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## What makes a tree die? - Bark beetle-induced mortality causes abrupt declines in tree diameter

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The climate change has brought better environmental conditions for numerous bark beetles to reproduce in unmet amounts. Large-scale tree mortality events have been witnessed globally due to mass outbreaks of phloem feeding pest insects, such as *Ips typographus* (L.), that are jeopardizing numerous ecosystem services forests provide. To be able to assess the current and future bark beetle-induced tree mortality, we need more profound understanding of the processes that occur after the infestation of a tree, eventually leading to tree mortality. We measured the diurnal variation in tree stem diameter from four healthy and four infested trees during an *I. typographus* infestation in Helsinki, Finland, of which the four infested trees died during the investigation period between June and September in 2020. The condition of the tree crowns was also visually assessed in the beginning and the end of the study period.

We found that the amplitude of diurnal diameter variation was considerably smaller in the infested trees compared to healthy trees indicating smaller diurnal variation in the water content of the stem. The decrease in diurnal diameter variation was followed by abrupt and irreversible declines in tree diameter likely indicating tissue damage due to hydraulic failure. The declines were triggered largely by increased atmospheric water demand during the hottest days of the investigation period. The condition of the tree crown in the beginning of the study did not reflect the timing of the decline in tree diameter, but one of the most visually vital trees declined first.

The results indicate that hotter summer temperatures will increase and hasten bark beetle-induced tree mortality. This happens because irreversible hydraulic failure seems to occur in a cross pressure of bark beetle-induced stress and increased atmospheric water demand. Trees are likely more vulnerable to bark beetle-related hydraulic failure in the future because of increasing atmospheric water demand and more intense droughts. The triggers and processes that cause bark beetle-related tree mortality need more careful investigation to incorporate them into models that forecast tree mortality.