing season itself, and the very end of growing season. Only with knowledge on intra-annual tree growth, a further indication can be obtained whether the wounds originated during the first half or second half of the growing season.

Discussion and conclusions

Based on these studies, we dated outbreaks with high precision and reconstructed the population dynamics of *Anoplophora* spp. in The Netherlands. We observed that *A. glabripennis* (Almere outbreak) in The Netherlands tends to form exit-holes and oviposition pits late in the season, whereas *A. chinensis* appears much earlier. These findings could contribute to answering the question: why was *A. glabripennis* naturally declining in population size during an outbreak in Almere (The Netherlands) over time? On the other hand, dating exit-holes made by *A. chinensis* in imported *Acer* trees, contributes to determine the exact location where adult beetles have emerged and take appropriate measures.