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PERSONAL NOTE

What is 'wood' – An anatomical re-definition

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ABSTRACT

The technical definition of 'wood' is well accepted, but its botanical understanding remains vague. Different degrees and amounts of lignification in plants and their imprecise description, together with a conceptually doubtful life form catalog including trees, shrubs and herbs further complicate our understanding of 'wood'. Here, we use permanent micro sections to demonstrate that the xylem and bark of terrestrial plants can vary from one tissue with a few lignified cells to an almost fully lignified tissue. This universal principle of plant growth and stabilization, accounting for all taxonomic units within vascular plants, suggests that the classical life form separation into herbs, shrubs and trees is not valid. An anatomical-based differentiation between 'wood', 'woody' and 'woodiness' is also only meaningful if supplemented by insight on the particular plant section and its lignified proportion. We therefore recommend utilizing the botanically more neutral term 'stem anatomy' instead of 'wood anatomy', which further implies integration of the xylem and bark of all terrestrial plants. Since dendrochronology considers shrubs, dwarf shrubs and perennial herbs in addition to trees, its semantic expansion toward 'xylemchronology' might be worthwhile considering.

Introduction

'Wood' has been well defined as a raw material for many years (Trendelenburg and Mayer-Wegelin, 1955), and also recognized as an energetic resource with many technical and artistic applications (Vorreiter, 1949). The technical meaning of 'wood' is scientifically well established (Sell, 1987), and also accepted by foresters and carpenters, as well as a broader public. 'Wood science', including dendrochronology and wood anatomy, generally focuses on trees and the assessment of 'wood'. The plant anatomical definition of 'wood', however, remains diffuse, because 'wood' is related to a complex interplay of ontogenetic processes of primary and secondary meristems (Evert, 2006; Dulin and Kirchoff, 2010), cell formation and chemical composition, as well as phylogenetic origin (Schweingruber et al., 2012). Precise categories of lignified, non-lignified and partly lignified plants and their conceptual classification into trees, shrubs and herbs also remain debatable (see also references herein). Explicit descriptions and boundaries of the theoretically separated dendrochronological and wood anatomical communities are still limited, and their associated disciplinary foci are expected to further diminish in academia.

At the same time are distinct terminologies key requirements for any unequivocal communication, within and between all kinds of communities. Terms and definitions within the broad field of 'wood science', however, often can have varying meanings. 'Wood', 'woody' and 'woodiness' are frequently used but rarely explained (Dulin and Kirchoff, 2010). In fact, 'wood' is often equally used as 'xylem' of plants with secondary radial thickening (Carlquist, 2001). The term 'wood' was traditionally also employed if most cell walls per unit were lignified. Nevertheless, this rather simplistic assumption contradicts anatomical evidence of differently lignified intensities and patterns that can range from the cell to the plant. 'Woody' and 'woodiness' may therefore describe various transitional forms of lignified parts within a plant, such as those cell walls that are impregnated with lignin (Evert, 2006). Additional complexity originates from diverse lignified proportions within one individual specimen (Lens et al., 2012). Different degrees of plant-internal lignification, together with continuous and/or abrupt transitions of lignified cell walls are semantically not yet deliberated in a sufficient way. A straightforward scientific depiction is missing.

Recent endeavors at the (traditional) interface of dendrochronology and wood anatomy analyze annual growth increments of arctic shrubs (Myers-Smith et al., 2011), alpine herbs (Schweingruber et al., 2006) and temperate meadows (Mitlacher et al., 2002), for instance. These pioneering examples underline the importance of microscopic investigations at the level of cellular

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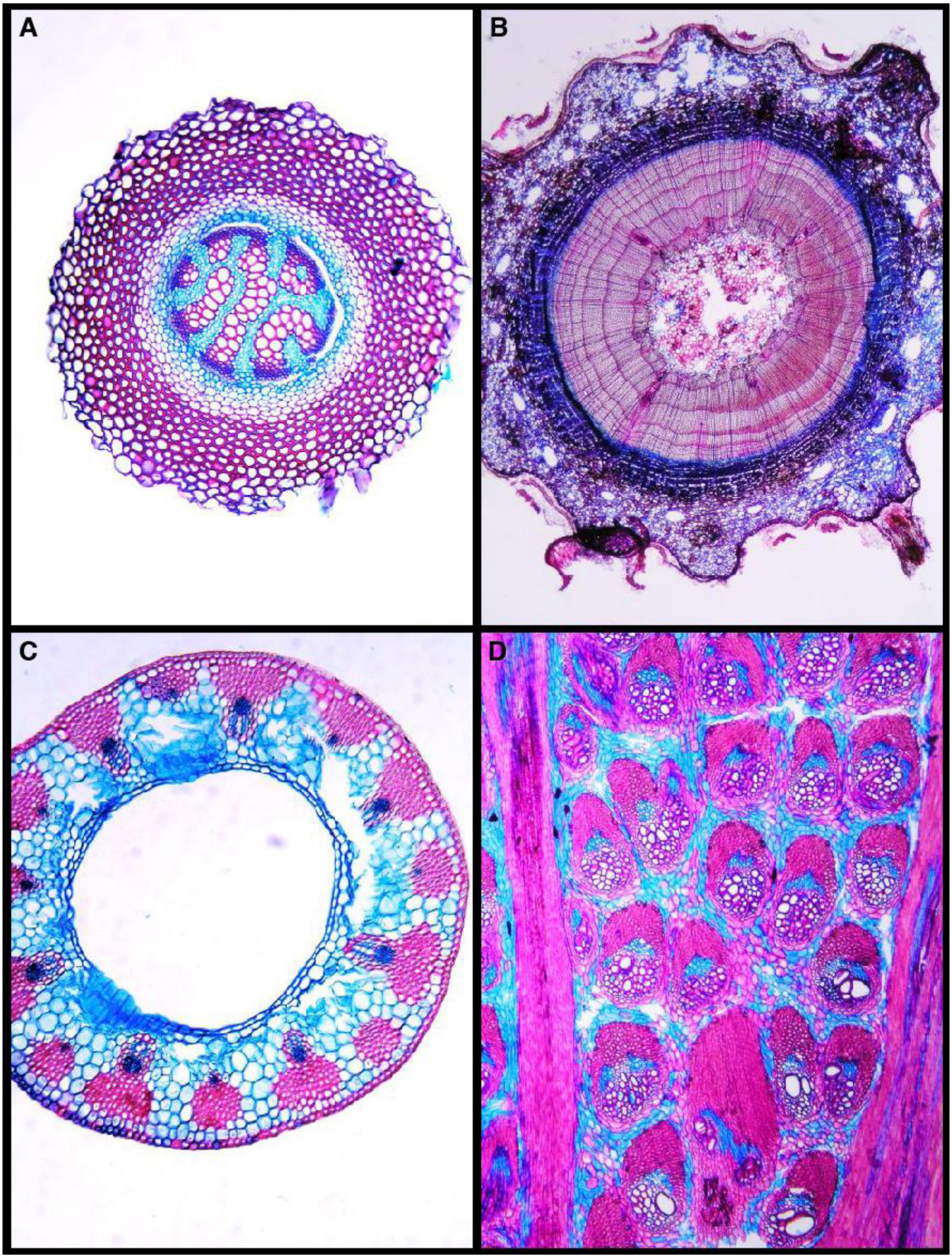

Fig. 1. Microscopically magnified thin sections of lycopods, conifers and monocots that visualize various plant-specific lignification degrees (red). (A) Perennial herb, 40 cm in length, lycopodiaceae without cambium, *Lycopodium alpinum*, shoot. A thick-walled and intensively lignified cortex surrounds a non-lignified parenchymatic tissue and irregularly formed vascular bundles consisting of lignified tracheids. 40×. (B) Tree, conifer with cambium, *Picea abies*, twig. A large cortex and a small phloem surround the intensively lignified xylem with distinct annual rings (20×). (C) Herb, grass, 10 cm in height, monocotyledonae without cambium. *Trisetum distichophyllum*, culm. Vascular bundles with thin surrounding sheaths and triangular peripheral thick-walled groups of fibers (40×). (D) Tree, palm, 15 m in height, monocotyledonae without cambium. *Phoenix dactylifera*, stem. Vascular bundles with lignified vessels and thick-walled unilateral sheaths of fibers between two lignified radial leaf traces (40×).