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Seasonal trends in phloem traitsin Pinus spp. from drought-prone environments

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Previous studies of phloem structure in trees growing in temperate environments have shown that annual periodicity of cambial production is detectable in phloem traits. In species like Fagus sylvatica, Picea abies and Pinus sylvestris from the temperate sites, it is possible to clearly identify the last formed phloem increments, phloem ring boundaries and to distinguish between early- and late- phloem (Gričar et al. 2016). Such increments cannot be defined in Mediterranean conifers like Pinus halepensis from southern Spain; this can be, among others, ascribed to lack of cambial dormancy in winter (Prislan et al. 2016).
The aim of the present study was to monitor cambial activity of mature trees of stone pine (Pinus pinea) and Aleppo pine (Pinus halepensis) with specific focus on phloem formation. Samples of the cambial zone were taken at bi-weekly intervals from both species growing at drought prone Mediterranean sites in southern Italy and southern Spain. The cross-sections were observed under a light microscope to follow phloem formation throughout the year. Furthermore, we applied digital image analysis techniques to quantify the variation of anatomical and cytological traits of recently formed phloem.
The results showed that annual phloem increments and the boundaries between them could not be clearly defined. Nevertheless, it was possible to differentiate between the non-collapsed and the collapsed phloem. Radial dimensions of sieve cells along the radial files did not clearly reflect characteristics of early and late phloem. The size of newly formed cells fluctuated possibly due to variations in cambial production throughout the year which slowed down during the drought period and the colder period and increased during the wet-warm months of the year. Axial parenchyma was not arranged in tangential bands as typical for some temperate species but the frequency of axial parenchyma seemed to vary during the year depending on climatic conditions.
The observed phloem structure might be ascribed to the ability of cambium to produce new phloem cells throughout the entire year with lack of cambial dormancy in winter. Furthermore, at the same time when the cambium produces new sieve cells the older sieve cells collapse (Prislan et al. 2018) and the balance between the two processes seemingly helps the tree to maintain relatively constant width of the non-collapsed phloem.
In this context, the variation of the radial dimensions of the sieve cells along the radial rows seems to be helpful information to follow the dynamics of phloem formation in Mediterranean trees. Further studies, together with xylogenesis monitoring, would be useful to help linking anatomical signals in phloem with climate parameters and resource availability.