MODEL OF TRACHEID DEVELOPMENT EXPLAINS CONIFER TREE-RING STRUCTURE

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In general, conifer tree rings are composed by light earlywood with large thin-walled cells followed by dense latewood with small thick-walled cells. Yet, how wood formation processes (cell enlargement and cell-wall deposition) and associated kinetics create this universal pattern remains poorly understood. Here, we quantify the duration and rate of xylogenesis by weekly monitoring tree-ring formation over 3 years (2007–2009) in 45 trees of three conifer species (*Abies alba* Mill., *Picea abies* (L.) Karst., *Pinus sylvestris* L.) in France. These data were used to investigate xylogenesis kinetics, and to attribute the relative importance of rate and duration of cell enlargement and wall deposition on tree-ring structure. Cell enlargement duration contributed to 75% of changes in cell diameter along the tree-rings, while the rate and duration of cell-wall deposition contributed equally to changes in cell wall material. Remarkably, the amount of wall material per cell was constant along most of the rings. Consequently, in contrast to conventional wisdom, changes in cell-wall thickness were not principally attributed to the kinetics of wall deposition (33%), but rather to the changes in cell size (67%). The duration of enlargement, as the main driver of cell size and wall thickness, contributed to 56% of wood density variation along the rings. This study unravels how kinetics of tracheid development shapes conifer tree-ring structure. This mechanistic framework now forms the basis for unravelling how environmental stresses trigger deviations (e.g. false rings) from the universal tree-ring structure.