Exploring the Growth-Differentiation Balance Hypothesis (GDBH) in trees. Evidence from Dutch elm disease.

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Trees are long-lived organisms suffering attacks from many pathogens during their lifetime. Disease results from timely combination of a susceptible state of the tree, the presence of a virulent pathogen and favourable environment over a sufficient time period. Under adaptive equilibrium, it is environmental changes favouring the pathogen that lead to disease. Conversely, when an alien pathogen is introduced, disease may occur under optimal conditions for the tree. This is the case with European and American elms, which are devastated by a virulent and invasive fungus, which causes Dutch elm Disease (DED). Nevertheless the trees show a strong and surprising seasonal variation in susceptibility against DED, demonstrating an inherent ability to resist infection. The period in which elms can become diseased is generally restricted to a few weeks in spring. DED occurs because during this time the vector beetles emerge and inoculate the pathogen. The reason for this window of susceptibility is not well understood, but sporadic studies indicate a link to tree growth rate and morphogenesis.

To investigate how these relationships may determine the expression of a susceptibility response, an in-depth study of the time course of primary and secondary growth including meristem reactivation, leaf area and wood development, was run in combination to assessment of susceptibility through repeated artificial inoculations from late winter to summer in a reference elm clone.

The study revealed that three growth patterns, predetermined, free and by successive flows, coexist in the elm. Each of the growth types had a specific temporal and spatial distribution in the architecture of the plant, which corresponded to different wood anatomy patterns and responses to DED inoculation. Maximum susceptibility coincided with an initial growth phase, during which expanding leaves were net carbon sinks, and spring wood was formed. The first reduction in susceptibility occurred with transition to a later growth phase when intense photosynthesis was ensured by an increasing number of mature leaves as energy sources. The results are in agreement with the GDBH, which predicts that any slowdown in growth rate that does not reduce the rate of photosynthesis can increase the resources available for defence.