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Dendrometer records are strongly influenced by hygroscopicity of the bark, which impairs assessment of tree water status and radial stem growth

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Time series of stem diameter variations (SDVs) recorded by dendrometers are composed of two components: (i) irreversible radial stem growth and (ii) reversible stem shrinking and swelling caused by dynamics in water storage in elastic tissues outside the cambium. The reversible component is regarded to be the result of changing water potential gradients within the stem and a measure of water translocation from elastic tissues outside the cambium (phloem) to the xylem and vice versa. However, SDVs measured over bark, which comprises dead outer bark (periderm) and living cells of the inner bark (functional and non-functional phloem) could also be affected by absorption and evaporation of water from dead bark tissue. Therefore, the focus of this study was to determine the influence of hygroscopic shrinkage and swelling of dead bark (thickness c. 2 mm) on the reversible component of dendrometer traces of Scots pine (Pinus sylvestris) saplings for three years under field conditions. To accomplish this, temperature compensated diameter dendrometers were mounted over dead bark on six trees (height <1.5 m; stem diameter ca. 2.5 cm) and tree death by 'root burn' was induced in a subset of trees (n = 3) by deploying granular fertilizer in early spring. Tree mortality considered as 100 % needle browning occurred until end of May. Although dehydration caused gradual shrinkage of the stem diameter in dying saplings, dead trees still showed high synchronicity in reversible daily SDVs compared to living trees ($r = 0.906$; $P<0.0001$; $n = 1005$). Furthermore, daily SDVs in dead Scots pine saplings were significantly related to relative air humidity ($r = 0.505$; $P<0.001$) and vapour pressure deficit ($r = 0.464$; $P<0.001$). Hence, results indicate that dendrometers mounted over dead outer bark predominantly record hygroscopic shrinking and swelling of the bark tissue rather than radial water exchange between water storage components outside the cambium and the xylem. Therefore, SDVs measured over dead outer bark are not accurately reflecting fluctuations in whole-tree water status and might mistakenly indicate radial stem growth during periods of increasing air humidity.
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