DendroEnto

photos : N. Bréda

Wood anatomical and isotopes markers for studying the effect of insect defoliation on carbon allocation to growth

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Thematic action concerned: WP2

Context — Besides drought exposure, past and recent forest declines frequently involved the concurrence of biotic threats, including defoliating insects, especially in oak stands. However, information about insect outbreaks and intensity of tree defoliation are more difficult to obtain than meteorological data, especially for retrospective studies. Dendrochronological methods are still widely used to study the tree's response to their environment, and the environment itself. The climate variations imprint inter-annual variations in the width, density, anatomy and isotopes composition of the rings. However, even if pest insects are well known to decrease photosynthetic capacity, to change the carbon allocation pattern and to disturb water relations, only few studies reported the effect of insect outbreaks on $\delta^{13}C$ or on wood anatomy. This project investigates the effect of the oak processionary moth (OPM, *Thaumetopoea processionea*) on pedunculate oak (*Quercus robur*) which, in interaction with climate change, threaten its health and productivity.

Objectives —

The first objective of this project is to depict specific isotopic signal or anatomical features in the tree rings of partially to totally defoliated oak trees that could track the defoliation events. Such markers would allow tracking past defoliations in tree-rings chronologies. Besides providing long-term valuable information for the study of OPM defoliations, these archives would be particularly wanted to disentangle the effect of biotic and abiotic factors in the forest decline etiology.

The second objective is to take advantage of the natural defoliation to progress in the understanding of the pattern of carbon allocation in oak trees, specifically to the radial growth and storage processes.

Several hypotheses will be specifically tested: 1) Are stored carbohydrates, rather than assimilates, used to resume (or maintain) radial growth after or during the defoliation? To answer that question, the high-frequency $\delta^{13}C$ variations will be analyzed in the rings built during and following the outbreaks in search of $\delta^{13}C$ anomalies in the defoliated trees, indicating the use of 13C-enriched starch reserves. 2) Is partial defoliation sufficient to modify the anatomy of the wood? 3) Which functions (carbon storage / water transport / mechanical strength) are affected by these anatomical changes? 4) Can the anatomy of the earlywood be marked from the first defoliation by a direct disturbance of the cambial function or only during a succession of defoliations via carbon starvation?

Approaches —

This incentive project is based on *Q. robur* mature trees growing on alternatively waterlogged and dried soils and submitted to a long series of defoliator outbreaks in the Pays des Etangs forests. Annual monitoring of the intensity of spring and summer defoliations was done on 250 individual trees distributed in 13 forest stands over the 2009-2014 period. In addition, complete radial growth chronologies (up to 2013) and maximum non-structural carbohydrates (NSC) storage (measured annually from 2009 to 2013, except in 2011) are available for each tree.

Five trees severely impacted by the repeated defoliations and five trees only mildly impacted have been selected (based on past monitoring data) and cored at the end of the past vegetation season (fall 2022). The high-frequency sampling within the 2008-2014 rings is currently underway and the corresponding $\delta^{13}C$ measurements are scheduled for March 2023. The tests for the quantitative anatomy analysis are being finalized and the observations should start soon. Both anatomical traits and high-frequency $\delta^{13}C$ profiles are measured at the SILVA-Tech platform.

Two master students (Océane Oliva, UCB, 13/03-30/04/23 ; Jean-Baptiste Sarraute, Univ. Montpellier, 04/04-18/08/23) have been hired and will be engaged in the isotopic and anatomical analyses, respectively.