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Preface

FUNCTIONAL TRAITS IN WOOD ANATOMY

Pieter Baas, Hans Beeckman, Katarina Čufar & Veronica De Micco (editors)

Functional traits have been attributed to wood from the earliest days of botanical science. Theophrastus (372–287 BC) already opined on the diversity of mechanical strength and growth rate in conifers and broadleaved trees. The four great earliest microscopists of wood in the 17th century, Hooke, Grew, Malpighi and Leeuwenhoek were also strongly pre-occupied with the presumed functions of what they saw (Baas 1982). However, comparative functional and ecological wood anatomy did not take wings until the second half of the twentieth century with the publication of "*Ecological Strategies in Xylem Evolution*" by Sherwin Carlquist (1975) and many studies on wood anatomical variation in clades and regional floras along mesic-xeric and/or hot tropical to arctic or alpine gradients (*e.g.* Baas 1976; Carlquist & Hoekman 1985; Wheeler *et al*. 2007 and many others). Simultaneously, pioneers like Martin Zimmermann tackled the recalcitrant and intricate problems of whole tree physiology experimentally, with major breakthroughs in the understanding of structure-function relationships in xylem transcending the hypothetical and speculative interpretations of comparative plant anatomists (Zimmermann 1983). Meanwhile the combined and detailed study of wood structure and function, especially in tree hydraulics, has evolved as one of the most exciting fields in plant biology and evolution and forest ecology (*e.g.* Hacke 2015). At the same time the approach of forest ecosystems as specific assemblages of functional traits is gaining coinage in modern ecology and global change biology, and it is important to inform the relevant research communities of the rich treasure of functional traits that is wood (Beeckman 2016).

The EU Cost-Action FP1106, STReESS (Studying Tree Responses to extreme Events: a SynthesiS) has created an active multidisciplinary network between 2011 and 2016 for the study of trees and whole forest ecosystems under extreme droughts or other unusual stresses. Throughout its existence this network has strengthened synergies between dendrochronology, wood anatomy and ecophysiology, focusing on structure-function relationships as a key to understand the trees' responses to past, present and future changes in the physical and biotic environment. Within the STReESS Action, a Topic Group was dedicated to Wood Anatomical Functional Traits: its two chair persons, Hans Beeckman and Katarina Čufar, coordinated lively discussions on the categorization of wood-anatomical variables that potentially contain information on stress responses in trees and could support the working groups on database construction and modelling. The Topic Group was – *inter alia* – inspired to use the IAWA Hardwood and Softwood Lists for microscopic wood identification (IAWA Committee 1989, 2004) as a checklist of diagnostic features that could be considered when reviewing potential functional traits in wood anatomy. Throughout we were very much aware

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that the IAWA Lists, with arbitrary delimitations of qualitative character states and semi-quantitative size or frequency classes, had been designed for practical wood identification aims, and not for functional interpretation. Yet they appear to be very useful checklists for functional traits relevant for hydraulic efficiency and safety, biomechanical properties of stem and branchwood, and for the vital functions of sapwood and heartwood in storage and biological defence. At the same time this approach also showed that certain structural features such as definition and typology of growth ring boundaries and ring- or diffuse-porosity, as well as intra-annual density fluctuations, vessel occlusions, inter-conduit pit (ultra)structure, and occurrence, type and severity of reaction wood are not well enough treated in the IAWA Lists to be of direct use in a discussion on functional traits. Especially some of these "missing traits", particularly those associated with tree rings and cambial dynamics in response to environmental stressors that highlight the important time dimension are emphasized in this special IAWA Journal issue on "*Functional Traits in Wood Anatomy*" (Bräuning *et al*. 2016; De Micco *et al*. 2016a & b; García-González *et al*. 2016; Giagli *et al*. 2016; Gričar *et al*.; Kitin & Funada 2016; Lazzarin *et al*.; Li *et al*.; Novak *et al*. 2016; Tarelkin *et al*. 2016). Indeed, the very close collaboration between the Topic Group on Wood Anatomical Functional Traits and other groups of the STReESS Action highlighted how the application of an "upscaling approach", both in temporal and spatial terms, in the study of wood from cambial cell activity up to long tree-ring series is needed to interpret tree responses to a changing climate. Understanding how functional traits arise in wood during its formation, and linking them to environmental changes, is the key to interpret past wood reactions and forecast future growth responses. For the more obvious functional traits like conduit diameter and frequency in hydraulic architecture, reaction wood, and parenchyma types and abundance, the reader can find a rich literature cited in for instance Gardiner *et al*. (2014), Hacke (2015), and Morris & Jansen (2016).

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