USING DENDROCHRONOLOGY TO DETECT SPRUCE BUDWORM (*CHORISTONEURA FUMIFERANA*) OUTBREAKS

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Objectives

Insect outbreaks are one of the major disturbances affecting the boreal forest. Defoliation of host species by spruce budworm has a significant influence on forest stand dynamics by reducing tree growth, increasing tree mortality, and changing species composition. Three spruce budworm outbreaks occurred in the 20th century: 1919 to 1929, 1930 to 1950, and 1970 to 1989 (Morin *et al*. 1993).

Our first objective was to analyse the impact of spruce budworm on the radial growth of the host species balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), and black spruce (*Picea mariana*) that survived the last outbreak. Our second objective was to age some dead trees to check if their death was related to the budworm outbreaks and to describe their decomposition state.

Material and methods

The study site is located within the Lake Duparquet Research and Teaching Forest in the area of the southern mixed boreal forest of Quebec. The analyzed stand, initiated after a fire in 1760, was mainly composed of balsam fir, white and black spruce, white birch, and white cedar with a dense understory of *Acer spicatum* and ferns. Some cutting has occurred in the past. Increment cores were taken at 0.3 m stem height for 13 balsam fir, 10 white spruce and 4 black spruce. In addition, discs of 13 dead balsam fir and 3 white spruce were collected. The decomposition state of the snags (8 classes) and the downed debris (4 classes) of fir was visually determined and related to the date of death. The samples were sanded and cut with razor blades followed by tree-ring counting, pointer year detection, tree-ring measuring, and visual crossdating on a light table. Cross-dating was statistically verified using the program COFECHA (Holmes *et al*. 1986). Seven living and seven dead balsam fir, seven living and one dead white spruce, and three living black spruce were successfully cross-dated. Chronologies were built for each tree species by separating between living and dead material using the program ARSTAN (Cook 1985).

Results

The living trees of balsam fir and black spruce were relatively young with less than 50 tree rings at coring height (except one balsam fir with 71 tree-rings). The white spruce samples, however, had more than 100 tree rings. A maximum of 60 tree rings was found on the dead samples, even when the bark was preserved. The living individuals of all three species exhibited an abrupt growth reduction starting in 1981 and lasting between 5 and 7 years, which was caused by the last spruce budworm outbreak. Death of balsam fir and white spruce occurred between 1979 and 2000 and was generally proceeded by severely reduced ring widths. The white spruce chronology, reaching back to 1920, showed that the first budworm outbreak caused an abrupt decrease in growth in the mid-1920's that lasted about 6 years.

The degree of decay of balsam fir increased slowly with the year since death. However, linear regression failed.

Conclusion

Most of the dead trees could be cross-dated in spite of the short tree-ring series, partially because of the characteristic growth patterns caused by the budworm outbreaks.

The last spruce budworm outbreak in the area of Lake Duparquet, lasting from 1970 to 1989, affected the trees at the study site, but only in the 1980s. The trees of all three host species responded to the defoliation by an abrupt decrease of the radial increment and some individuals, particularly firs, even died. White spruce showed the same growth response to the first outbreak in the 1920s. These periods of growth reduction correspond well to those published for the study area. Tree-ring analysis, therefore, can furnish valuable information about temporal and even spatial patterns of insect outbreaks.

A greater number of samples as well as the comparison with growth of a non-host species such as white cedar will be needed to confirm our results and to extract more information about the influence of budworm outbreaks on growth and population dynamics of the host species. Similarly, a higher sampling size would also allow to better describe the decay process of dead balsam firs.

References

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